Brentwood Borough Council

Water Cycle Study

8 November 2018

Amec Foster Wheeler Environment
& Infrastructure UK Limited

Report for

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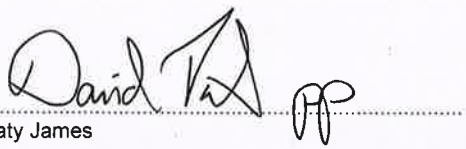

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Document revisions

No.	Details	Date
1	Draft Report issued for Client Comment	December 2017
2	Water Cycle Study Version 2	March 2018
3	Updated report	November 2018

Executive Summary

The purpose of this Water Cycle Study is two-fold: to undertake a Water Quality Assessment and a Water Resources Assessment.

The Water Resources assessment was undertaken to assess pressures on water resource availability by reviewing water companies' water resource management plans and the implications on these of future growth. The assessments considered the following:

- There are two companies that supply water in the Brentwood Borough Council remit zone – Affinity Water and Essex and Suffolk Water.
- Affinity Water's WRZ5 encompasses the north western quarter of the Brentwood Borough Council area. Essex and Suffolk Water's WRZ covers the remaining area.
- Affinity Water WRZ5 is currently in deficit (WRMP14). The resource situation in this area is constrained by environmental water availability, and with growth forecast, if there were no interventions security of supply would be at risk. In addition, the strategy outlined by Affinity Water in their WRMP to reduce the supply demand deficit for WRZ5 includes a range of metering, water efficiency and leakage reduction measures, as well as the amendment to four source supplies. The Affinity Water forecast WRMP14 takes into account that over 33,020 new properties will be built in WRZ5 by the end of the planning period in 2040. The number of proposed homes in the Brentwood Borough Council area encompassed within WRZ5 is 133 (Kelveden Hatch, Hooks End/ Tipps Cross and Blackmore).
- The Essex and Suffolk WRZ baseline supply demand balance as presented in the WRMP14 states that the Essex WRZ had a supply deficit. The strategy outlined by Essex and Suffolk Water concluded that the Abberton Scheme would ensure no supply deficit over the planning scenario. The Abberton Scheme has now been completed in the dWRMP19 and the supply surplus remains. The number of new properties proposed by Brentwood Borough Council in the Essex WRZ is up to 6,453 by 2033. The dWRMP19 calculations have allowed for 7,240.

The review of Affinity Water and Essex and Suffolk Water's WRMPs provided in this high level review of water resources suggests that both companies have the potential to provide enough capacity within each of the water resources zones to accommodate additional development, however further confirmation from the individual water companies will be required to assess what developments are occurring outside of the Brentwood area, and to ensure that the individual developments proposed have been fully incorporated into each WRMP, and water can be supplied by each of the water companies operating in the area.

The Water Quality Assessment (WQA) was prepared for Brentwood Borough Council in order to assess whether housing growth would have significant impacts on the water environment, and specifically to produce a defendable, clear and concise evidence base that will help with the production of the Local Plans which will comply with the National Planning Policy Framework and also the Water Framework Directive (2000/60/EC). The purpose of this WQA was to understand the environmental impact of proposed future housing growth on the water bodies which receive discharges of treated sewage effluent from Wastewater Treatment Works (WwTWs) associated with the growth areas. Any impacts were to be investigated in line with the Water Framework Directive (WFD) objectives.

A number of objectives were set for the WQA, which are:

- To identify the impacts on water quality in receiving water bodies from future housing growth downstream of the WwTWs related to the housing growth areas (i.e. from increases in discharges of treated sewage effluent from 2016 onwards);
- Clarify if future housing growth will impact on the WFD objectives to:
  - Ensure no deterioration in WFD class of any element;
  - Ensure the WFD water bodies can achieve the 2027 objectives as set out in the 2015 RBMPs; and

    - Limit in class deterioration to less than 10% (an aspirational objective set by the Environment Agency).
- Model the future discharge permit standards from the WwTWs to reverse potential deterioration in downstream river quality if applicable; and
- Identify if there are any cumulative impacts from increases in discharges from WwTWs within the same catchment.

Results

The WQA has indicated that future housing growth is not predicted to cause significant deterioration in water quality for the Shenfield & Hutton, Ingatestone and Brentwood WwTWs. However, the housing development plan predictions indicate potential for deterioration in water quality with respect to WFD class for ammonia at the Doddinghurst and Upminster WwTWs. Under the current conditions the 90th percentile ammonia concentrations are very close to the class boundary, such that additional loading could cause a class change.

Preventing the modelled WFD class deterioration could be achieved through improvement in discharge quality, namely a reduction in ammonia loading, and therefore, permit levels may need to be revised for ammonia at Doddinghurst and Upminster WwTWs.

Assessment of DWFs indicate that Shenfield & Hutton WwTW will remain within their DWF permit levels, but that the other four WwTWs could need to consider capacity upgrades, diversion of flows and/or water reduction measures to provide additional treatment capacity/headroom.

It has been identified that there may need to be some consideration to sewerage network upgrade evidenced by modelled flooding of Ingatestone High Street during a 1 in 100 year annual event due to capacity of sewer network in the area.

Action Plan

WwTW	Water Body ID and Water Body Name	Operational Catchment	Now	By 2020	By 2025	By 2030	By 2033
Doddinghurst	GB105037028720 - Doddinghurst Brook	Chelmer		Update permit levels for ammonia	WwTW capacity upgrade*		
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Chelmer					
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Chelmer	WwTW capacity upgrade *				
Upminster	GB106037028080 - Mardyke (West Tributary)	Mardyke		Update permit levels for ammonia	WwTW capacity upgrade *		
Brentwood	GB106037028130 - Ingrebourne	Roding Beam and Ingrebourne	WwTW capacity upgrade *				

*e.g. Divert flows to nearby WwTW or undertake a combination of review of consent limits and water reduction measures

Contents

1. Introduction

This introductory section of the report provides an overview of drivers for the Brentwood Borough Council Water Cycle Study.

1.1 Purpose of the Water Cycle Study

1.1.1 Housing growth is critical for both social and economic benefits to meet the growing needs of the United Kingdom but must comply with the needs of National Planning Policy Framework and Planning Practice Guidelines (primarily the Climate Change and Natural Environment guidance) and be robust enough to stand up against public examination.

1.1.2 The Brentwood Borough Council area (the Council) is located to the south west of the Essex County Council area in the South East of England. The Local Plan for the Brentwood Borough Council is currently in draft format, with the Strategic Assessment (ref 39645D022) options, dated July 2017, identifying areas for sustainable growth to help meet their needs across the main towns and villages, up to 2033. The housing strategy for the Council identifies planned growth of up to 9855 new homes (including existing completions and permissions) up to the year 2035. The housing strategy also includes the potential for additional new homes to be built, up to 20% in excess of the planned growth.

1.1.3 This Water Cycle Study (WCS) was undertaken to assess whether growth would have a significant impact on the water environment. Specifically, it will produce a defendable, clear and concise evidence base that will help with the production of Local Plans that comply with the National Planning Policy Framework and also the Water Framework Directive (2000/60/EC). The purpose of this WCS was to understand the environmental impact of proposed future housing growth on the watercourses which received discharges of treated sewage effluent from Wastewater Treatment Works (WwTWs) associated with the growth areas and to clarify if there will be any further pressures on water resources in the area from increases in demand.

1.1.4 Impacts on water quality were investigated in line with the Water Framework Directive objectives (WFD). The WFD is a key directive that seeks to protect and improve the water environment and its ecology. Its overarching aim is to prevent deterioration in the status of water bodies and to achieve 'Good Status' for rivers, lakes, coastal waters and groundwater by no later than 2027. This includes:

- Protecting all forms of water (inland, surface, transitional, coastal and ground);
- Restoring the ecosystems in and around these bodies of water; and
- Reducing pollution in water bodies.

1.1.5 Impacts on water resources were reviewed in line with the water companies Water Resource Management Plans.

1.2 Aims and objectives

1.2.1 A number of objectives were set for the WCS, which are:

- To identify the impacts on water quality in receiving watercourses from future housing growth downstream of the WwTWs related to the housing growth areas (i.e. from increases in discharges of treated sewage effluent from 2015 onwards);
- Clarify if future housing growth will impact on the WFD objectives to:
  - Ensure No Deterioration in WFD class of any element;
  - Ensure the WFD water bodies can achieve the 2027 objectives as set out in the 2015 RBMPs;

- Limit in class deterioration to less than 10% (an aspirational objective set by the Environment Agency);

- Model the potential future discharge permit standards from the WwTWs, to reverse potential deterioration in downstream river quality;
- Identify if there are any cumulative impacts from increases in discharges from WwTWs within the same catchment; and
- Assess pressures on water resource availability.

1.2.2 This report is structured as follows:

- Section 2: Planned Growth. A presentation of the planned growth statistics provided by the Council in June 2017 (ref 39645D022)
- Section 3: Assessment Methodologies. A summary of the data, methods and results for the Water Quality, Flood Risk and Water Resource assessments for the growth areas.
- Section 4: Water Resource and Supply infrastructure Assessment. The results of the reviews of the water company's water resource management plans and the implications for future growth.
- Section 5: Waste Water Treatment, Water Quality and Sewerage Assessment. An overview of the water quality assessments for growth areas including the implications for WFD compliance.
- Section 6: Strategy Recommendations.

2. Planned Growth

This section report provides an overview of Planned Growth within the Brentwood Borough Council area.

2.1 Planned growth

2.1.1 The Brentwood Borough Council area is located in Essex, in South England. Development is planned at 53 locations which are shown in Figure 2.1. Included within these sites are four Strategic Growth Areas which are:

- Brentwood North (mixed use);
- West Horndon (west) (mixed use);
- West Horndon (east) (mixed use); and
- Dunton Hills Garden Village (employment site).

2.1.2 The growth area falls across three management catchments including

- The Roding, Beam and Ingrebourne;
- The Essex Combined; and
- The Essex South Management Catchments.

2.1.3 These catchments lie within two River Basin Districts (RBDs), which are the Thames and Anglian RBDs.

2.1.4 The settlements were initially grouped together in various combinations in six prospective growth options which could either be categorised as 'Existing Settlement Extension Driven' and 'New Settlement Driven'. A final growth plan option ("Option 7") was supplied to Wood on 16 October 2018. This option includes the Dunton Hills Village, which is a new settlement driven option. The Water Cycle Assessment was completed for Option 7 only.

2.1.5 Based on the sites identified by the Council five major wastewater treatment works (WwTWs) were identified that serve the areas. Details on the growth areas, housing numbers and associated WwTWs are included in Table 2.1.

Table 2.1 Housing allocation sites with associated number of dwellings and WwTW

WwTW	Housing Allocation Site	Option 7 Dwellings (Net)	Sub-total
Doddinghurst WwTW	Land South of Redrose Lane	30	
	Chestnut Field, Blackmore Road	5	
	Land adj Tipps Cross Community Hall, Blackmore Road	5	
	Land South of Redrose Lane	40	
	Swedish Field, Stock Lane	0	
	Brizes Corner Field, Blackmore Road, Kelvedon Hatch	23	
	Land off Stocks Lane, Kelvedon Hatch	30	133
Shenfield & Hutton WwTW	Eagle and Child Pub, Shenfield	20	
	Land at Crescent Drive, Shenfield	55	
	Sow and Grow, Ongar Road, Pilgrims Hatch	38	
	Land at Priests Lane	95	
	Land off Doddinghurst Road*	100	
	Land east of Chelmsford Rd, Shenfield	215	
	Land north of A1023 Chelmsford Road, Shenfield	100	
	Officer's Meadow	510	1133

WwTW	Housing Allocation Site	Option 7 Dwellings (Net)	Sub-total
Ingatestone WwtW	Ingatestone Garden Centre	120	
	Land adjacent to Ingatestone By-pass	57	
	Former A12 Work Site	41	218
Upminster WwTW	Council Depot, Warley	123	
	Ford Headquarters, Warley	350	
	West Horndon Industrial Estate	580**	
	Dunton Hills Garden Village (plan period)	2500	3553
Brentwood WwTW	Land at Hunter House, Western Road	48	
	Chatham Way / Crown Street Car Park	31	
	Westbury Road Car Park	45	
	Wates Way Industrial Estate	80	
	Brentwood railway station car park	100	
	William Hunter Way	300	
	Land adj to Carmel, Mascalls Ln	9	
	Land west of Warley Hill	43	
	Land East of Nags Head Lane, Brentwood	125	
	Land at Honeypot Lane	200	
	Land off Doddinghurst Road*	100	1081
Housing Givens	Housing completions (up to 31st March 2017)	497	
	Housing permissions (up to 31 March 2017)	807	
	Housing windfall sites (2020 – 2033) ***	468	
	Forward forecast of housing completions and permissions (1 April 2017 – 31 March 2018)	300	2072
		TOTAL	**8190**

* Indicates the housing allocation site was split evenly across two WwTWs
** West Horndon Industrial Estate dwellings were partially serviced by Shenfield WwTW. New development was assumed to be solely in Upminster WwTW catchment.
*** The term 'windfall sites' is used to refer to those sites which become available for development unexpectedly and are therefore not included as allocated land in a planning authority's development plan.

2.1.6 For each growth area the housing numbers and therefore results, were produced based on 5-yearly water company planning cycles in order to bring the water quality assessments in line with water company planning and funding to assist with identifying when any improvement actions may be required. Any growth beyond 2033 would need to be included in further studies and falls outside the scope of this assessment. The results were also assessed against the six year cycles of the WFD. Although the WFD currently only states objectives for getting to Good Status by 2027, the six year planning cycle continues beyond that in order to ensure no deterioration.

Water Supply

2.1.7 This housing and employment growth would impact on two Water Resource Zones (WRZ's) across two water companies namely the Essex WRZ (Essex and Suffolk Water) and "WRZ 5" (Affinity Water).

Key

- Development Areas*
- Brentwood Borough Council Boundary
- Water Resource Zone Boundary

*as per shapefile 34fbaf4d-2540-4e1d-a597-85161932356e.shp received from Brentwood Borough Council

0 1 2 3 4 km

Scale at A3: 1:70,000

Brentwood Borough Council Water Cycle Study

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Figure 2.1
Proposed Development Areas and Water Supply Boundaries

November 2018 Figure_2-1.mxd jamek

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3. Assessment methodologies

This section of the report provides a summary of the data and methodologies for the Water Quality and Water Resource assessments for the Brentwood area.

3.1 Water Resources Assessment

3.1.1 The baseline information collated for the water resources in this study included a review and critical evaluation of the Water Resource Management Plans produced by the two companies that supply water to houses in the Brentwood Borough Council area (Affinity Water and Essex and Suffolk Water).

The Brentwood Borough Council sits across two Water Resource Zones (WRZ); Affinity Water's WRZ5 and Essex and Suffolk Water's Essex WRZ. The Environment Agency defines a water resource zone as 'the largest possible zone in which all resources, including external transfers, can be shared and, hence, the zone in which all customers will experience the same risk of supply failure from a resource shortfall'.

3.1.2 Affinity Water and Essex and Suffolk Water have both published their current 2014 Water Resource Management Plans (WRMP14), as mandated within the Water Act 2003 and both plans are available online. The plans forecast supply and demand across a 25 year planning horizon, taking into account:

- Forecast changes in population and consumption behaviour;
- The impact of climate change on demand and water resource availability; and
- The impact of environmental constraints on the volume of water that each water company is permitted to abstract from its network of surface and groundwater sources.

3.1.3 At their core, the plans set out the various options that are available to close any forecast supply deficits and details the company's preferred solutions with cost-benefit justification, the outcomes of which are presented in this report.

3.1.4 Affinity Water's most recently published water resources plan is available online at https://stakeholder.affinitywater.co.uk/water-resources.aspx. The plan details the substantial investment programme required in Affinity Water's Central Zone, in which the WRZ5 lies. WRZ5 covers the north-western areas of Brentwood Borough Councils remit zone, as seen in Figure 2.1.

3.1.5 Essex and Suffolk Water's most recently published water resources management plan is available online at https://www.eswater.co.uk/your-home/current-WRMP.aspx. The Essex WRZ covers the east, south and western areas of Brentwood Borough Councils remit zone, as seen in Figure 2.1.

3.1.6 The baseline information from the Water Resources Management Plans provided by both companies was compared against the planned growth scenario outlined in Section 2.

3.1.7 It should be noted that draft 2019 Water Resource Management Plans (dWRMP19) have now been published and the full 2019 WRMP will be available imminently, and plans may need to be reviewed in due course.

3.2 Water Quality Assessment

Data collation

3.2.1 For the water quality assessment, a number of data sets were required from the Environment Agency (EA), water companies or the Council (Table 3.1). This included information on the growth being considered, estimates of river flow, river quality and also data on effluent flow and quality. For the river and effluent quality, the main focus was on phosphate, ammonia and biological oxygen demand (BOD, a key influence on dissolved oxygen in rivers).

3.2.2 Water quality models for the Thames and Anglian River Basin Districts were also obtained from the Environment Agency (EA). These models use SIMCAT and RQP modelling software, which is explained in more detail in Section 3.2.14.

3.2.3 All data sets were reviewed to ensure that information was complete and suitable, before being converted to a format for use in the water quality assessments. Where sample data was not available, existing data from the EA's water quality models was used.

Table 3.1 Data collated and its purpose for the water quality assessments

Data	Description and purpose	Source
WwTW effluent quality data (2013-2015)	Current WwTW quality (BOD, ammonia and phosphate) discharged to receiving waters. For input to the Simcat and RQP modelling tools.	Environment Agency
WwTW flow data (2013-2015)	Current WwTW flows discharged to receiving waters. For input to the Simcat and RQP modelling tools.	Environment Agency
River quality data (2013-2015)	Current river quality (BOD, ammonia and phosphate) in receiving waters upstream and downstream of WwTWs (where available). For input to the Simcat and RQP modelling tools.	Environment Agency
River flow data (2010-2015)	Current river flow in receiving waters upstream and downstream of WwTWs (where available). For input to the Simcat and RQP modelling tools.	Environment Agency
Simcat models (Anglian RBD and Thames RBD models)	Water quality model for the Thames and Anglian Catchments, used to undertake the assessments	Environment Agency
Growth areas and annual housing numbers	Proposed future dwelling numbers in each growth area. For input to the Simcat and RQP modelling tools to understand potential discharge increase at WwTWs	Brentwood Borough Council
WFD classifications	Current water quality classifications under the WFD and future objectives for potentially impacted water bodies	Environment Agency's Online Catchment Data Explorer
Pollution Incidents	Records of pollution incidents and their severity were used to conduct high level review of potential pressures on sewerage network capacity	Environment Agency

Baseline data

3.2.4 This section provides a high level summary of the current conditions of the watercourses associated with the growth areas and their WwTWs. The baseline was set at three levels, Catchment, Waterbody and Site. This was done in order to help not only identify impacts at a Site and waterbody level for the WFD, but also to assess any potential for cumulative impacts at the catchment level, where required.

3.2.5 As part of the WFD, catchments have been broken down into smaller units, known as water bodies. These are made up of reaches or entire lengths of designated watercourses. The five WwTWs affected by future growth are located in five water bodies within the three operational catchments. Of these, the EA have reported that all five of the water bodies are at less than Good Ecological Status (Table 3.2). The main elements found to be at less than Good were fish, invertebrates, macrophytes and phytobenthos combined, BOD, phosphate and ammonia.

Table 3.2 Current WFD status at Operational Catchment level

WwTW	Water Body ID and Water Body Name	Operational Catchment	Overall Status 2016 Cycle 2
Doddinghurst	GB105037028720 - Doddinghurst Brook	Chelmer	Poor
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Chelmer	Poor
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Chelmer	Moderate
Upminster	GB106037028080 - Mardyke (West Tributary)	Mardyke	Moderate
Brentwood	GB106037028130 - Ingrebourne	Roding Beam and Ingrebourne	Moderate

3.2.6 The EA monitors water quality in each water body. This is done at one or more sample points and can be used to break a water body up into stretches to help target issues and measures. The main baseline water quality data can be found in Appendix B. As much as was possible, actual sample data was used to set the baselines. However, where no river quality data was available, estimates from the Simcat model were used.

3.2.7 In order to assess the relative impacts of future growth, WFD water quality standards were identified for each sample point used. Table 3.3 shows the WFD Standards that were used for all downstream sample points in the WwTW assessments when assessing risk of deterioration, and where necessary, calculating any permit levels. Ammonia and BOD standards were consistent for all sample points; however, phosphate standards vary between rivers and monitoring points, based on the elevation of the river/monitoring point and alkalinity of the water. The exact standards used by the EA for phosphates were not available at the time of assessment. In their place calculated standards based on the RBMP Cycle 2 methodology[1] have been applied to allow assessments to be undertaken.

Table 3.3 Water Framework Directive Standards for water quality (in mg\l) at sample points assessed for the WwTWs

Determinand	Sample Point	High	Good	Moderate	Poor	Bad
Phosphate	Varies*	0.031- 0.040	0.057 – 0.072	0.141 – 0.169	0.791 – 0.860	>0.791 - 0.860
BOD	All	4	5	6.5	9	>9
Ammonia	All	0.3	0.6	1.1	2.5	>2.5

* The values indicated for phosphate vary between each sample site, the values shown are the value for the site with the lowest threshold and the value for the site with the highest threshold.

3.2.8 To clarify if housing growth would cause a greater than 10% deterioration in water quality a threshold was set based on the baseline concentrations recorded at the downstream sample point (i.e. 2015 baseline plus 10%). The future scenarios were also assessed against that threshold.

Growth Scenarios

3.2.9 The Council provided Wood with a growth projection summary which indicated potential net dwelling numbers at specified sites (these are presented in Table 2.1 and Appendix A).

[1] Calculations based on methodology in the Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

3.2.10 Housing growth sites included ‘housing givens’ which comprised the following: housing completions (up to 31st March 2017); housing permissions (up to 31 March 2017); forward forecast of housing completions and permissions (1 April 2017 – 31 March 2018); and housing windfall sites (2020 – 2033). The term 'housing windfall sites' referred to an allowance of sites, which may become available for development unexpectedly and were therefore not included as allocated land in a planning authority's development plan. The values for these ‘housing givens’ were the same across each growth option.

3.2.11 The summary also included a number of housing allocation sites for which allocations may be dedicated. A total of seven housing growth scenarios were presented in the summary, each with different combinations of potential housing allocation sites included in the option, indicated by a tick or a cross. This assessment was undertaken for Option 7 (a new settlement driven option. Additionally, a 10% and 20% uplift to these numbers was also modelled. This allowed for the impact of unexpected additional housing growth on water quality to be assessed for contingency and conservatism.

3.2.12 Each allocation site was assigned to a WwTW based on its drainage catchment area. Where housing allocation site crossed two WwTW catchment boundaries, the numbers were either split evenly between the two WwTW or assigned to one WwTW based on the amount of overlap between the WwTW catchment areas.

3.2.13 The water quality modelling was undertaken in line with water company business cycles to assist with identifying when any mitigation might be required (i.e. 2016 – 2020, 2021 – 2025, 2026 – 2030, and 2031 – 2036). This was undertaken to show what the potential water quality impacts could be on the receiving watercourses by 2020, 2025, 2030 and 2036. However, the model assessment was conducted on projected housing growth to 2033. Therefore, any additional projected housing growth for 2033 – 2036 has not been assessed. The model results were assessed against the WFD objectives and the water quality assessment objectives as set out in Section 3.2.5 and Table 3.3.

Use of Simcat and River Quality Planning (RQP) tool

3.2.14 For all of the WwTW which discharged to rivers, Simcat and RQP models were identified to be the most appropriate tools to undertake the modelling as they use Monte Carlo calculations[2]. The models were used to assess potential future impacts from housing growth. The Simcat model allows for more complex scenarios to be modelled (e.g. catchments), where either multiple WwTWs might interact or other sources or pollutants might need to be accounted for. The RQP tool is more simplistic and can be used for modelling point source impacts of single discharges. The models were used to model the impacts on the WwTW discharges on phosphate, ammonia and BOD concentrations in rivers where applicable.

Calibration of the SIMCAT model

3.2.15 The Simcat models were provided by the Environment Agency. Before the modelling for the water quality assessments were undertaken, the calibration of the Simcat model was reviewed at locations upstream and downstream of the WwTWs being assessed to determine how accurately water quality monitoring data was being represented.

3.2.16 Where observed data were available, quality data (phosphate, BOD and ammonia) for river sample points were updated in the model based on data from 2013-2015 (average and standard deviation) and an initial baseline run carried out. Following completion of the baseline run, the modelled and observed concentrations were compared. Where a difference greater than 10% between modelled and observed was identified, an expert view was taken as to whether a change to the model was required. If the difference was significant then river flows, discharge volumes, and diffuse concentrations and flows were all checked in the model and changes made where appropriate. Due to uncertainties in their sources the main focus of any changes was on the diffuse inputs.

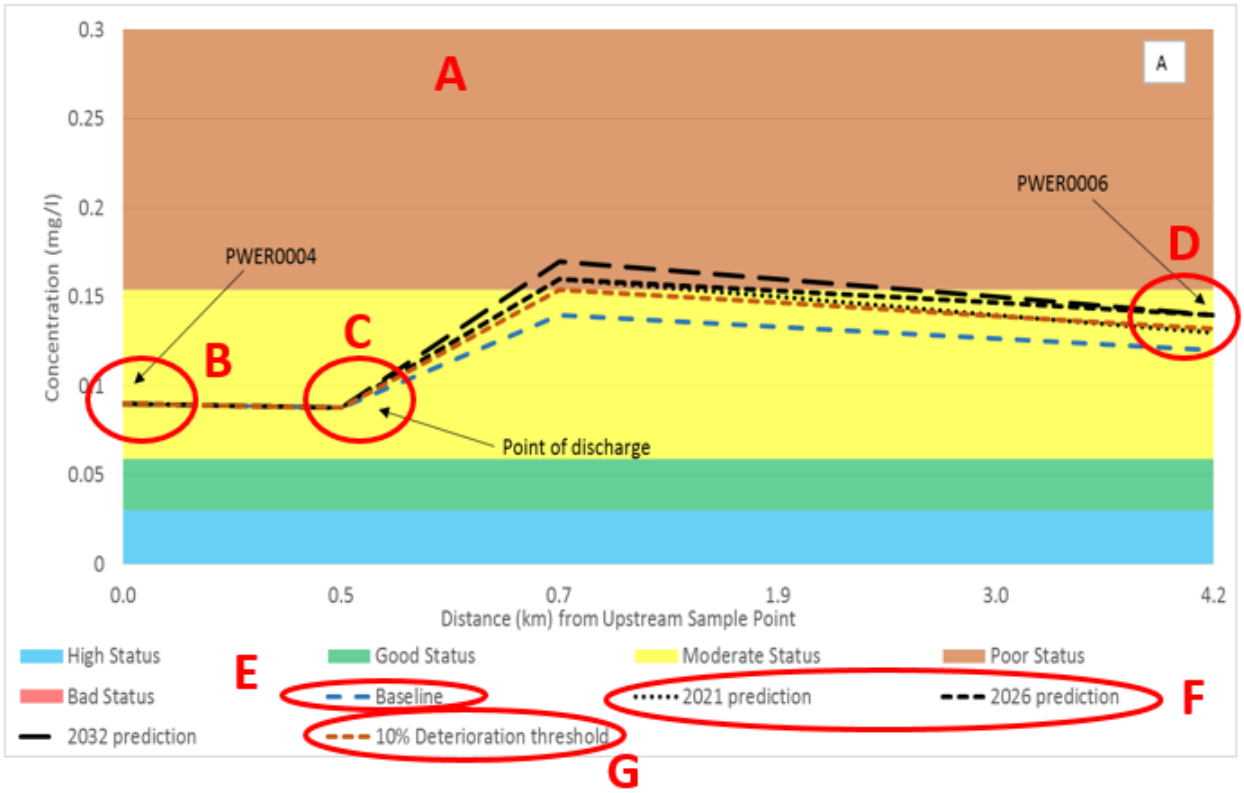
[2] A standard mathematical method used for probabilistic modelling.

Graphical representation of Simcat Results

3.2.17 To more easily assess the extent of water quality impacts due to increased discharges of treated sewage effluent caused by future housing growth, the model outputs from Simcat were put into graphical format. The graphs were set out to show the potential impacts at the end of each period of housing growth, estimates on the length of river reach impacted as well showing whether the impacts would cause significant deterioration. Figure 3.1 shows an example of the graphs which specifically show:

- WFD class boundaries specific to the determinand and watercourse (marked as A);
- The upstream actual or estimate river quality (marked as B);
- The point and immediate impact of the WwTW discharge (marked as C);
- The downstream point used for the deterioration assessments (marked as D);
- The 2015 baseline set using current data from which the impact of increase in volume of treated effluent was modelled (marked as E);
- The results showing the level of impact of the increases in the treated effluent at the end of each growth period (marked as F); and
- The 10% deterioration threshold, set based on the 2015 baseline and used as an aspirational target by the Environment Agency (marked as G).

Figure 3.1 Example graph showing the Simcat model results for the water quality impacts of future housing growth due to one wastewater treatment works.



3.2.18 In the example, if the future predictions of water quality (i.e. 2021, 2026 and 2032 predictions in Figure 3.1) were above the baseline, then a deterioration would be identified. However, it was only deemed to be significant if the results showed that at the downstream sample point, the concentrations were either a different WFD class or were greater than the 10% threshold. For example, Figure 3.1 shows that although all future predictions show a deterioration from the baseline by PWER0006 they are still Moderate Status. Therefore, there is no class deterioration. However, by 2026 the deterioration does exceed the 10% deterioration threshold. Therefore, an indicative permit would need to be calculated in order to show how to prevent this potential deterioration.

3.2.19 Section 5 contains explanatory text for the five WwTWs in this assessment. The background data, calculation sheets for model inputs and the output results from the modelling, including the graphs can be found as electronic files in Appendix B. The model results for each WwTW for each Scenario are presented in Tables C1 to C5 of Appendix C.

Volumetric capacity assessment for WwTWs

3.2.20 All WwTWs are permitted to discharge a set volume of treated effluent based on the population size they serve. This is generally referred to as the Dry Weather Flow (DWF), which is the baseflow going to a WwTWs of raw sewage with a small amount of groundwater infiltration with no surface water drainage inputs. The DWF is used to help determine the quality of effluent required to protect the water environment and can also be used as an indicator of when a WwTW is reaching it volumetric design capacity and requires an upgrade.

3.2.21 Using data provided by the EA an initial assessment of the current volumes of treated effluent discharged by the main WwTWs indicated that Brentwood WwTW has already been discharging volumes in excess of the permits and Ingatestone WwTW had less than 10% capacity left (Table 3.4).

3.2.22 Assessment of future DWF flows is presented in Section 5.

Table 3.4 Calculated DWFs consent limits for WwTWs (in m^3/day)

WwTW	3 year DWF m^3/d (20^{th}%ile, 2013 - 2015)	Permitted DWF m^3/d	Comment
Doddinghurst	1,478	1,900	Within permit
Shenfield and Hutton	9,148	12,650	Within permit
Ingatestone	1,538	1,600	<10% capacity left
Upminster	3,879	6,300	Within permit
Brentwood / Nag's Head	7,516	7,000	Exceeding DWF

3.2.23 In parallel to the review on the capacity of the WwTW a high level assessment was undertaken on the relative capacity of the associated public sewerage networks. This was completed by reviewing previous water pollution incidents and any other evidence for sewer network overflows within the WwTW Brentwood District. Any areas that had a history of problems that overlapped with growth areas were highlighted for the relevant WwTWs for future improvements. It was assumed that there is a higher pressure on capacity when incidents had occurred in the last 10 years.

Overall assumptions and caveats for assessments

3.2.24 A number of assumptions and caveats have been identified and used when undertaking the water quality assessment work. These were taken from standard approaches in the UK and were used in order to improve the certainty behind the findings and to take a precautionary approach due to some uncertainties (e.g. number of people who will eventually live in the dwellings). The assumptions and caveats are:

- A single dwelling has an occupancy of 5 people (this follows national guidance for the assessment process but presents a worst case scenario compared to the national average occupancy of 2.5 people per dwelling)[3];
- There has been no consideration of future climate change within the modelling itself, however consideration is made when discussing the water resource results (Section 4);
- 150l per person per day residential waste water flow loading to a WwTW (e.g. based on national guidance); and
- Where data were not available water quality modelling was based on predicted flow and quality estimates for growth on top of current mean discharge volume.

2.1.1 It is important to note that the household occupancy value used is based on an assumption that an average house comprises 3 bedrooms, a size which is 'designed for a minimum population of 5 people[3]. This is an overestimate based on an average household size of 2.5 persons[3] in 2011. For the purposes of modelling the use of 5 persons per dwelling provides a 'worst case' scenario for consideration.

3.3 Mitigation measures assessment

3.3.1 If the water quality or water resource assessments identified any significant impacts a further assessment was undertaken to clarify if relevant mitigation measures were technically feasible and if they could be delivered within the lifetime of the Local Plan. Potential mitigation measures include:

- End of pipe treatment (e.g. tertiary nutrient stripping);
- Water efficiency measures (to reduce the flow to the works);
- Decrease water abstractions (e.g. to increase flow and dilution in the receiving waters);
- Catchment management to reduce upstream concentrations of pollutants; and
- Effluent reuse.

[3] http://www.ons.gov.uk/ons/rel/census/2011-census/population-estimates-by-five-year-age-bands--and-household-estimates--for-local-authorities-in-the-united-kingdom/stb-population-and-household-estimates-for-the-united-kingdom-march-2011.html

4. Water Resource and Supply infrastructure Assessment

This section provides the results of the reviews into the current water company's water resource management plans (WRMP14) and the implications for future growth.

4.1 Affinity Water - Water Resource Management Plan

4.1.1 One water resource zone in the Brentwood Borough Council is encompassed within Affinity Water's "Central Region" area; Water Resource 5 (WRZ5). Affinity Water assess supply and demand at a WRZ level as well as at the integrated regional and company-wide level.

4.1.2 The Central region provides water to north London and extends into rural parts of Essex, Hertfordshire and Buckinghamshire, with a population of 3.2 million. Approximately 60% of the water in the central zone is from groundwater sources with the remaining water sourced from surface water sources and imports from neighbouring water companies; Thames Water, Anglian Water and Cambridge Water. In addition, there are two net exports to South East Water and Cambridge Water, and emergency cross-border transfer connections with neighbouring water companies that do not contribute to deployable output but do provide additional resilience.

4.1.3 Affinity Water have produced a plan which sets out how they intend to maintain the balance between water supply and demand over a 25-year period. Affinity forecast supply and demand across the 25-year period at WRZ level, in order to determine whether an individual WRZ will have a surplus or deficit in water resource availability over the planning period. Where the demand is higher than supply, and Affinity Water do not have enough capacity to meet customer demand, an investment appraisal has been undertaken.

4.1.4 The calculations for supply consider:

- Deployable Output;
- Levels of Service;
- Climate Change;
- Sustainability Reductions;
- Outage; and
- WRZ Integrity.

4.1.5 The calculations for demand consider all WRZs in Affinity Water's Central Region and the individual WRZ5 which is encompassed within the Central Region.

Understanding Supply in WRZ5 (Central Region)

4.1.6 WRZ5 is approximately 11,815 km^2 (based on calculations from mapping available from the Affinity Water WRMP14), of which only 46 km^2 (less than 0.4%) overlaps with the Brentwood Borough Council area.

4.1.7 Much of WRZ5 appears to be sourced from groundwater supplies (Appendix 4e, WRMP14). Additionally, there is currently a water import from Cambridge Water to Affinity WRZ5 (0.31 Ml/d) and from Essex and Suffolk Water to Affinity WRZ5 (0.03 Ml/d).

4.1.8 In the WRMP14, no sustainability reductions were planned in Affinity WRZ5 between AMP6 and AMP7. Based on UKCP09 scenarios a vulnerability assessment was undertaken to assess which sources were vulnerable to climate change. A reduction in water available for abstraction is

considered to impact future average deployable output (ADO) by 0.40 Ml/d and peak DO by 0.95 Ml/d by 2035. Average deployable output for WRZ5 is 70.77 Ml/d, with the PDO at 73.38 Ml/d (these values exclude bulk transfer imports), and thus the future reductions represent between a 0.5% (ADO) and 1.2% (PDO) reduction in water available for abstraction.

4.1.9 At the time of publishing the WRMP14, the WRZ had a population of 289,142 (2012/13). The forecast provided by Affinity Water showed an increase to 307,418 by 2020 and an increase to 362,351 in 2040. This represents a 25% increase in population between WRMP14 and 2040.

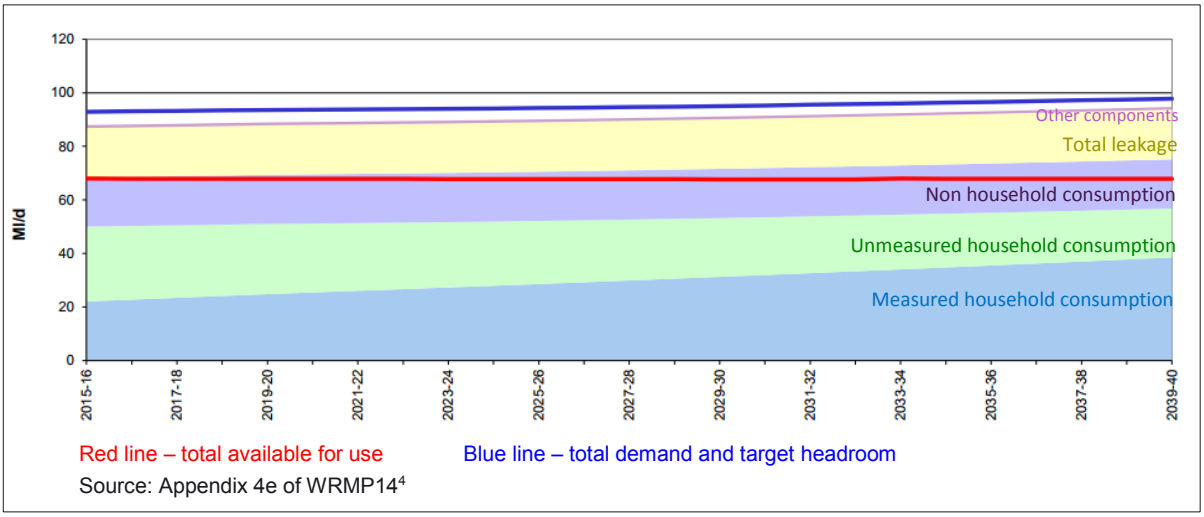
4.1.10 At the time of publishing the WRMP14, the WRZ had 111,813 households (2012/13). The forecast provided by Affinity Water showed an increase to 120,200 homes by 2020 and an increase to 144,833 homes by 2040. This represent a 30% increase in the number of homes in the region between WRMP14 and 2040.

4.1.11 In a normal year the annual average demand is expected to rise from 84.21 Ml/d (2014/15) to 90.95 Ml/d (2039/40).

4.1.12 The WRZ5 baseline supply demand balance in 2015 was considered to be between 1 and 10 Ml/d deficit in a Dry Year Annual Average (DYAA) event and Dry Year Critical Period (DYCP) event. As shown in Figure 4.1 and Figure 4.2. The red line is the supply forecast, and this includes all water that is available for use, including water imported from other zones. The blue line is the forecast demand, including a buffer (headroom) to allow for and increase resilience to any uncertainties in the forecasts.

4.1.13 The WRZ5 baseline supply demand balance in 2040 was considered to be more than 10 Ml/d in a Dry Year Annual Average (DYAA) event and Dry Year Critical Period (DYCP) event.

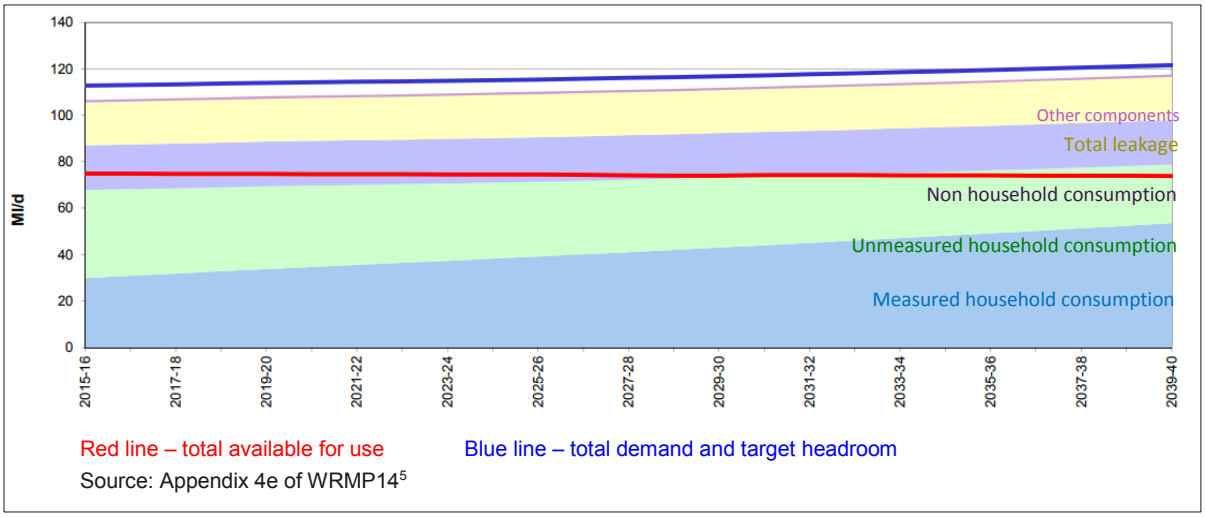
Figure 4.1 Baseline Supply-Demand Balance and Components of Demand (DYAA)



Source: Appendix 4e of WRMP14[4]

[4] Appendix 4e available at https://stakeholder.affinitywater.co.uk/docs/WRZ5_Dry%20Year%20Annual%20Average%20rev.pdf

Figure 4.2 Baseline Supply-Demand Balance and Components of Demand (DYCP)



Source: Appendix 4e of WRMP14[5]

Strategic Plan for WRZ5 (Central Region)

4.1.14 The strategy to reduce the supply demand deficit for WRZ5 in the WRMP14 includes a range of metering, water efficiency and leakage reduction measures, as well as amendment to four source supplies.

4.1.15 The metering programme was completed in 2015, as well as water efficiency measures which included water audits of commercial use (process and non-process). Active leakage control (ALC) to reduce leakage was scheduled for delivery in 2015 (3.5 Ml/d).

4.1.16 Water efficiency measures planned in the future include additional water efficiency for households (2033) and airport water efficiency at Stanstead Airport (2039).

4.1.17 The supply options include source optimisation at Widford, Hempstead and Great Dunmow and an increase in the licence at Stanstead.

4.1.18 The bulk transfers will continue for the planning period. There are no plans for any additional bulk transfers importing or exporting water to or from WRZ5.

4.1.19 The final supply demand balance in the WRMP14 for the DYAA and DYCP events with the above mitigations (4.1.15-4.1.16) are shown in Figures 4.3 and 4.4. The red line is the supply forecast, and this includes all water that is available for use, including water imported from other zones. The blue line is the forecast demand, including a buffer (headroom) to allow for and increase resilience to any uncertainties in the forecasts.

4.1.20 The dWRMP19[6] for Affinity Water shows that going forwards the preferred options to meet future demand includes an upgrade to a source works in WRZ5 (by 2025), continued metering and further leakage reduction and active leakage control. Alternative options also include additional water efficiency measures or a new bankside storage reservoir within the catchment although this has been included as an option considerably beyond the timescale of the local plan (2079).

[5] Appendix 4e available at https://stakeholder.affinitywater.co.uk/docs/WRZ5_Dry%20Year%20Critical%20Period%20rev.pdf
[6] Draft Water Resources Management Plan available at: https://www.affinitywater.co.uk/docs/Draft_Water_Resources_Management_Plan_2020-2080_March%202018.pdf

Figure 4.3 Final Supply-Demand Balance and Components of Demand (DYAA)

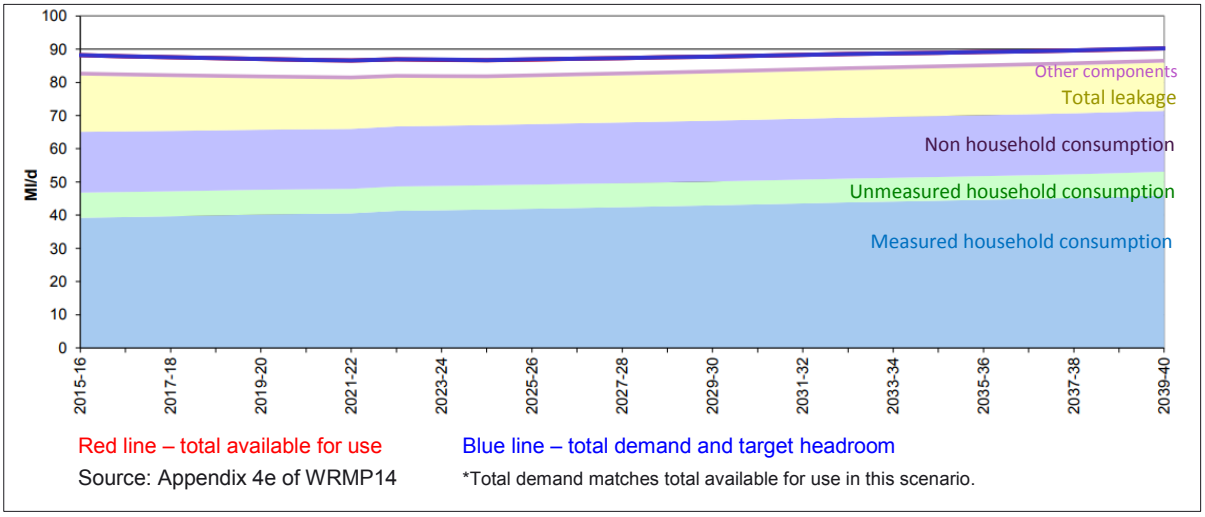
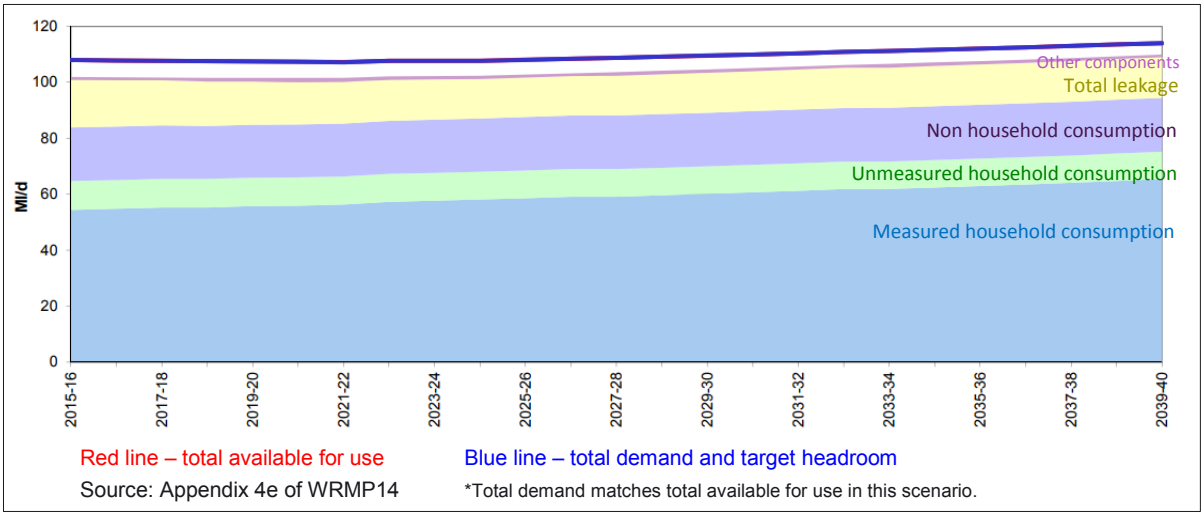


Figure 4.4 Final Supply-Demand Balance and Components of Demand (DYCP)



Potential for Affinity Water to accommodate growth

4.1.21 It is clear from the forecast supply-demand balance and the main Water Resources Management Plan (WRMP14) that the resource situation in this area is constrained by environmental water availability, and that with growth forecast, if there were no interventions security of supply would be at risk.

4.1.22 The forecast in the WRMP14 takes into account that over 33,020 new properties will be built in WRZ5 by the end of the planning period in 2040.

4.1.23 There are 133 homes scheduled in the Affinity Water WRZ5. Due to the low volume of development in the WRZ5 growth plans set out by Brentwood Borough Council certainly have the potential to be accommodated within the overall Affinity Water WRZ5 WRMP14, however, further confirmation from Affinity Water will be required to firstly assess demands developments occurring outside of the Brentwood area and to ensure that the individual developments proposed have been fully incorporated into each WRMP. There will need to be confirmation that water can be supplied to each individual development during the planning permission phase.

4.2 Essex and Suffolk Water - Water Resource Management Plan

4.2.1 The Essex WRZ is bounded by the Thames Estuary in the south and the Essex coastline as far north as Salcott in the east. The WRZ stretches as far north as Silver End and as far west as the London

Boroughs of Redbridge, Barking and Havering and includes the towns of Southend-on-Sea, Chelmsford, Witham, Brentwood, Billericay, Basildon, Grays, Dagenham and Romford.

4.2.2 Water resources in the Essex WRZ are taken from the Essex rivers; the Chelmer, Blackwater, Stour and Roman River which support pumped storage reservoirs at Hanningfield and Abberton. 3% of water is sourced directly from groundwater.

4.2.3 Water transferred into the Essex WRZ comes from two sources, namely the Chigwell raw water bulk supply from Thames Water 's Lea Valley Reservoirs and the Ely-Ouse to Essex transfer scheme (EOETS); a scheme which transfers raw surface water from Denver in Norfolk to the headwaters of the River Stour and River Blackwater). Approximately 20% of potable water supplied in the Essex WRZ is provided via the Chigwell raw water bulk supply.

4.2.4 There are also two groundwater river support schemes which are operated by the Environment Agency and discharge water into the catchment, namely the; Stour Augmentation Groundwater Scheme (SAGS) and the Great Ouse Groundwater Scheme (GOGS). The Agency owned and operated SAGS and GOGS groundwater sources provide support to the Rivers Stour and Blackwater (pp.290 ESW WRMP14).

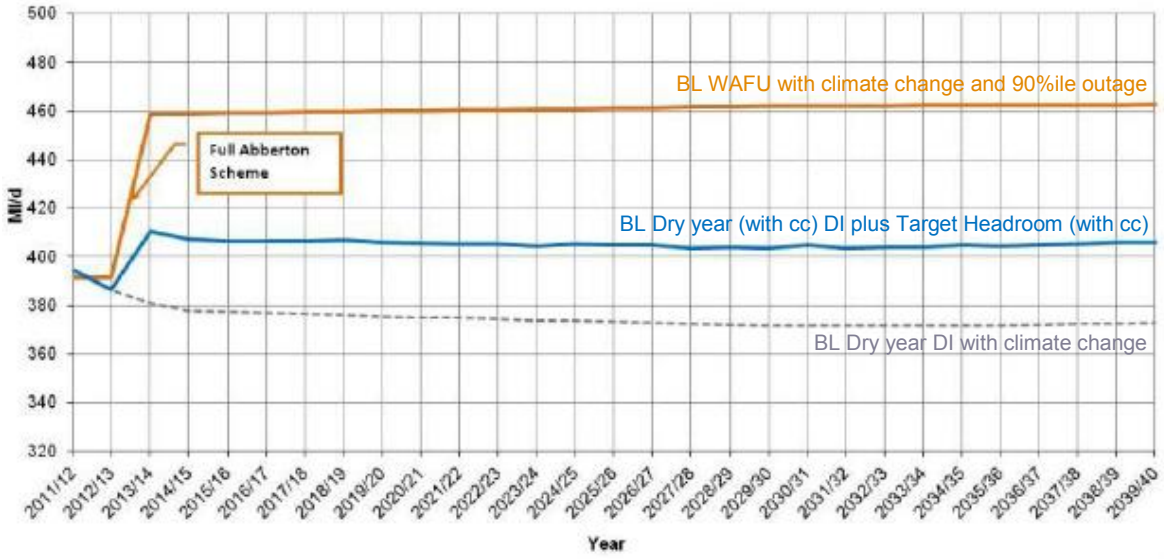
4.2.5 The DO of the Essex WRZ has three separate components which are:

- the Essex System (including Langford Recycling Scheme);
- groundwater sources; and
- the Chigwell bulk supply.

4.2.6 The Essex WRZ baseline supply demand balance as presented in the current WRMP14 is presented in Figure 4.5. Prior to 2012/13 the WRMP14 states that the Essex WRZ had a supply deficit. As a result of this deficit an options appraisal was undertaken. This concluded that the Abberton Scheme would ensure no supply deficit over the planning scenario.

4.2.7 The Abberton Scheme is a three part scheme and included the upgrade of the EOETS outlined above; a variation to the abstraction licence at Denver in Norfolk from where water is transferred by the EOETS; and the enlargement of the Abberton Reservoir. The EOETS upgrade included two new pipelines and an upgrade to the pumping facilities.

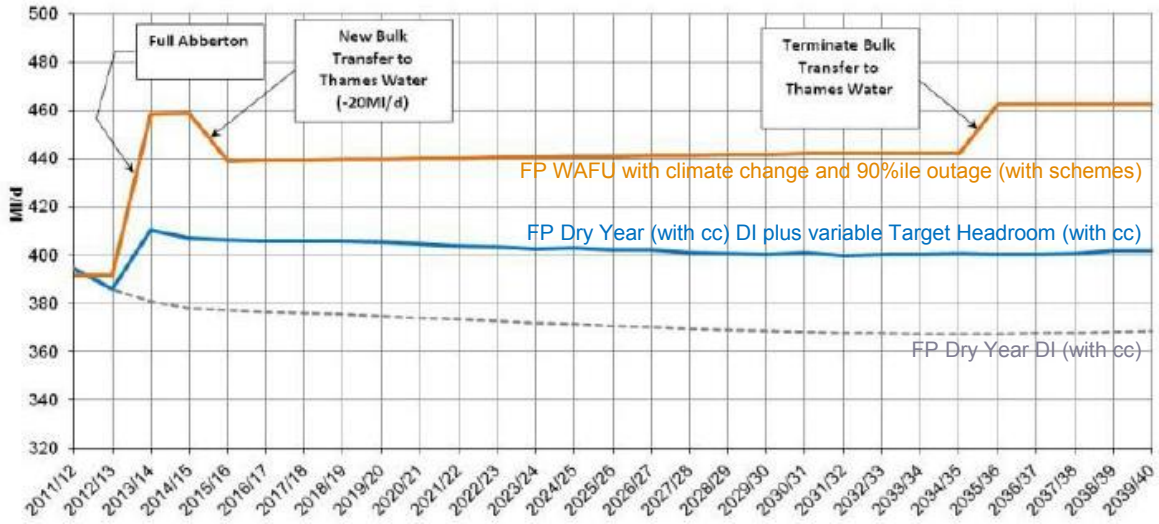
Figure 4.5 Draft Final WRMP14 Baseline Supply Demand Balance (Essex WRZ)



4.2.8 In the WRMP14 ESW had taken the sub National population projections and substituted these into the draft Final Plan tables to see what effect the absolute worst case would have on the supply demand balance for the Essex WRZ. This includes a 7% increase in population over the next 25 years.

4.2.9 In the WRMP14 ESW had agreed in principal to a 20 Ml/d trade with TWU between 2015 and 2035. This was incorporated into the Final Planning Supply and Demand Balance for the Essex Water Resource Zone and demonstrated a significant surplus in the zone for the whole planning period.

Figure 4.6 Draft Final WRMP Baseline Supply Demand Balance (Essex WRZ)



4.2.10 In the dWRMP19[7] it is evident that the Essex WRZ remains in a supply surplus position, however, there has been a slight decrease in the surplus volume as a result of the Thames Water Utilities trade (2015) for 20 Ml/d. It appears that the Abberton Scheme has now been completed.

Potential for Essex and Suffolk Water to accommodate growth

4.2.11 Essex and Suffolk Water projections have shown a supply-surplus under current forecasts in the WRMP14 to 2040.

4.2.12 The WRMP14 forecast takes into account that 136,504 properties will be built by 2030 and the household population is expected to expand from 1.628 million to 1.866 million people.

4.2.13 The draft Water Resources Management Plan 2019 has concluded that the Brentwood area has a 7,240 housing target to 2033 and this has been included in the draft plan calculations. The development sites located within the Brentwood Borough Council area and the Essex WRZ include 5,985 area, and with the windfall estimates of 468 (6,453 sites) (Appendix A), the total number of sites planned to 2033 is less than the housing target considered in the dWRMP19. Therefore, with a WRZ in supply surplus and given that the housing numbers included in ESWs plan, it is likely that the sites required by Brentwood Borough Council can be accommodated. Further confirmation from Essex and Suffolk will be required to assess during the planning permission phase to ascertain whether water can be supplied to each individual development.

[7] Draft Water Resources Management Plan available at: https://www.eswater.co.uk/_assets/documents/ESW_PR19_WRMP_Report_Template_-_V3.pdf

5. Wastewater treatment, water quality and sewerage assessment

This section provides an overview of the water quality assessments for growth areas including the implications for WFD compliance.

5.1 Overview

5.1.1 The assessment of potential impacts of proposed growth were based on the water quality baseline and assumptions detailed in Section 2. Modelling of the water quality impacts of housing growth has been summarised in the following section, along with a cumulative assessment for all growth areas. This takes account of the impact of growth plans to 2020, 2025, 2030 and 2033 to allow understanding of the timescales of the potential impacts. For each WwTW receiving water consideration is made of:

- the baseline classification;
- changes in WFD class or deterioration leading to an exceedance of the 10% deterioration threshold;
- the potential for the waterbody to reach the WFD objective of Good Status;
- impacts beyond the main water body;
- the potential of the WwTW to accommodate the increased discharge flows and any potential permit requirements calculated; and
- the capacity of the sewerage network connecting the growth sites to the receiving WwTW.

5.1.2 To identify potential future impacts on receiving waters from increases in treated sewage effluent from housing growth, the water quality assessments were taken at the site level (e.g. the WwTWs and the impacts immediately downstream). The impacts were then linked to the potential impacts at the waterbody or catchment level and also in reference to the Local Plan housing numbers.

5.2 Wastewater treatment and water quality

5.2.1 The numerical predictive assessment of catchment water quality has been completed using Simcat. The number of dwellings for the Option 7 housing plan are shown in Table 2.1 and Appendix A. The housing plan has been used to derive the input values for the Simcat models; these spreadsheets of calculations are included in the electronic files in Appendix B and include the output Simcat values for the reaches and points of interest.

5.2.2 The results of predictions for BOD, ammonia and phosphate are presented in Tables in Appendix C, with one table per Wastewater Treatment Works. The tables in Appendix C present the results for each of the three scenarios (Option 7, Option 7 + 10% and Option 7 + 20%). The tables in Appendix D provide further summary discussion on whether the level of deterioration is significant taking into account the WFD objectives and the EA predictions for the water bodies by 2027.

5.2.3 The model results have been summarised further and presented in Table 5.1 for:

- The monitoring point upstream of the WwTW
- A point immediately upstream of the WwTW
- A point immediately downstream of the WwTW
- The monitoring point immediately downstream of the WwTW

Table 5.1 Summary of Model Results by Parameter and WwTW

Parameter	Water Treatment Works	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	Downstream sample point
BOD	Doddinghurst WwTW	High	High	High	High
	Shenfield & Hutton WwTW	High	High	High	High
	Ingatestone WwTW	High	High	High	High
	Upminster WwTW	High	High	High	High
	Brentwood WwTW	High	High	Poor	Poor
Ammonia	Doddinghurst WwTW	Good	Good	Moderate	**Moderate**
	Shenfield & Hutton WwTW	High	High	Moderate	Good
	Ingatestone WwTW	High	High	Good	Good
	Upminster WwTW	Moderate	Moderate	Moderate	**Moderate**
	Brentwood WwTW	High	High	Moderate	Moderate
Phosphate	Doddinghurst WwTW	Moderate	Poor	Poor	Poor
	Shenfield & Hutton WwTW	Poor	Poor	Poor	Poor
	Ingatestone WwTW	Poor	Poor	Poor	Poor
	Upminster WwTW	Bad	Bad	Bad	Bad
	Brentwood WwTW	Poor	Poor	Bad	Bad

Bold red text indicates a change in WFD class relative to the baseline model.

5.2.4 The outputs from the models are summarised as follows:

- Downstream of Doddinghurst WwTW the waters are classed as High for BOD, Moderate for Ammonia and Poor for Phosphate. Under the baseline model for Doddinghurst WwTW the WFD class is Good for ammonia upstream of the WwTW, reducing to Moderate immediately downstream of the WwTW, then the quality improves to Good status at the downstream sample point (although the baseline model 90th percentile value is at 0.59 mg/L, very close to the class boundary). Model scenarios for the housing growth plans predict the ammonia 90th percentile concentration increases to around 0.63 mg/l, at the downstream monitoring location, indicating a deterioration in WFD Class relative to the baseline model.
- Downstream of Shenfield and Hutton WwTW the waters are classed as High for BOD, Good for Ammonia and Poor for Phosphate. The models do not predict a deterioration in WFD Class for BOD, Ammonia or Phosphate under the proposed development plans.
- Downstream of Ingatestone WwTW the waters are classed as High for BOD, Good for Ammonia and Poor for Phosphate. The models do not predict a deterioration in WFD Class for BOD, Ammonia or Phosphate under the proposed development plans.
- Downstream of Upminster WwTW the waters are classed as High for BOD, Moderate for Ammonia and Bad for Phosphate. The modelled water quality for Ammonia in the baseline model is Moderate upstream of the WwTW and immediately downstream of the WwTW but improves to Good by the downstream monitoring point – however, is close to the class boundary (90th percentile concentration of 0.59 mg/l as N, and the Class boundary value is 0.6 mg/l as N). Under the different scenarios, Ammonia at the downstream monitoring point increases to around 0.6 mg/l. Given uncertainties in the modelling it is not possible to state with confidence that a WFD class change will not occur.
- Downstream of Brentwood WwTW the waters are classed as Poor for BOD, Moderate for Ammonia and Poor for Phosphate. The models do not predict a deterioration in WFD Class for BOD, Ammonia or Phosphate under the proposed development plans.

5.2.5 The key points from the models are summarised as follows:

- For each of the model outputs, the results typically showed that concentrations downstream of the WwTWs would increase for parameter, for each period and for each scenario, as would be expected as a result of increasing flows but no changes to the discharge concentrations (see tables in Appendix C).
- None of the results predicted an increase of greater than 10% relative to the baseline model conditions (i.e. no exceedance of the 10% aspirational growth threshold). It should be noted that for Doddinghurst under Option 7 + 20% the predicted increase in ammonia is around 8.4% in 2033.
- The results indicated that the increases could give rise to changes in WFD Class for ammonia at Doddinghurst and Upminster WwTWs. It should be noted that there is significant uncertainty in this result for Upminster, and this is further discussed in Section 6.3.
- For Shenfield and Hutton, Ingatestone, and Brentwood WwTW the results appear to be favourable, in so far as there the WFD classes are not predicted to change and there are no exceedances of the aspirational growth threshold.

In addition to the WFD class and the 10% deterioration aim, it is also necessary to consider the EA's WFD aim that all water bodies should achieve 'Good Status' for rivers, lakes, coastal waters and groundwater by no later than 2027:

- Whilst there is no prediction of deterioration of WFD status for 3 of the areas, or an increase of 10% above baseline, the proposed housing development plans are predicted to lead to increases to discharge loadings of BOD, Ammonia and Phosphate.
- To achieve the EA's general objective of Good status means that there is an overall requirement to improve water quality within the catchments not at Good status. Therefore, potentially, housing growth may not be supported where it will make achieving Good status more difficult (i.e. by increasing total nutrient loadings in the rivers).
- Growth and additional housing means that WwTW discharge flows will increase. However, if appropriate actions are undertaken to reduce nutrient loading within the catchments then housing growth may not be at odds with achieving Good status by 2027. Net reductions in nutrient loading could be achieved by improving treatment/lowering discharge loads, or by reducing nutrient loading from other sources.

5.2.1 With respect to the potential WFD class changes for Ammonia at Doddinghurst WwTW and Upminster WwTW, RQP modelling calculations have been used to evaluate the discharge limits that could be necessary in order to avoid the change in WFD status. These calculations have been based on the worst case scenario for Option 7 + 20% at 2033.

- For Doddinghurst WwTW the projected mean discharge quality required to prevent class deterioration is 0.42 mg/L. The projected 95-percentile discharge quality required to prevent class deterioration is 0.98 mg/L. This should be achieved by 2020.
- For Upminster WwTW the projected mean discharge quality required to prevent class deterioration is 0.36 mg/L. The projected 95-percentile discharge quality required to prevent class deterioration is 0.83 mg/L. This should be achieved by 2020.

5.3 Sewerage assessment and WwTW volumetric capacity

Sewerage capacity including Pollution incidents

5.3.1 The Strategic Flood Risk Assessment[8] (SFRA) identifies one location in the Brentwood Borough where there is a risk of flooding caused by sewer blockage/capacity issue. The assessment refers to a possible flood event at Ingatestone High Street, at a low point, due to sewer flooding at Whadden Chase. The potential flooding would occur for a 1 in 100 year annual probability event. This area

[8] Amec Foster Wheeler (2017) Strategic Flood Risk Assessment for Brentwood Borough Council

drains into the Ingatestone WwTW and as such represents a potential constraint to housing growth with regard to sewerage network capacity.

5.3.2 Five crude sewage pollution incidents in the Brentwood District have been reported by the EA within the past 10 years. Of these incidents two were at the Shenfield WwTW occurring in February 2006 and June 2016 and one was at Doddinghurst WwTW in September 2009. The only location where a repeated sewage related incident was at Shenfield WwTW. However, the events were 10 years apart and as such were not considered a result of pressures on sewerage network capacity.

5.3.3 Thames Water were contacted[9] with regards to network constraints for the Brentwood (Nags Head Lane) Sewage Treatment Works. The Thames Water response was as follows:

> *Most of the Brentwood catchment is considered as a catchment with available headroom, however the north part (Pilgrims Hatch, Crow Green, Coxtie Green) experiences lack of local capacity. Sawyer's Hall and Brook Street areas are also suffering from limited capacity as well as sewers along A128, A1023 and trunk sewers especially downstream of Mascalls.*

5.3.4 Anglian Water were also contacted[10] with respect to the Brentwood area. Anglian Water reported that there were no plans to upgrade the Water Recycling Centres in the ownership of Anglian Water in the Brentwood Administrative Area as part of the 2015 to 2020 Asset Management Plan. Anglian Water are developing a 25 year growth forecast and are developing long term integrated strategies. The Anglian Water long-term plan[11] indicates that there is expenditure planned for Upminster and Shenfield & Hutton to increase drainage capacity, and for additional flow capacity at Doddington WwTW.

5.3.5 For Thames Water the constraints described above should be taken into consideration with respect to the proposed housing developments. Further information should be sought with regards to Anglian Water in relation to the proposed housing growth plan. Detailed assessments would be required during planning to confirm there will be sufficient capacity to accommodate the developments.

Predicted WwTW volumetric capacity constraints

5.3.6 Table 3.4 shows the current dry weather flows and the associated permitted volumes. Based on the assumptions in Section 3.2, the predicted increases to the various WwTW are shown in

[9] Email from Jill Warren of Brentwood Borough Council to Amec Foster Wheeler, 15 August 2017
[10] Email from Stewart Patience (Anglian Water) to Jill Warren (Brentwood Borough Council) and Amec Foster Wheeler, 23 August 2017.
[11] https://www.anglianwater.co.uk/_assets/media/water-recycling-long-term-plan.pdf

5.3.7 Table 5.2, with values highlighted where permitted capacity is approached or exceeded as follows:

- Values highlighted in pale yellow are within 10% of the consent limit
- Values highlighted in pale orange exceed the consent limit by less than 10%
- Values highlighted in dark orange exceed the consent limit by 10-20%
- Values highlighted in red exceed the consent limit by 20-30%

Table 5.2 Calculated DWF for WwTWs under different scenarios (m^3/day)

Treatment works	Scenario	Consent limit	3 year DWF 20%ile Average (2013 - 2015)	Projected DWF values			
				2020	2025	2030	2036
Doddinghurst WWTW	Option 7	1900	1478	1669	1721	1773	1814
	Option 7 + 10%	1900	1478	1688	1745	1802	1848
	Option 7 + 20%	1900	1478	1707	1770	1832	1881
Shenfield & Hutton / Billaricay WWTW	Option 7	12650	9148	9526	9766	10005	10234
	Option 7 + 10%	12650	9148	9564	9828	10091	10343
	Option 7 + 20%	12650	9148	9602	9890	10177	10451
Ingatestone WWTW	Option 7	1600	1538	1745	1813	1881	1938
	Option 7 + 10%	1600	1538	1766	1840	1915	1978
	Option 7 + 20%	1600	1538	1786	1868	1949	2018
Upminster WWTW	Option 7	6300	3879	4711	5404	6098	6780
	Option 7 + 10%	6300	3879	4794	5557	6319	7070
	Option 7 + 20%	6300	3879	4878	5710	6541	7360
Brentwood / Nag's Head WWTW	Option 7	7000	7516	7885	8114	8344	8563
	Option 7 + 10%	7000	7516	7922	8174	8427	8668
	Option 7 + 20%	7000	7516	7958	8234	8510	8772

5.3.8

5.3.9 Table 5.2 shows that the capacity is approached or exceeded for four of the five WWTWs, and these exceedances and their implications are summarised as follows:

- Shenfield and Hutton WwTW should have sufficient capacity and will not need to be upgraded before 2033 under the planned development schedule.
- Doddinghusrt WwTW will have sufficient capacity to accommodate the increased DWF flows but will be within 10% of its capacity from 2025.
- The Ingatestone WwTW is currently within 10% of its consented DWF flow, and the planned developments would result in the DWF being exceeded by up to 20-30% from 2030.
- The Upminster WwTW is projected to approach and exceed its consented DWF from around 2030 under the base case option but could be by as much as 10-20% over based on the Option 7+10% or Option 7+20% scenarios.
- The DWFs for Brentwood WwTW are currently calculated to exceed the consented DWF. Increased flows from the planned developments are project to exceed the DWF by 10-20% from 2020 and by 20-30% from 2033 (under the base case) or from 2030 under Option 7 + 10% and Option 7 + 20%.

Overall, the calculations indicate that only Shenfield and Hutton has sufficient capacity to manage the increased flows under the proposed development scheme. The other WwTWs will need to be upgraded to increase capacity/improve treatment, or for flows to be diverted elsewhere in order to handle the projected increased DWFs. DWFs up to 20-30% above the consent limit are estimated for the Ingatestone and Brentwood WwTWs. The calculations do not indicate that flows for any of the WwTWs will exceed permitted flows by greater than 30% of the consent limits.

5.4 Conclusions

5.4.1 The assessments of impacts on water quality and the WwTW show future housing growth is not predicted to cause significant deterioration in water quality for the Shenfield & Hutton, Ingatestone and Brentwood WwTWs. The housing growth is predicted to give rise to deterioration in water quality with respect to WFD class for ammonia at the Doddinghurst and Upminster WwTWs: under the current conditions the 90th percentile ammonia concentrations are very close to the class boundary, such that additional loading could cause a class change.

5.4.2 Preventing the modelled WFD class deterioration could be achieved through improvement in discharge quality, namely a reduction in ammonia loading, and therefore, permit levels may need to be revised for ammonia at Doddinghurst and Upminster WwTWs.

5.4.3 Assessment of DWFs indicate that Shenfield & Hutton WwTW will remain within their DWF permit levels, but that the other four WwTWs would need to consider capacity upgrades, diversion of flows and/or water reduction measures to provide additional treatment capacity/headroom.

5.4.4 It has been identified that there may need to be some consideration to sewerage network upgrade evidenced by modelled flooding of Ingatestone High Street during a 1 in 100 year annual event due to capacity of sewer network in the area. Anglian Water and Thames Water should be approached to discuss specific developments and whether the sewage network capacity can handle the additional flows.

6. Strategy recommendations

This section summarises the strategy recommendations for water resource availability and water quality in order to meet planned growth targets.

6.1 Overview

6.1.1 The water quality and water resource assessments have shown that some actions may be required. However, measures to be implemented for water resources have already been identified through the water company business plans. For water quality the following issues were identified: operational capacity of the WwTWs, ability to receive sewer flows; and ammonia class deterioration downstream of Doddinghurst WwTW and Upminster WwTW. This section outlines both site based and catchment based options for managing increased flows due to housing growth and their lead in time.

6.2 Water Resources Assessments

6.2.1 The review of Affinity and South East waters WRMPs provided in this high level review of water resources suggests that both companies have the potential to provide enough capacity within each of the water resources zones to accommodate additional development however, further confirmation from the individual water companies will be required to assess what developments are occurring outside of the Brentwood area, and to ensure that the individual developments proposed have been fully incorporated into each WRMP, and water can be supplied by each of the water companies operating in the area.

6.3 Water Quality Assessments

Ammonia, phosphate and BOD

6.3.1 Downstream of Doddinghurst WwTW there is a predicted WFD class deterioration for Ammonia. For Upminster, modelling indicates that Ammonia levels are already predicted to be very close to the Good/Moderate class boundary and that additional housing could cause a WFD Class deterioration with respect to Ammonia. Therefore, permit revisions have been recommended for both those WwTWs in order to mitigate against a change of WFD class. However, current and predicted 90th percentile ammonia concentrations downstream of Upminster WwTW lie very close to the WFD Good/Moderate class boundary, both in the modelled baseline and future scenarios (the 90th percentile monitored ammonia concentration downstream of Upminster WwTW in 2013-2015 is 0.595 mg/l, compared with the class boundary of 0.60 mg/l). Given the uncertainty in growth forecasts and the model predictions, and conservatism in input data (the assumption of 5 occupants per dwelling) it is recommended that actual housing growth is regularly reviewed against forecasts and the need for a revised permit reconsidered as individual applications come forward for consideration.

6.3.2 For Doddinghurst WwTW the projected mean discharge quality required to prevent class deterioration is 0.42 mg/L. The projected 95-percentile discharge quality required to prevent class deterioration is 0.98 mg/L. This should be achieved by 2020.

6.3.3 For Upminster WwTW the projected mean discharge quality required to prevent class deterioration is 0.36 mg/L. The projected 95-percentile discharge quality required to prevent class deterioration is 0.83 mg/L. This should be achieved by 2020.

6.3.4 In addition to the WFD class and the 10% deterioration aim, it is also necessary to consider the EA's WFD aim that all water bodies should achieve 'Good Status' for rivers, lakes, coastal waters and groundwater by no later than 2027. The proposed housing development plans are predicted to lead to increases to discharge loadings of BOD, Ammonia and Phosphate, and to achieve the EA's objective of Good status means that there is an overall requirement to improve water quality within the

catchments not at Good status. Therefore, potentially, housing growth may not be supported where it will make achieving 'Good status' more difficult (i.e. by increasing total nutrient loadings in the rivers).

6.3.5 Growth and additional housing means that WwTW discharge flows will increase. However, if appropriate actions are undertaken to reduce nutrient loading then housing growth may not be at odds with achieving Good status by 2027. Net reductions in nutrient loading within the catchment could be achieved by improving treatment/lowering discharge loads, or by reducing nutrient loading from other sources.

WwTW Capacity

6.3.6 A capacity upgrade to a WwTW generally requires a physical increase to the WwTW size although it can be achieved by changes to management practices at the WwTW. However, the scale of the upgrade can have significant implications on lead in times for when the WwTW would be fully operational. **Error! Reference source not found.**6.1 shows the general lead in times used when planning for these such upgrades.

6.3.7 As shown in Section 5, Doddinghurst, Ingatestone, Upminster and Brentwood WwTWs should review the need for capacity upgrades in order to accommodate the increase in sewage from future housing development.

6.3.8 The predicted DWF exceeds the current consent limit by between 20% and 30% for Ingatestone and Brentwood WwTWs by 2033, and by 10-20% for Upminster WwTW. Therefore, the recommendation for these WwTWs is to consider transfer of flows to an adjacent WwTW (Table 6.1). Lead in time for this option is 1-3 years, so can be delivered within the life of the Local Plan. Alternatively, a combination of review of consent limits and water reduction measures could be implemented to manage future flows

Table 6.1 Lead in times for different options to increase capacity at WwTWs

Interventions	Lead in times
0 – 10% increase: Review consent	N/A
10%-20& increase: Reduce Infiltration and/or water use reduction measures.	1 – 2yrs
20%-30% increase: Consider transfer of flows to an adjacent WwTW which has capacity	1 – 3 yrs
Greater than 30% increase: Consider upgrade of small works	2 – 5 yrs
Greater than 30% increase: Consider upgrade of large works	5 -10 yrs.

6.4 Summary

6.4.1 It is recommended that Doddinghurst, Ingatestone, Upminster and Brentwood WwTWs review volumetric capacity to manage future DWF as a result of increased housing growth within their respective catchment areas. A diversion of flows to nearby WwTW could be considered or a combination of review of consent limits and water reduction measures.

6.4.2 A permit revision has been recommended for Ammonia at Doddinghurst WwTW and Upminster WwTW (although the requirement for revision at Upminster is noted to be uncertain).

6.5 Action Plan

Table 6.2 Action Plan

WwTW	Water Body ID and Water Body Name	Operational Catchment	Now	By 2020	By 2025	By 2030	Examples of measures
Doddinghurst	GB105037028720 - Doddinghurst Brook	Chelmer		Update permit levels for ammonia	WwTW capacity upgrade		Divert flows to nearby WwTW or undertake a combination of review of consent limits and water reduction measures
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Chelmer					
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Chelmer	WwTW capacity upgrade				Divert flows to nearby WwTW or undertake a combination of review of consent limits and water reduction measures
Upminster	GB106037028080 - Mardyke (West Tributary)	Mardyke		Update permit levels for ammonia	WwTW capacity upgrade		Divert flows to nearby WwTW or undertake a combination of review of consent limits and water reduction measures
Brentwood	GB106037028130 - Ingrebourne	Roding Beam and Ingrebourne	WwTW capacity upgrade				Divert flows to nearby WwTW or undertake a combination of review of consent limits and water reduction measures

Appendix A
Housing Growth Options in The Brentwood Borough to be Delivered by 2033

Site Ref	Settlement Area	Site Name	Gross Site Area (ha)	Net Developable Area (ha)	Estimated Dwelling Yield (Net) to 2033 (Net)	Assumed Waste Water Treatment Works	Water Supplier
2	Brentwood	Brentwood Railway Station car park	1.07	0.96	100	Brentwood	Essex and Suffolk Water
3	Brentwood	Wates Way Industrial Estate, Ongar Road, Brentwood	0.99	0.89	80	Brentwood	Essex and Suffolk Water
39	Brentwood	Westbury Road Car Park, Westbury Road, Brentwood	0.27	0.27	45	Brentwood	Essex and Suffolk Water
40	Brentwood	Chatham Way / Crown Street Car Park, Brentwood	0.33	0.33	31	Brentwood	Essex and Suffolk Water
41	Brentwood	Land at Hunter House, Brentwood	0.21	0.21	48	Brentwood	Essex and Suffolk Water
81	Warley	Council Depot, The Drive Warley	2.98	2.24	123	Upminster	Essex and Suffolk Water
102	Brentwood	William Hunter Way car park, Brentwood	1.3	1.22	300 300 (179-300 range)	Brentwood	Essex and Suffolk Water
117A &117B	Warley	Ford Offices, Eagle Way, Warley, Brentwood	8.09	4	350	Upminster	Essex and Suffolk Water
186	Shenfield	Land at Crescent Drive, Shenfield	1.54	1.39	55	Shenfield & Hutton	Essex and Suffolk Water
311	Shenfield	Eagle and Child Pub, Shenfield	0.24	0.24	20	Shenfield & Hutton	
044 &178	Brentwood	Land at Priests Lane, Shenfield	5.12	3.84	95	Shenfield & Hutton	Essex and Suffolk Water
020; 021 & 152	West Horndon	West Horndon Industrial Estate, Childerditch Lane and Stateion Road, West Horndon	17.06	10.23	580	Upminster	
10	Pilgrims Hatch	Sow and Grow, Ongar Road, Pilgrims Hatch	1.2	1.08	38	Shenfield & Hutton	Essex and Suffolk Water
22	Brentwood	Land at Honeypot Lane, Brentwood	10.93	7.09	200	Brentwood	Essex and Suffolk Water
023A & 023B	Pilgrims Hatch / Brentwood	Land off Doddinghurst Road, either side of A12,	8.19	6.14	200	Shenfield & Hutton / Brentwood (even split).	Essex and Suffolk Water
27	Warley	Land adjacent to Carmel, Mascalls Lane, Warley	0.34	0.34	9	Brentwood	Essex and Suffolk Water
32	Brentwood	Brook Street Land east of Nags Head Lane,	5.88	4.35	125	Brentwood	Essex and Suffolk Water
034, 087,235 & 276	Shenfield	Officer's Meadow, land off Alexander Lane, Shenfield	24.44	15.89	510	Shenfield & Hutton	Essex and Suffolk Water
83	Warley	Land west of Warley Hill, Pastoral Way, Warley	2.21	1.6	43	Brentwood	Essex and Suffolk Water
158	Shenfield	Land north of A1023 Chelmsford Road, Shenfield	4.45	3.44	100	Shenfield & Hutton	Essex and Suffolk Water
263	Shenfield	Land east of Chelmsford Road, Shenfield	9.85	8.87	215	Shenfield & Hutton	Essex and Suffolk Water
079A	Ingatestone	Land adjacent to Ingatestone by-pass (part bounded by Roman Road, south of flyover)	1.39	1.25	57	Ingatestone	Essex and Suffolk Water
106	Ingatestone	Site adjacent to Ingatestone Garden Centre (former A12 works site)	4.65	3.49	41	Ingatestone	Essex and Suffolk Water
128	Ingatestone	Ingatestone Garden Centre, Roman Road, Ingatestone	3.45	2.44	120	Ingatestone	Essex and Suffolk Water
075B	Kelvedon Hatch	Land off Stocks Lane, Kelvedon Hatch	2.15	1.61	30	Doddinghurst	Affinity Water
76	Blackmore	Land south of Redrose Lane, north of Orchard Piece, Blackmore	1.69	1.52	30	Doddinghurst	Affinity Water
77	Blackmore	Land south of Redrose Lane, north of Woollard Way, Blackmore	3.3	2.48	40	Doddinghurst	Affinity Water
194	Kelveldon Hatch	Brizes Corner Field, Blackmore Road, Kelvedon Hatch	0.87	0.78	23	Doddinghurst	Affinity Water
294	Hook End / Tipps Cross	Chestnut Field, Blackmore Road, Hook End	0.33	0.33	5	Doddinghurst	Affinity Water
085B	Hook End / Tipps Cross	Land adjacent to Tipps Cross Community Hall, Blackmore Road, Tipps Cross	0.33	0.33	5	Doddinghurst	Affinity Water
200 -	Strategic Allocation	Dunton Hills Garden Village	257	128.5	**2,500** (2,500 in plan period to 2033; 4,000 total Beyond Plan Period)	Upminster	

Appendix B
Summary Data Inputs, Workings and Results for Housing Growth Options

Please See Zipped File Appendix B1 – B3

Appendix C
Simcat Model Output Summary Tables

Doddinghurst WwTW: Simcat Model Output Summary

Location		Option 7				Option 7 + 10%				Option 7 + 20%			
		Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point
Parameter		BOD 90%ile (mg/l)				BOD 90%ile (mg/l)				BOD 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	4				4				4			
	Good	5				5				5			
	Moderate	6.5				6.5				6.5			
	Poor	9				9				9			
Baseline (up to 2015)		1.77	1.46	2.45	2.36	1.77	1.46	2.45	2.36	1.77	1.46	2.45	2.36
Baseline + 10%					2.59				2.59				2.59
2020		1.77	1.46	2.49	2.42	1.77	1.46	2.50	2.43	1.77	1.46	2.50	2.43
2025		1.77	1.46	2.50	2.43	1.77	1.46	2.51	2.43	1.77	1.46	2.51	2.44
2030		1.77	1.46	2.51	2.44	1.77	1.46	2.52	2.44	1.77	1.46	2.52	2.45
2036		1.77	1.46	2.52	2.45	1.77	1.46	2.52	2.45	1.77	1.46	2.53	2.46

Parameter		AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.3				0.3				0.3			
	Good	0.6				0.6				0.6			
	Moderate	1.1				1.1				1.1			
	Poor	2.5				2.5				2.5			
Baseline (up to 2015)		0.39	0.34	0.66	0.59	0.39	0.34	0.66	0.59	0.13	0.34	0.66	0.59
Baseline + 10%					0.65				0.65				0.65
2020		0.39	0.34	0.68	0.62	0.39	0.34	0.69	0.63	0.12	0.34	0.69	0.63
2025		0.39	0.34	0.69	0.63	0.39	0.34	0.69	0.63	0.12	0.34	0.70	0.63
2030		0.39	0.34	0.70	0.63	0.39	0.34	0.70	0.63	0.12	0.34	0.70	0.64
2036		0.39	0.34	0.70	0.63	0.39	0.34	0.70	0.64	0.12	0.34	0.71	0.64

Parameter		PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.040				0.040				0.040			
	Good	0.072				0.072				0.072			
	Moderate	0.17				0.17				0.17			
	Poor	0.86				0.86				0.86			
Baseline (up to 2015)		0.13	0.24	0.31	0.31	0.13	0.24	0.31	0.31	0.13	0.24	0.31	0.31
Baseline + 10%					0.34				0.34				0.34
2020		0.12	0.24	0.31	0.31	0.12	0.24	0.31	0.31	0.12	0.24	0.31	0.31
2025		0.12	0.24	0.31	0.31	0.12	0.24	0.31	0.31	0.12	0.24	0.31	0.32
2030		0.12	0.24	0.31	0.32	0.12	0.24	0.31	0.32	0.12	0.24	0.31	0.32
2036		0.12	0.24	0.31	0.32	0.12	0.24	0.31	0.32	0.12	0.24	0.31	0.32

***Greyed boxes are 'baseline +10%' for comparison with EA objective (no deterioration greater than 10%). These are calculated limits for comparison, not model results.**

Shenfield WwTW: Simcat Model Output Summary

		Option 7				Option 7 + 10%				Option 7 + 20%			
Location		Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point
Parameter		**BOD 90%ile (mg/l)**				**BOD 90%ile (mg/l)**				**BOD 90%ile (mg/l)**			
WFD class boundaries (i.e. lower limits)	High	**4**				**4**				**4**			
	Good	**5**				**5**				**5**			
	Moderate	**6.5**				**6.5**				**6.5**			
	Poor	**9**				**9**				**9**			
Baseline (up to 2015)		2.02	1.87	2.20	2.18	2.02	1.87	2.20	2.18	2.02	1.87	2.20	2.18
Baseline + 10%					2.40				2.40				2.40
2020		2.02	1.88	2.21	2.19	2.02	1.88	2.22	2.19	2.02	1.88	2.22	2.19
2025		2.02	1.88	2.22	2.19	2.02	1.88	2.23	2.20	2.02	1.88	2.23	2.20
2030		2.02	1.88	2.23	2.20	2.02	1.88	2.23	2.20	2.03	1.88	2.23	2.20
2036		2.02	1.88	2.23	2.20	2.03	1.88	2.24	2.21	2.03	1.88	2.24	2.21
Parameter		**AMMONIA 90%ile (mg/l)**				**AMMONIA 90%ile (mg/l)**				**AMMONIA 90%ile (mg/l)**			
WFD class boundaries (i.e. lower limits)	High	**0.3**				**0.3**				**0.3**			
	Good	**0.6**				**0.6**				**0.6**			
	Moderate	**1.1**				**1.1**				**1.1**			
	Poor	**2.5**				**2.5**				**2.5**			
Baseline (up to 2015)		0.27	0.15	0.60	0.57	0.27	0.15	0.60	0.57	0.27	0.15	0.60	0.57
Baseline + 10%					0.62				0.62				0.62
2020		0.27	0.15	0.60	0.57	0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57
2025		0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57
2030		0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57
2036		0.27	0.15	0.61	0.57	0.27	0.15	0.61	0.57	0.27	0.15	0.62	0.57
Parameter		**PHOSPHATE MEAN (mg/l)**				**PHOSPHATE MEAN (mg/l)**				**PHOSPHATE MEAN (mg/l)**			
WFD class boundaries (i.e. lower limits)	High	**0.036**				**0.036**				**0.036**			
	Good	**0.065**				**0.065**				**0.065**			
	Moderate	**0.157**				**0.157**				**0.157**			
	Poor	**0.831**				**0.831**				**0.831**			
Baseline (up to 2015)		0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29
Baseline + 10%					0.32				0.32				0.32
2020		0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29
2025		0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29
2030		0.25	0.21	0.29	0.30	0.25	0.21	0.29	0.29	0.25	0.21	0.29	0.29
2036		0.25	0.21	0.29	0.30	0.26	0.21	0.29	0.29	0.26	0.21	0.29	0.29

***Greyed boxes are 'baseline +10%' for comparison with EA objective (no deterioration greater than 10%). These are calculated limits for comparison, not model results.**

Ingatestone WwTW: Simcat Model Output Summary

		Option 7				Option 7 + 10%				Option 7 + 20%			
Location		Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point
Parameter		BOD 90%ile (mg/l)				BOD 90%ile (mg/l)				BOD 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	4				4				4			
	Good	5				5				5			
	Moderate	6.5				6.5				6.5			
	Poor	9				9				9			
Baseline (up to 2015)		1.60	1.55	1.65	1.65	1.60	1.55	1.65	1.65	1.60	1.55	1.65	1.65
Baseline + 10%					1.82				1.82				1.82
2020		1.59	1.56	1.67	1.67	1.59	1.56	1.67	1.67	1.59	1.56	1.68	1.67
2025		1.59	1.56	1.68	1.67	1.59	1.56	1.68	1.67	1.59	1.55	1.68	1.67
2030		1.60	1.55	1.68	1.67	1.60	1.55	1.68	1.68	1.60	1.55	1.69	1.68
2036		1.60	1.55	1.69	1.68	1.60	1.55	1.69	1.69	1.60	1.55	1.70	1.69

Parameter		AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.3				0.3				0.3			
	Good	0.6				0.6				0.6			
	Moderate	1.1				1.1				1.1			
	Poor	2.5				2.5				2.5			
Baseline (up to 2015)		0.29	0.27	0.34	0.34	0.29	0.27	0.34	0.34	0.29	0.27	0.34	0.34
Baseline + 10%					0.37				0.37				0.37
2020		0.29	0.27	0.35	0.34	0.29	0.27	0.34	0.34	0.29	0.27	0.35	0.34
2025		0.29	0.27	0.35	0.35	0.29	0.27	0.35	0.35	0.29	0.27	0.35	0.35
2030		0.29	0.27	0.35	0.35	0.29	0.27	0.35	0.35	0.29	0.27	0.36	0.35
2036		0.29	0.28	0.36	0.35	0.29	0.28	0.36	0.35	0.29	0.28	0.36	0.36

Parameter		PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.035				0.035				0.035			
	Good	0.065				0.065				0.065			
	Moderate	0.156				0.156				0.156			
	Poor	0.827				0.827				0.827			
Baseline (up to 2015)		0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31
Baseline + 10%					0.34				0.34				0.34
2020		0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31
2025		0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31
2030		0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31
2036		0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31	0.28	0.28	0.31	0.31

***Greyed boxes are 'baseline +10%' for comparison with EA objective (no deterioration greater than 10%). These are calculated limits for comparison, not model results.**

Upminster WwTW: Simcat Model Output Summary

		Option 7				Option 7 + 10%				Option 7 + 20%			
Location		Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point
Parameter		BOD 90%ile (mg/l)				BOD 90%ile (mg/l)				BOD 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	4				4				4			
	Good	5				5				5			
	Moderate	6.5				6.5				6.5			
	Poor	9				9				9			
Baseline (up to 2015)		2.65	2.62	2.84	2.70	2.65	2.62	2.84	2.70	2.65	2.62	2.84	2.70
Baseline + 10%					2.96				2.96				2.96
2020		2.65	2.62	2.84	2.74	2.65	2.62	2.88	2.74	2.65	2.62	2.84	2.74
2025		2.65	2.62	2.84	2.77	2.65	2.62	2.91	2.78	2.65	2.62	2.84	2.78
2030		2.65	2.62	2.84	2.81	2.65	2.62	2.95	2.81	2.65	2.62	2.84	2.81
2036		2.65	2.62	2.84	2.83	2.65	2.62	2.97	2.83	2.65	2.62	2.84	2.83

Parameter		AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.3				0.3				0.3			
	Good	0.6				0.6				0.6			
	Moderate	1.1				1.1				1.1			
	Poor	2.5				2.5				2.5			
Baseline (up to 2015)		0.69	0.68	0.62	0.58	0.69	0.68	0.62	0.58	0.69	0.68	0.62	0.58
Baseline + 10%					0.64				0.64				0.64
2020		0.69	0.68	0.64	0.60	0.69	0.68	0.64	0.60	0.69	0.68	0.64	0.60
2025		0.69	0.68	0.64	0.59	0.69	0.68	0.64	0.60	0.69	0.68	0.63	0.60
2030		0.69	0.68	0.64	0.60	0.69	0.68	0.64	0.60	0.69	0.68	0.64	0.60
2036		0.69	0.68	0.64	0.60	0.69	0.68	0.64	0.60	0.69	0.68	0.65	0.60

Parameter		PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.039				0.039				0.039			
	Good	0.071				0.071				0.071			
	Moderate	0.167				0.167				0.167			
	Poor	0.855				0.855				0.855			
Baseline (up to 2015)		1.37	1.39	3.41	3.08	1.37	1.39	3.41	3.08	1.37	1.39	3.41	3.08
Baseline + 10%					3.39				3.39				3.39
2020		1.37	1.39	3.47	3.15	1.37	1.39	3.48	3.16	1.37	1.39	3.48	3.16
2025		1.37	1.39	3.51	3.20	1.37	1.39	3.52	3.21	1.37	1.39	3.53	3.22
2030		1.37	1.39	3.55	3.25	1.37	1.39	3.56	3.26	1.37	1.39	3.57	3.27
2036		1.37	1.39	3.59	3.29	1.37	1.39	3.60	3.30	1.37	1.39	3.61	3.32

***Greyed boxes are 'baseline +10%' for comparison with EA objective (no deterioration greater than 10%). These are calculated limits for comparison, not model results.**

Brentwood WwTW: Simcat Model Output Summary

Location		Option 7				Option 7 + 10%				Option 7 + 20%			
		Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point	Upstream Sample Point	Upstream of WwTW	Downstream of WwTW	At downstream sample point
Parameter		BOD 90%ile (mg/l)				BOD 90%ile (mg/l)				BOD 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	4				4				4			
	Good	5				5				5			
	Moderate	6.5				6.5				6.5			
	Poor	9				9				9			
Baseline (up to 2015)		2.83	2.86	6.76	6.61	2.83	2.86	6.76	6.61	2.83	2.86	6.76	6.61
Baseline + 10%					7.27				7.27				7.27
2020		2.83	2.86	6.76	6.61	2.83	2.86	6.82	6.66	2.83	2.86	6.82	6.67
2025		2.83	2.86	6.76	6.61	2.83	2.86	6.84	6.69	2.83	2.86	6.85	6.70
2030		2.83	2.86	6.76	6.61	2.83	2.86	6.87	6.73	2.83	2.86	6.87	6.74
2036		2.83	2.86	6.76	6.61	2.83	2.86	6.89	6.76	2.83	2.86	6.90	6.77

Parameter		AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)				AMMONIA 90%ile (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.3				0.3				0.3			
	Good	0.6				0.6				0.6			
	Moderate	1.1				1.1				1.1			
	Poor	2.5				2.5				2.5			
Baseline (up to 2015)		0.21	0.21	0.94	0.91	0.21	0.21	0.94	0.91	0.21	0.21	0.94	0.91
Baseline + 10%					1.01				1.01				1.01
2020		0.21	0.21	0.95	0.92	0.21	0.21	0.95	0.92	0.21	0.21	0.95	0.92
2025		0.21	0.21	0.95	0.92	0.21	0.21	0.95	0.93	0.21	0.21	0.95	0.93
2030		0.21	0.21	0.96	0.93	0.21	0.21	0.96	0.93	0.21	0.21	0.96	0.93
2036		0.21	0.21	0.96	0.93	0.21	0.21	0.97	0.94	0.21	0.21	0.97	0.94

Parameter		PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)				PHOSPHATE MEAN (mg/l)			
WFD class boundaries (i.e. lower limits)	High	0.031				0.031				0.031			
	Good	0.057				0.057				0.057			
	Moderate	0.141				0.141				0.141			
	Poor	0.791				0.791				0.791			
Baseline (up to 2015)		0.15	0.17	1.09	1.07	0.15	0.17	1.09	1.07	0.15	0.17	1.09	1.07
Baseline + 10%					1.18				1.18				1.18
2020		0.15	0.17	1.10	1.08	0.15	0.17	1.10	1.08	0.15	0.17	1.10	1.08
2025		0.15	0.17	1.10	1.08	0.15	0.17	1.10	1.09	0.15	0.17	1.10	1.09
2030		0.15	0.17	1.11	1.09	0.15	0.17	1.11	1.09	0.15	0.17	1.11	1.09
2036		0.15	0.17	1.11	1.09	0.15	0.17	1.11	1.10	0.15	0.17	1.12	1.10

***Greyed boxes are 'baseline +10%' for comparison with EA objective (no deterioration greater than 10%). These are calculated limits for comparison, not model results.**

Appendix D
Model Output Summary

Water Body Water Quality					Housing Growth Scenario - Option 7						
WwTW	Water Body ID and Water Body Name	Determinand	Classification (2016 cycle 2)	2027 Water Body Level Objectives and Elements Predicted to be at Less Than Good Status	Modelled Baseline Class at Downstream Sample Location	Are There Any Upstream Impacts by 2036?	Is There a Risk of Class Deterioration Downstream of the WwTW by 2036?	Will There be a >10% Deterioration in Water Quality downstream of the WwTW by 2036?	Summary	Can The Water body Still Get to Good After Growth	Is an Upgrade Needed to the WwTW (Determinand and New Permits)
Doddinghurst	GB105037028720 - Doddinghurst Brook	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	The EA prediction for 2027 is poor status.	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Poor		Good	None identified	Yes. Baseline model = 0.593 mg/L, 2020 = 0.623 mg/L, 2025 = 0.628 mg/L, 2030 = 0.632 mg/L, 2036 = 0.635 mg/L. Good/moderate boundary is at 0.6 mg/L Baseline model has good status (by 0.007 mg/L). Future epochs are projected to deteriorate to moderate status. Results are too borderline to indicate with confidence that no change in WFD could occur.	No	No upstream impacts, no deterioration above 10% of baseline, but there is a class deterioration by 2020.	No. However, ammonia meets the overall class objective for the waterbody.	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.98 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	Moderate		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	None identified	No.	No	No upstream impacts, no deterioration above 10% of baseline, no class deterioration, when calibration factor is accounted for	Not applicable - already good or better	No
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain poor. All other components assessed are predicted to be good or high	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	A minor deterioration in ammonia concentrations upstream of Ingatestone WwTW has been modelled over the plan period. This is potentially due to Doddinghurst WwTW which is located upstream. The impact is not considered significant as all future projections return to high status, just upstream of the WwTW and no cumulative impact on downstream quality is predicted.	No	No	Not applicable	Not applicable - already good or better	No
Upminster	GB106037028080 - Mardyke (West Tributary)	Phosphate	Bad	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad, dissolved oxygen to be poor, ammonia to be moderate biological quality elements for fish and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Moderate		Moderate	None identified	Yes. Baseline = 0.582 mg/L, 2020 = 0.601 mg/L, 2025 = 0.595 mg/L, 2030 = 0.602 mg/L, 2036 = 0.599 mg/L. Good/moderate boundary is at 0.6 mg/L. Calibration factor = 0.07, meaning that modelled results can be increased by 0.07, to be in line with observed results. However, model reuslts are so close to Class Boundary that a change in class cannot be ruled out.	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.86 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Brentwood	GB106037028130 - Ingrebourne	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad and biological quality elements for macrophytes and phytobenthos combined and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	Good		Poor	None identified	No	No	Not applicable	No objective or prediction for BOD specifically	No
		Ammonia	Good		Poor	None identified	No	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	No

Water Body Water Quality					Housing Growth Scenario - Option 7						
WwTW	Water Body ID and Water Body Name	Determinand	Classification (2016 cycle 2)	2027 Water Body Level Objectives and Elements Predicted to be at Less Than Good Status	Modelled Baseline Class at Downstream Sample Location	Are There Any Upstream Impacts by 2036?	Is There a Risk of Class Deterioration Downstream of the WwTW by 2036?	Will There be a >10% Deterioration in Water Quality downstream of the WwTW by 2036?	Summary	Can The Water body Still Get to Good After Growth	Is an Upgrade Needed to the WwTW (Determinand and New Permits)
Doddinghurst	GB105037028720 - Doddinghurst Brook	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	The EA prediction for 2027 is poor status.	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Poor		Good	None identified	Yes. Baseline model = 0.593 mg/L, 2020 = 0.626 mg/L, 2025 = 0.630 mg/L, 2030 = 0.634 mg/L, 2036 = 0.638 mg/L. Good/moderate boundary is at 0.6 mg/L Baseline model has good status (by 0.007 mg/L). Future epochs are projected to deteriorate to moderate status. Results are too borderline to indicate with confidence that no change in WFD could occur.	No	No upstream impacts, no deterioration above 10% of baseline, but there is a class deterioration by 2020.	No. However, ammonia meets the overall class objective for the waterbody.	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.98 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	Moderate		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	None identified	No.	No	No upstream impacts, no deterioration above 10% of baseline, no class deterioration, when calibration factor is accounted for	Not applicable - already good or better	No
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain poor. All other components assessed are predicted to be good or high	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	A minor deterioration in ammonia concentrations upstream of Ingatestone WwTW has been modelled over the plan period. This is potentially due to Doddinghurst WwTW which is located upstream. The impact is not considered significant as all future projections return to high status, just upstream of the WwTW and no cumulative impact on downstream quality is predicted.	No	No	Not applicable	Not applicable - already good or better	No
Upminster	GB106037028080 - Mardyke (West Tributary)	Phosphate	Bad	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad, dissolved oxygen to be poor, ammonia to be moderate biological quality elements for fish and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Moderate		Moderate	None identified	Yes. Baseline = 0.582 mg/L, 2020 = 0.602 mg/L, 2025 = 0.598 mg/L, 2030 = 0.602 mg/L, 2036 = 0.600 mg/L. Good/moderate boundary is at 0.6 mg/L. Calibration factor = 0.07, meaning that modelled results can be increased by 0.07, to be in line with observed results. However, model reuslts are so close to Class Boundary that a change in class cannot be ruled out.	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.86 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Brentwood	GB106037028130 - Ingrebourne	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad and biological quality elements for macrophytes and phytobenthos combined and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	Good		Poor	None identified	No	No	Not applicable	No objective or prediction for BOD specifically	No
		Ammonia	Good		Poor	None identified	No	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	No

Water Body Water Quality					Housing Growth Scenario - Option 7						
WwTW	Water Body ID and Water Body Name	Determinand	Classification (2016 cycle 2)	2027 Water Body Level Objectives and Elements Predicted to be at Less Than Good Status	Modelled Baseline Class at Downstream Sample Location	Are There Any Upstream Impacts by 2036?	Is There a Risk of Class Deterioration Downstream of the WwTW by 2036?	Will There be a >10% Deterioration in Water Quality downstream of the WwTW by 2036?	Summary	Can The Water body Still Get to Good After Growth	Is an Upgrade Needed to the WwTW (Determinand and New Permits)
Doddinghurst	GB105037028720 - Doddinghurst Brook	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	The EA prediction for 2027 is poor status.	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Poor		Good	None identified	Yes. Baseline model = 0.593 mg/L, 2020 = 0.628 mg/L, 2025 = 0.632 mg/L, 2030 = 0.636 mg/L, 2036 = 0.643 mg/L. Good/moderate boundary is at 0.6 mg/L Baseline model has good status (by 0.007 mg/L). Future epochs are projected to deteriorate to moderate status. Results are too borderline to indicate with confidence that no change in WFD could occur.	No	No upstream impacts, no deterioration above 10% of baseline, but there is a class deterioration by 2020.	No. However, ammonia meets the overall class objective for the waterbody.	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.98 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Shenfield	GB105037028680 - Wid (Doddinghurst Brook - Shenfield STW)	Phosphate	Poor	Moderate due to predicted moderate class for macrophytes and phytobenthos combined and poor class for phosphate	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	Moderate		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	None identified	No.	No	No upstream impacts, no deterioration above 10% of baseline, no class deterioration, when calibration factor is accounted for	Not applicable - already good or better	No
Ingatestone	GB105037028690 - Wid (Ingatestone Hall - Margaretting Hall)	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain poor. All other components assessed are predicted to be good or high	Poor	None identified	No	No	Not applicable	No, The EA prediction for 2027 is poor status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	High		Good	A minor deterioration in ammonia concentrations upstream of Ingatestone WwTW has been modelled over the plan period. This is potentially due to Doddinghurst WwTW which is located upstream. The impact is not considered significant as all future projections return to high status, just upstream of the WwTW and no cumulative impact on downstream quality is predicted.	No	No	Not applicable	Not applicable - already good or better	No
Upminster	GB106037028080 - Mardyke (West Tributary)	Phosphate	Bad	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad, dissolved oxygen to be poor, ammonia to be moderate biological quality elements for fish and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	No class has been indicated		High	None identified	No	No	Not applicable	Not applicable - already good or better	No
		Ammonia	Moderate		Moderate	None identified	Yes. Baseline = 0.582 mg/L, 2020 = 0.601 mg/L, 2025 = 0.596 mg/L, 2030 = 0.602 mg/L, 2036 = 0.603. mg/L. Good/moderate boundary is at 0.6 mg/L. Calibration factor = 0.07, meaning that modelled results can be increased by 0.07, to be in line with observed results. However, model reuslts are so close to Class Boundary that a change in class cannot be ruled out.	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	The permit level needs to be revised. The worse case scenario is 2036 Option7+20%. The projected 95-percentile discharge quality required to prevent class deterioration is 0.86 mg/L. This should be achieved by 2020, as this is when the earliest class deterioration is predicted.
Brentwood	GB106037028130 - Ingrebourne	Phosphate	Poor	No overall water body objective has been set, however the overall water body class is predicted to be moderate due to phosphate predicted to remain bad and biological quality elements for macrophytes and phytobenthos combined and invertebrates to be moderate. All other components assessed are predicted to be good or high	Bad	None identified	No	No	Not applicable	No, the EA prediction for 2027 is bad status	No
		BOD	Good		Poor	None identified	No	No	Not applicable	No objective or prediction for BOD specifically	No
		Ammonia	Good		Poor	None identified	No	No	Not applicable	No, ammonia meets the overall class objective for the waterbody	No