SIMCAT model node	Site Name	2nd cycle standard (mg/l)
PUTR0096	THAMES AT HANNINGTON BRIDGE	0.076
PUTR0097	THAMES AT INGLESHAM	0.077
PUTR0070	RAY AT MORRIS STREET, SWINDON	0.075
PUTR0069	RAY AT MOREDON BRIDGE, SWINDON	0.073
PUTR0071	RAY AT SEVEN BRIDGES, CRICKLADE	0.076
PUTR0072	RAY AT TADPOLE BRIDGE, PURTON	0.076
PUTR0057	KEY AT A419 ROADBRIDGE, CRICKLADE	0.077
PUTR0077	SHARE DITCH AT ROADBRIDGE, CASTLE EATON	0.078
PUTR0025	COLE AT B4019, COLESHILL	0.077
PUTR0104	THAMES AT SOMERFORD KEYNES ROADBRIDGE	0.074
PUTR0009	CERNEY WICK BROOK AT SPINE ROAD, SOUTH CERNEY	0.077
PUTR0051	GREAT BROOK AT CHIMNEY LANE, ASTON	0.082
PUTR0013	CHURN AT GAUGING STATION, CERNEY WICK	0.07
PUTR0017	CHURN BELOW HORSESHOE LAKE FISHERY	0.07
PUTR0014	CHURN AT NORTH CERNEY	0.057
PUTR0213	CHURN 300M BELOW COCKLEFORD FISH FARM	0.053
PUTR0036	COLN AT FOSSEBRIDGE	0.064
PUTR0037	COLN AT GAUGING STATION, BIBURY	0.068
PUTR0039	COLN AT ROUNDHOUSE, LECHLADE	0.076
PUTR0040	COLN AT WITHINGTON	0.058
PUTR0061	LEACH AT B4449, LECHLADE	0.078
PUTR0052	GREAT BROOK AT ISLE OF WIGHT BRIDGE	0.082
PUTR0080	SHILL BROOK AT ROADBRIDGE, BLACK BOURTON	0.077
PUTR0081	SHILL BROOK JUST ABOVE CARTERTON S/W	0.078
PUTR0175	AMPNEY BROOK BELOW AMPNEY MILL	0.071
PUTR0099	THAMES AT NEWBRIDGE	0.079
PUTR0107	THAMES AT WATER INTAKE, BUSCOT	0.077

On this basis the following P targets have been used at the STW discharge points assessed:

Table 3: Phosphate targets by STW

STW	Value	SIMCAT Model Node
ABINGDON (New outfall)	0.085	PTHR0152
ABINGDON (Lagoon)	0.08	PTHR0077
APPLETON	0.084	POCR0011
DIDCOT	0.086	PTHR0041
DRAYTON	0.086	PTHR0314
FARINGDON	0.08	None – default target used
KINGSTON BAGPUIZE	0.08	None – default target used
OXFORD	0.08	None – default target used
SHRIVENHAM	0.075	PUTR0117
STANFORD IN THE VALE	0.081	POCR0019
WANTAGE	0.08	POCR0008

B.3 Methodology

The contaminants assessed were Biochemical Oxygen Demand (BOD), Ammonia (NH_4) and Phosphate (P).

The selected approach was to use the EA River Quality Planning (RQP) tool in conjunction with their recommended guidance documents: "Water Quality Planning: no deterioration and the Water Framework Directive" and "Horizontal guidance"[1]. This uses a steady state Monte Carlo Mass Balance approach where flows and water quality are sampled from modelled distributions based on data where available.

The data required to run the RQP software were:

Upstream river data:

- Mean flow
- 95% exceedance flow
- Mean for each contaminants
- Standard deviation for each contaminant

Discharge data:

- Mean flow
- Standard deviation for the flow
- Mean for each contaminants
- Standard deviation for each contaminant

River quality target data:

- No deterioration target
- 'Good status' target

The above data inputs should be based on observations where available. In the absence of observed data EA guidance requires that:

[1] https://www.gov.uk/government/publications/h1-environmental-risk-assessment-for-permits-overview

- If the observed STW discharge flow and quality data are not available the following values may be used:
  - Flow mean: 1.25*DWF
  - Flow SD: 1/3*mean
  - Quality data: consent values
- If observed river flows were not available this were obtained from an existing model or a low-flows estimation software.
- If observed water quality data were not available these were obtained from an existing model or a neighbouring catchment with similar characteristics.
- Where a treatment works was predicted to lead to either a WFD class deterioration, or a deterioration of greater than 10%, it was necessary to determine a possible future consent value which would prevent either class deterioration or would return the works to a "no deterioration or "load standstill" situation, as follows:
  - For a class deterioration situation, the RQP tool can be set to "calculate required discharge quality" to calculate a consent value that would retain the water body at its current class.
  - For a "no-deterioration" situation, the future scenario presenting the worst case deterioration was used for each determinand. The discharge data Mean Quality and Standard Deviation were iteratively reduced until the present day 90th-percentile value was achieved. The standard deviation was assumed to be 1/3 of the mean.

B.4 Study objectives

RQP models were required to be set up and run using the present-day and 2019/20 and 2030/31 growth scenario effluent flows to assess the impact of the increased contaminant loads on the receiving watercourses due to the extra wastewater flows. These results were required to confirm that there will not be deterioration on the watercourse which will cause a downgrading of the current class for each individual element. This forms the water quality assessment for the Water Cycle Study. Should deterioration result a new consent value was required to be calculated.

Modelling was required to be undertaken for those STWs that are predicted to fail the 'good status' target due to the proposed growth in the population that they serve. This was to determine whether improvements are required both upstream as well as at each STW.

Addressing existing diffuse pollution is beyond the remit of the WCS, and therefore the analysis was undertaken following the assumption that that the upstream diffuse sources of pollution had been addressed (i.e. 'good status' achieved upstream). This was achieved by setting the upstream quality at the level of 'good status' in the model.

Table 4 below lists all the STWs to be assessed together with the actual consents values.

Table 4: STWs to be assessed and consented values

STW	Consented Flow - DWF Max value (m3/d)	Consented BOD 5 Day ATU 95%ile (mg/l)	Consented BOD - Max Value (mg/l)	Consented Ammoniacal Nitrogen as N 95%ile (mg/l)	Consented Ammoniacal Nitrogen as N Max value (mg/l)	Consented Phosphate Max value (mg/l)
ABINGDON (New outfall)	4524	20	55	15	44	2
ABINGDON (Lagoon)	8335	15	50	5	20	2
ABINGDON (Lagoon) from 31/03/2015	8335	10	50	3	May to Oct = 14; Nov to Apr = 20	2
APPLETON	2559	16	51	4	20	
DIDCOT	11476	10	50	9	33	2
DRAYTON	1672	20	56	12	41	

FARINGDON	2812	30	64			
KINGSTON BAGPUIZE	633	15	50	7	27	
OXFORD	50985	10	50	3	May to Oct = 14; Nov to Apr = 20	1
SHRIVENHAM	2842	11	50	2.5	May to Oct = 13; Nov to Apr = 20	
STANFORD IN THE VALE	650	30				
WANTAGE	6250	30	64	5	20	2

B.5 Data collection

The datasets required to assess the discharge consents are the following:

- River flow data (received from the EA)
- River quality data (received from the EA)
- Current STWs consents (received from the EA and Thames Water)
- RQP tool (received from the EA)
- Existing water quality models (received from the EA)
- Current river classifications (received from the EA)
- 2009 base line and 2013 WFD river target for BOD, P and NH_4 (received from the EA, see section B.2)
- EA guidance documents (received from the EA)
- STWs flow and quality data (received from Thames Water)
- STWs discharge information (e.g. location, receiving water, etc.) (received from Thames Water)
- GIS SIMCAT model (received from the EA)

B.6 Input data and results

The input data and RQP results are presented for each STW in a summary table. This contains also the source of each value. The STWs discharge flow statistics were calculated from the Dry Weather Flow (DWF) provided by Thames Water (see section 4.2.4.1 of main report) and as stated in the methodology the mean and standard deviation were estimates using the following relationships:

- Flow mean = 1.25*DWF
- Flow SD = 1/3*mean

Thames Water also provided all the effluent quality data for BOD and Ammonia. For Phosphate (P) data were available only for the sites with P consent limits: Abingdon Lagoon and New Stream, Didcot, Oxford and Wantage. The statistical values were derived from the 2011-13 observed values. For the others sites the data were extracted from the Thames 2009 SIMCAT model. Whilst for BOD and Ammonia Thames Water provided a future concentration value according to the future performances, for phosphate the same parameters were used for all the scenarios because this is removed by chemical dosing and therefore it was assumed that the same P reduction performance can be maintained by increasing the dosing.

All the upstream river flow data were extracted from the SIMCAT model since no low flow estimates were provided. Also the majority of the water river quality data were extracted from SIMCAT (calculated or observed) for two reasons:

- There are no water quality monitoring points upstream of the study STWs.

- The number of samples for the period 2008-13 were too low to make a sound statistical analysis.

B.6.1 Red / Amber / Green Analysis - STWs

Thames Water provided a red / amber / green traffic light score to assess the future final effluent (FE) concentration values for BOD and Ammonia. The colour definitions are shown below (for more information see section 4.2.2.1 of main report):

Can accommodate the proposed site allocation without upgrades	Can accommodate the proposed site allocation without upgrades but will bring the works close to its current capacity limit	Cannot accommodate all proposed site allocation. Further modelling will be required and subsequent upgrades may be needed
<70% of consent (90% for DWF)	70-80% of consent (90-100% for DWF)	>80% of consent (or other known issue)(>100% for DWF)

B.6.2 WFD Compliance

Compliance against WFD targets for the 2019/20 and 2030/31 scenarios was calculated using the Actual situation as baseline. Compliance / or non-compliance is indicated on the results tables as follows:

Modelled water quality is within the WFD target for the determinand in question.	Modelled water quality does not meet the WFD target for the determinand in question.

B.6.3 Abingdon STW (Lagoon outfall)

Abingdon STW has two discharge points: Lagoon and New Stream. Lagoon discharges into the Thames as shown in Figure 1. Note that this analysis only considers the water quality impact at the immediate point of discharge and the combined impacts of both outfalls once their flow combines at the confluence of the Odhay Hill Ditches with the Thames is not considered.

The status of the receiving watercourse is summarised in the Table 5 below where the baseline (2009) and the 2013 status are reported together with the objective for the waterbody.

Table 5: Thames status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Poor	Poor	Good	High	Moderate
2013 status	Moderate	Moderate	Good	High	Moderate
Objective	Good Status by 2027	Good Status by 2027	High status by 2015	NA	2015: Moderate (Disproportionately expensive (P1c))

Figure 1: GIS SIMCAT map of Abingdon Lagoon discharge location.

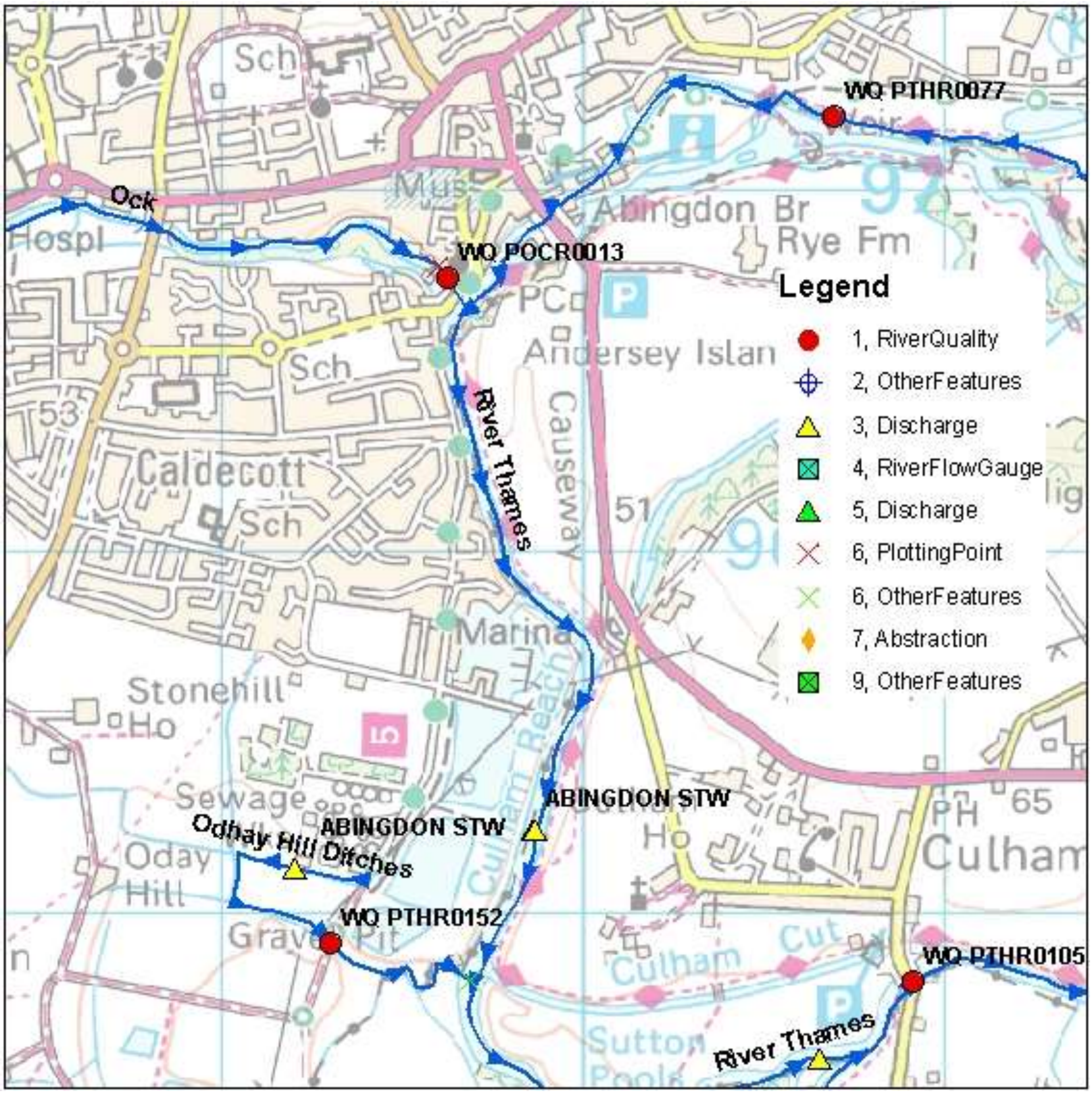


Table 6 shows the input data and RQP results for Abingdon Lagoon. The works has consented values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will be working below such values but it will be close to its current capacity for BOD. As predicted deterioration is less than 10%, no amendments to the consent would be required.

Table 6: input data and RQP results for Abingdon Lagoon STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	2773.5	SIMCAT calculated value just upstream STW	7.81	Thames Water	NA	7.99	Thames Water	NA	7.5	Thames Water	NA
	SD			2.6			2.66			2.5		
	5%ile	611.5										
BOD (mg/l)	Mean	1.25	U/s WQ point PTHR0077 from SIMCAT	4.2	Thames Water	2.04	4.3	Thames Water	2.04	4.3	Thames Water	2.04
	SD	0.62										
	95%ile			7.4			7.6			7.6		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.06	U/s WQ point PTHR0077 from SIMCAT	0.7	Thames Water	0.11	0.8	Thames Water	0.11	0.8	Thames Water	0.11
	SD	0.04										
	95%ile			1.7			1.9			2		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	U/s WQ point PTHR0077 from SIMCAT	1.18	Thames Water	0.27	1.18	Thames Water	0.27	1.18	Thames Water	0.27
	SD	0.08		0.87			0.87			0.87		
	Target Mean	0.08	2013 WFD									

The upstream WQ point is 2.98km from the discharge point. Table 7 below shows the statistics used in SIMCAT and those derived from the observed data provided:

Table 7: statistics used in SIMCAT and those derived from the observed data for WQ point PTHR0077.

			SIMCAT model				Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Distribution	Mean	SD	Samples	Data period
PTHR0077	2.98	BOD	1.254	0.622	36	2 Log-Normal			no data	
PTHR0077	2.98	Amm	0.055	0.038	38	1 Normal	0.019	0.01	5	09 only
PTHR0077	2.98	P	0.167	0.081	38	2 Log-Normal	0.121	0.063	5	09 only

Due to the low number of samples for the period 09-13 the SIMCAT data were used. This was a conservative assumption since the SIMCAT values for mean Ammonia and Phosphate are higher than those from the observed data. For consistency the SIMCAT observed data were used also for BOD. The EA guidance suggests considering the effect of the natural purification when the upstream point is some distance from the discharge point. However in order to take into account the load from the river Ock, which joins the Thames between the WQ point and the STW, no decay rate has been applied, again maintaining a degree of conservatism. Table 8 shows the SIMCAT calculated values immediately upstream of the STW:

Table 8: SIMCAT calculated values immediately upstream of the STW.

SIMCAT calculated values		
Pollutant	**Mean**	**SD**
BOD	1.260	0.190
Amm	0.039	0.016
P	0.248	0.075

Figure 2 and Figure 3 show the 2009 SIMCAT results where phosphate is the only pollutant that breaches the target. The RQP results confirm that the upstream WFD target for phosphate is not achieved for the present-day situation and the future scenarios. "No deterioration" is achieved for all pollutants.

SIMCAT shows that the watercourse fails its phosphate target upstream of the STW. The RQP function to calculate the required discharge quality in order to meet the river target using the present-day situation as input data (see Table 6) reports that: "the river quality target is not achievable without improving the upstream water quality".

The RQP tool was also run using the SIMCAT calculated values for BOD to check the impact of our assumption in choosing the input data. Table 9 shows that by using a smaller SD and a similar mean there is a lower impact on the downstream river concentration.

Table 9: input data and RQP results for BOD using SIMCAT calculated values.

Parameter	**Statistic**	**River**	**Source**	**Present day (2013)**			**2019/20**			**2030/31**		
				STW	**Source**	**RQP Result**	**STW**	**Source**	**RQP Result**	**STW**	**Source**	**RQP Result**
Flow (Ml/d)	**Mean**	2773.5	SIMCAT calculated value just upstream STW	7.81			7.99	Thames Water		7.5	Thames Water	
	SD			2.6	Thames Water	NA	2.66		NA	2.5		NA
	5%ile	611.5										
BOD (mg/l)	**Mean**	1.26	SIMCAT calculated value just upstream STW	4.2			4.3			4.3		
	SD	0.19			Thames Water	1.52		Thames Water	1.52		Thames Water	1.52
	95%ile			7.4			7.6			7.6		
	Target 90%ile	5	2013 WFD									

Figure 2: SIMCAT result for flow and phosphate.

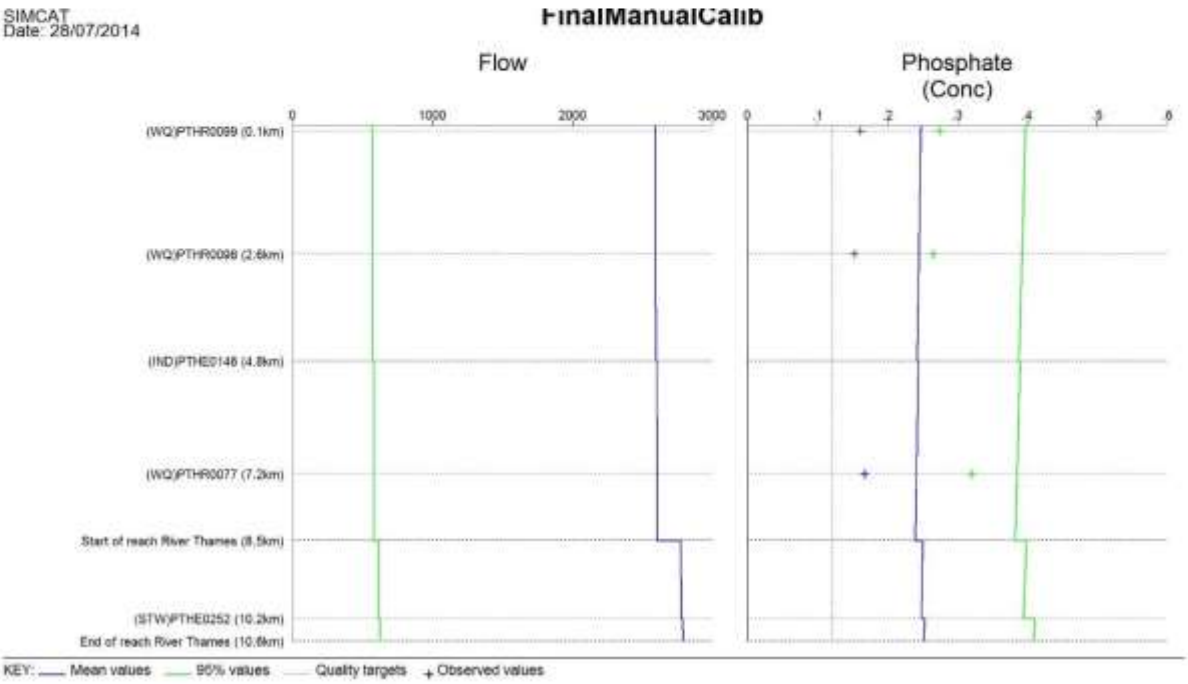
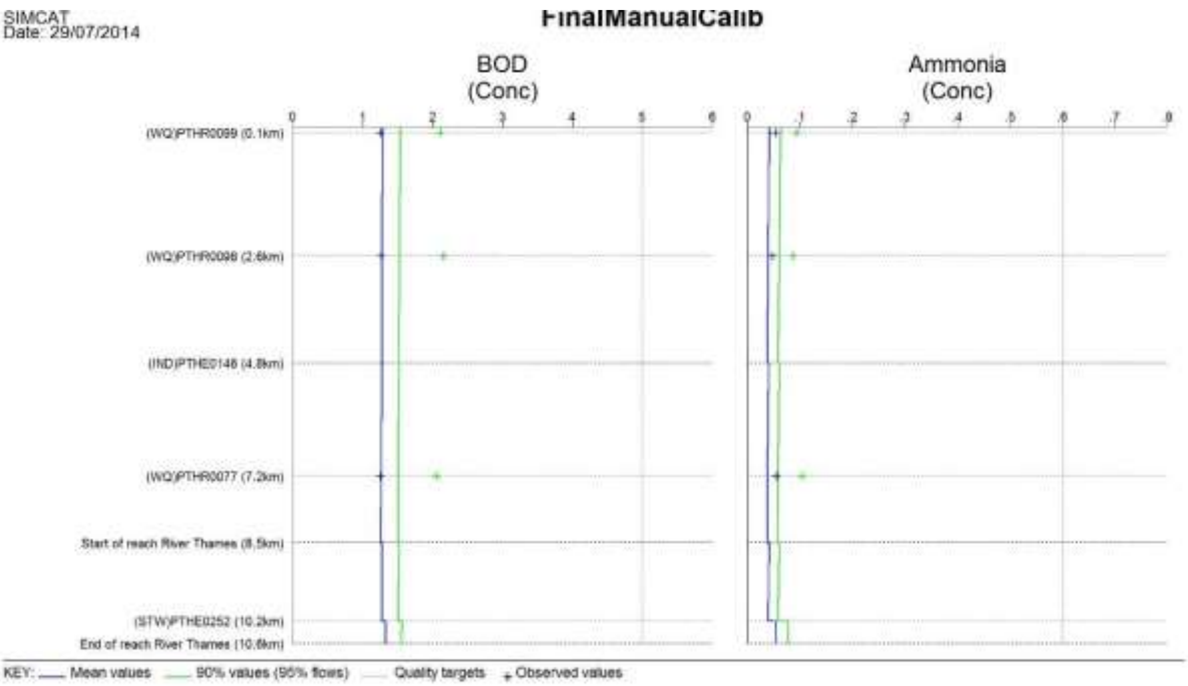


Figure 3: SIMCAT result for BOD and Ammonia.



B.6.4 Abingdon STW (New Stream Outfall)

Abingdon STW has two discharge points: Lagoon and New Stream. New Stream discharges into the Odhay Hill Ditches as shown in Figure 4. Note that this analysis only considers the water quality impact at the immediate point of discharge and the combined impacts of both outfalls once their flow combines at the confluence of the Odhay Ditches with the Thames is not considered.

The status of the receiving watercourse is summarised in the Table 10 below:

Table 10: Odhay Hill Ditches status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Poor	Poor	Good	High	Moderate
2013 status	Moderate	Moderate	Good	High	Moderate
Objective	Good Status by 2027	Good Status by 2027	High status by 2015	NA	2015: Moderate (Disproportionately expensive (P1c))

Figure 4: GIS SIMCAT map of Abingdon New Stream discharge location.

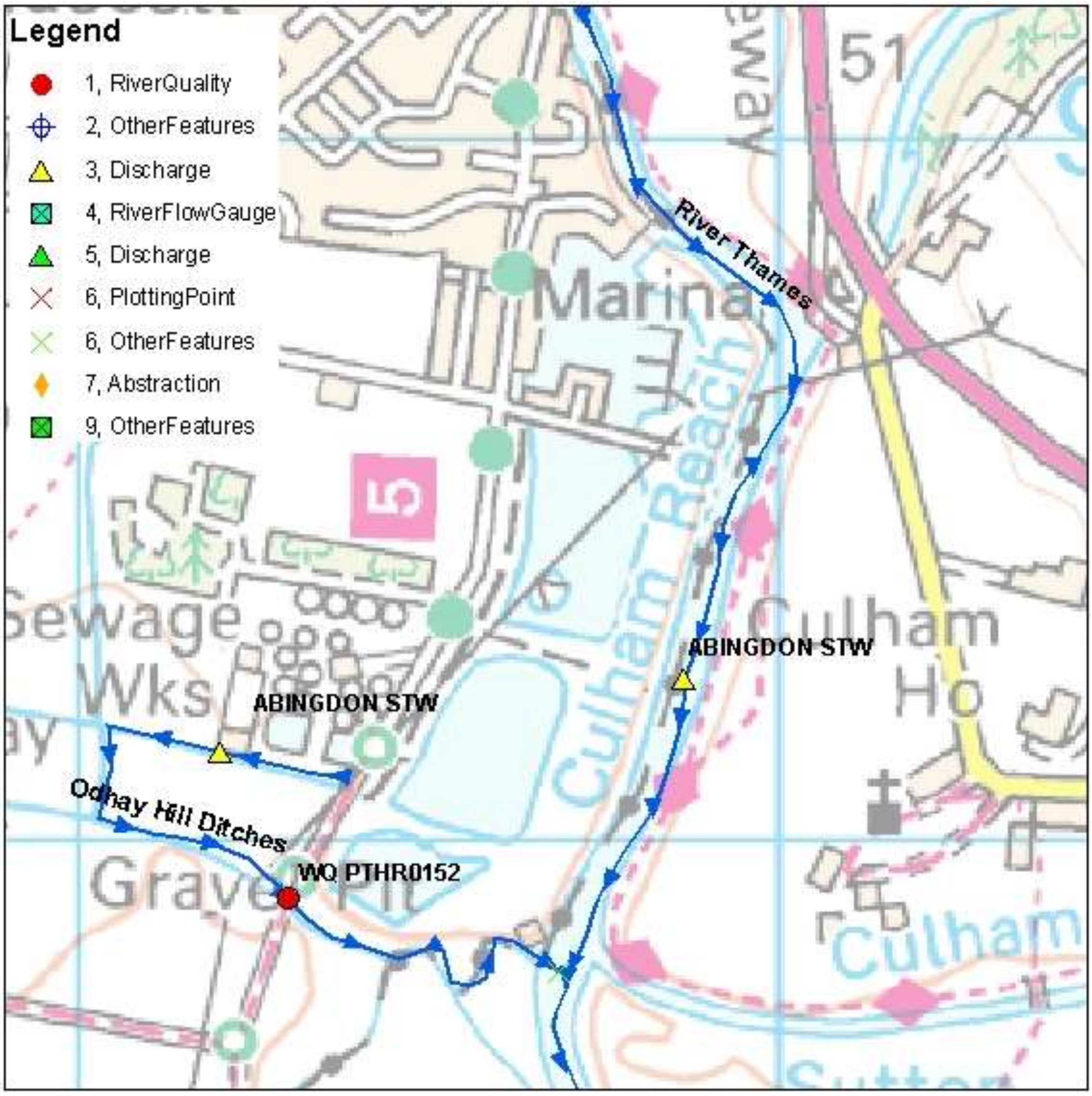


Table 11 shows the input data and RQP results for Abingdon New Stream. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its consent, but it will be close to its current capacity for BOD.

Table 11: input data and RQP results for Abingdon New Stream STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	1.51	SIMCAT calculated value just upstream STW	2.92	Thames Water	NA	2.96	Thames Water	NA	2.72	Thames Water	NA
	SD			0.97			0.99			0.91		
	5%ile	0.53										
BOD (mg/l)	Mean	4.57	SIMCAT calculated value just upstream STW	7.8	Thames Water	9.85	8	Thames Water	10.07	8	Thames Water	10.04
	SD	3.63										
	95%ile			12.8			13.1			13.2		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.83	SIMCAT calculated value just upstream STW	2.2	Thames Water	3.23	2.4	Thames Water	3.55	2.5	Thames Water	3.61
	SD	0.33										
	95%ile			5.1			5.7			5.9		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	1.38	Thames Water	1.77	1.38	Thames Water	1.77	1.38	Thames Water	1.73
	SD	0.034		0.76			0.76			0.76		
	Target Mean	0.085	2013 WFD									

There is no WQ point upstream of the STW and the river quality data were taken from the SIMCAT calculated values just upstream of the discharge point. The model underestimates the observed data for BOD and ammonia as shown in Figure 5 and Figure 6. However it indicates a failure of the targets for all the pollutants.

The RQP results indicate that the watercourse fails its targets for BOD, NH_4 and P for the present-day situation and the future scenarios. There is a 2% deterioration for BOD for both scenarios; 10% and 12% deterioration for ammonia for 2019/20 and 2030/31 respectively; no deterioration for phosphate with small improvement for the 2030/31 scenario.

SIMCAT shows that phosphate and ammonia fail their targets upstream of the STW. The RQP function to calculate the required discharge quality in order to meet the river target (and no-deterioration) using the actual scenarios for all the pollutants (see Table 11) as input data gives the following results:

Table 12: STW discharge quality required to meet WFD targets - Abingdon STW (New Stream)

Pollutant	Target	Mean	SD	95%ile
BOD	5	3.48	1.24	5.96
Amm	0.6	0.41	0.15	0.71
P	0.09	0.08	0.03	0.13

Figure 5: SIMCAT result for flow and phosphate.

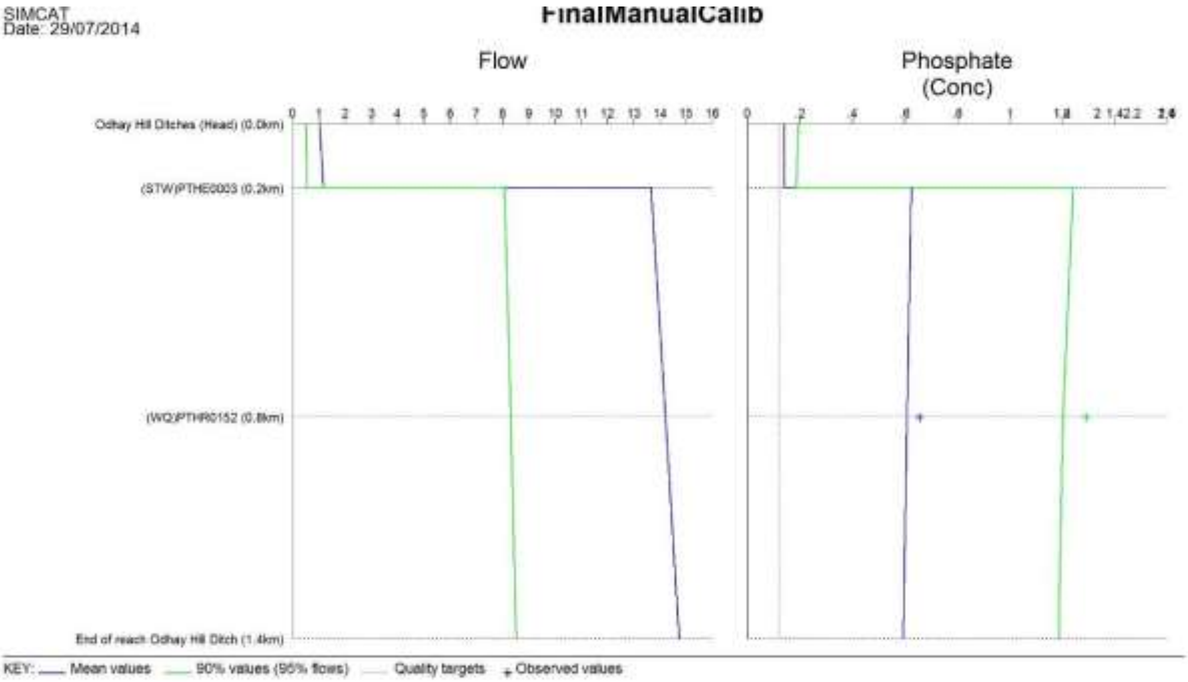
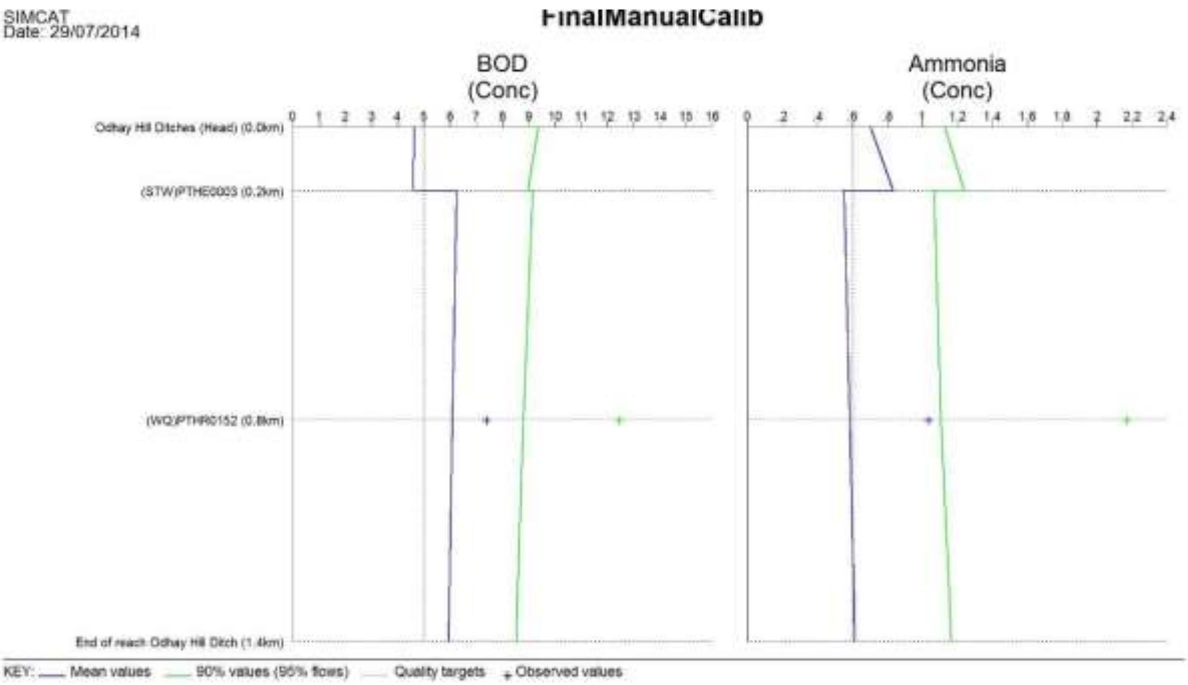


Figure 6: SIMCAT result for BOD and Ammonia.



B.6.5 Appleton STW

Appleton STW discharges into the Marcham Brook as shown in Figure 7.

The status of the receiving watercourse is summarised in the Table 13 below:

Table 13: Marcham Brook status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	not available	High	Bad
2013 status	Moderate	Moderate	not available	High	Poor
Objective	Good Status by 2027	Good Status by 2027	High status by 2015	NA	2015: Bad (Disproportionately expensive (P1a))

Figure 7: GIS SIMCAT map of Appleton discharge location.

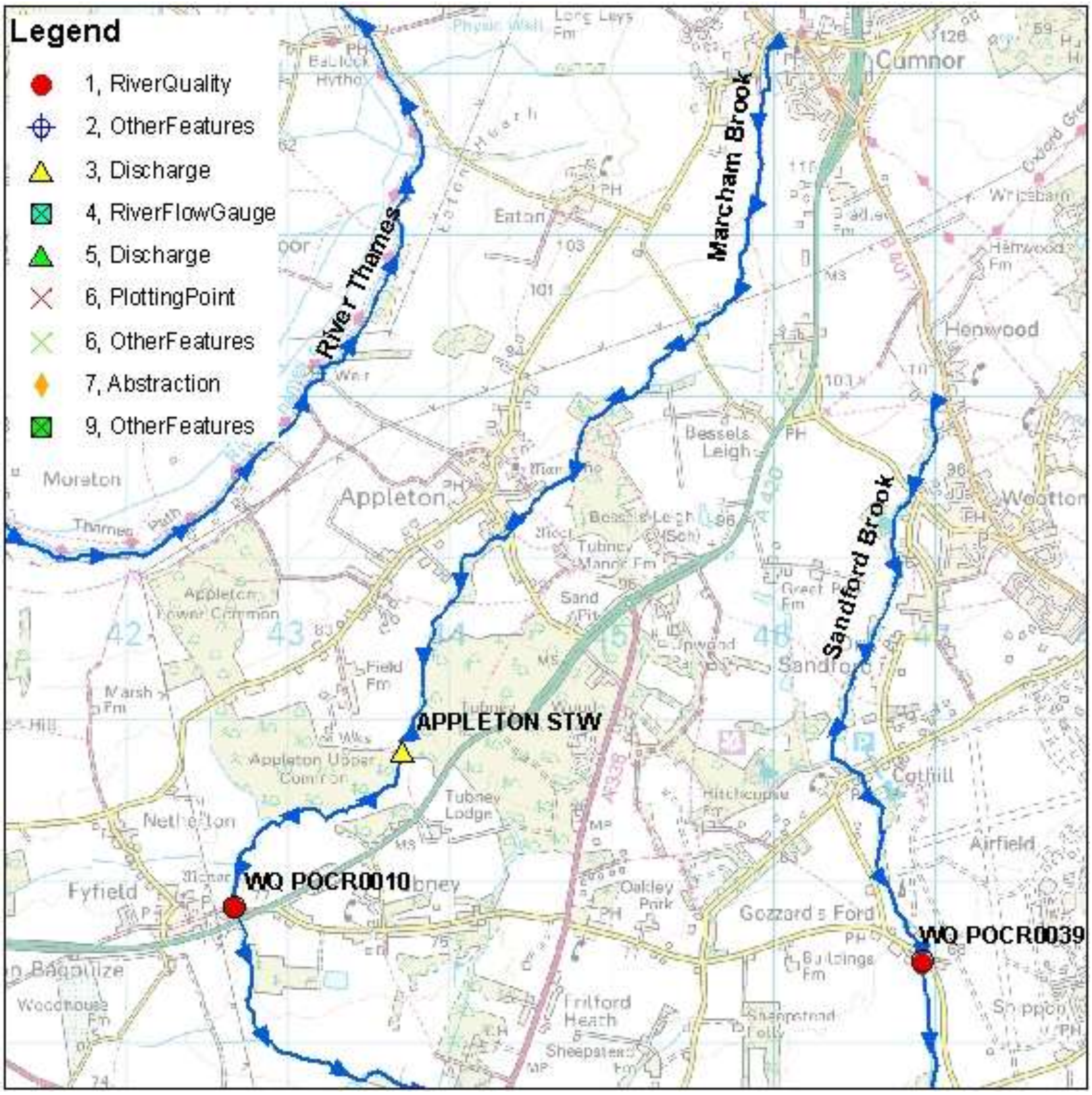


Table 14 shows the input data and RQP results for Appleton. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its consent but it will be close to its current capacity for BOD.

Table 14: input data and RQP results for Appleton STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	5.06	SIMCAT calculated value just upstream STW	1.04	Thames Water	NA	1.19	Thames Water	NA	1.06	Thames Water	NA
	SD			0.35			0.4			0.35		
	5%ile	1.9										
BOD (mg/l)	Mean	0.585	SIMCAT calculated value just upstream STW	6.6	Thames Water	2.58	7.1	Thames Water	2.98	7.1	Thames Water	2.8
	SD	0.097										
	95%ile			10.6			11.4			11.5		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.011	SIMCAT calculated value just upstream STW	0.6	Thames Water	0.27	0.8	Thames Water	0.4	0.9	Thames Water	0.4
	SD	0.005										
	95%ile			1.8			2.5			2.6		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	5.37	SIMCAT observed values	2.58	5.37	SIMCAT observed values	2.72	5.37	SIMCAT observed values	2.61
	SD	0.152		1.44			1.44			1.44		
	Target Mean	0.084	2013 WFD									

There is not a WQ point upstream of the STW and the river quality data were taken from the SIMCAT calculated values just upstream of the discharge point. The SIMCAT model overestimates the concentration for ammonia and gives a good calibration for phosphate and BOD as shown in Figure 8 and Figure 9. Only phosphate fails its target.

The RQP results show as well that only phosphate is failing its target for the present-day situation and the future scenarios. There is a 16% and 9% deterioration for BOD for 2019/20 and 2030/31 respectively; 48% deterioration for ammonia for both scenarios; 5% and 1% deterioration for phosphate for 2019/20 and 2030/31 respectively.

SIMCAT shows that phosphate is failing its target upstream of the STW. The RQP function to calculate the required discharge quality in order to meet the river target using the present-day situation as input data (see Table 14) gives as result: "the river quality target is not achievable without improving the upstream water quality".

In order to prevent a water quality deterioration at Appleton for future scenarios, sewage treatment would have to be improved to meet higher standards for BOD and Ammonia. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 15 must be met.

Table 15: 'No deterioration' consent values for Appleton STW

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Consent values required to meet "no-deterioration"		
			Mean Quality	Standard Deviation	95th Percentile
BOD	19/20	2.56	6.09	1.99	9.71
Ammonia	30/31	0.27	0.81	0.28	1.32
Phosphate	-	-	-	-	-

Figure 8: SIMCAT result for flow and phosphate.

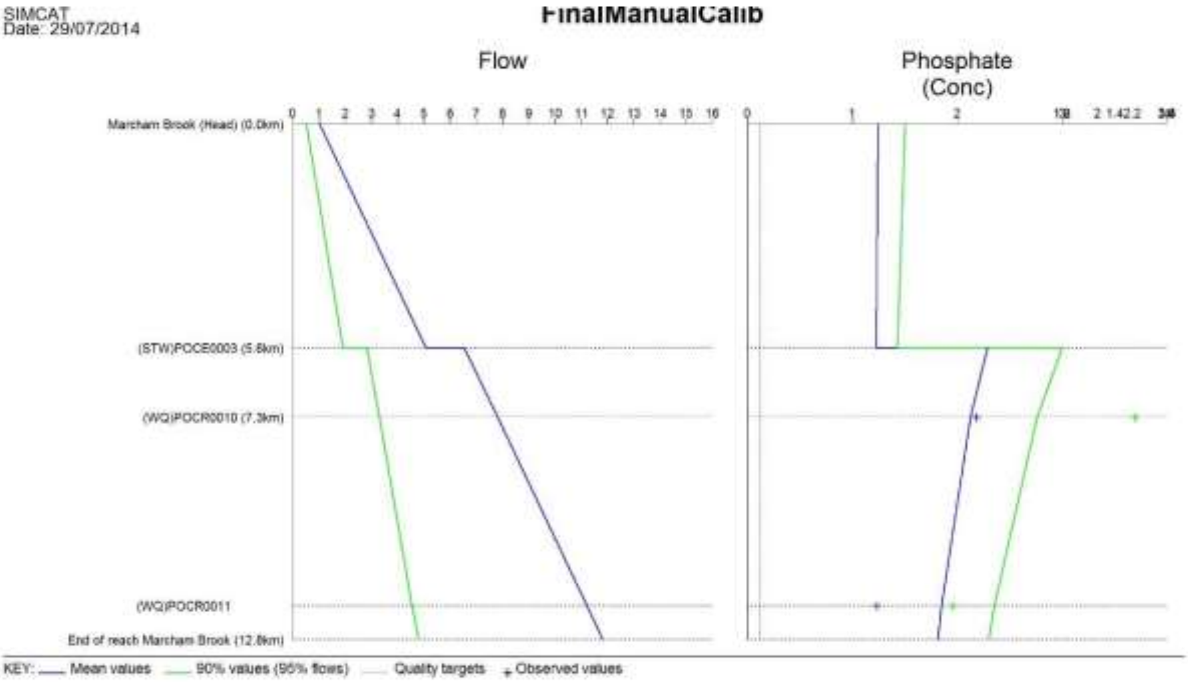
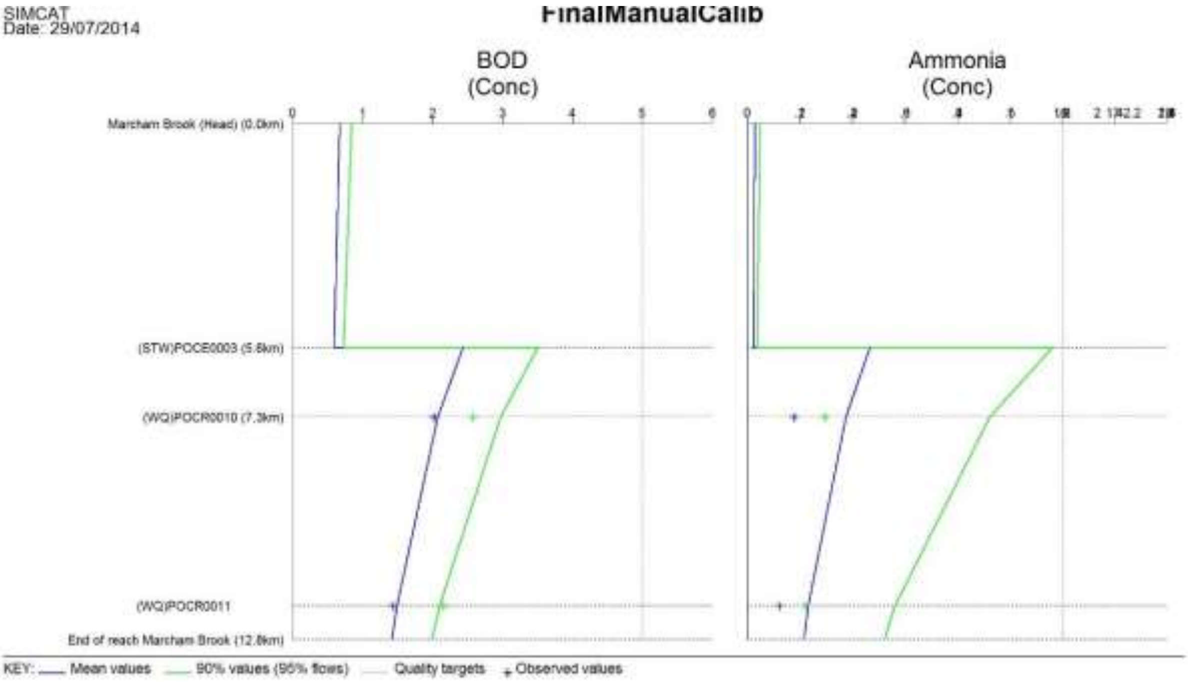


Figure 9: SIMCAT result for BOD and Ammonia.



B.6.6 Didcot STW

Didcot STW discharges into the Moor Ditch as shown in Figure 10.

The status of the receiving watercourse is summarised in the Table 16 below:

Table 16: Moor Ditch status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Poor	Poor	Good	High	Moderate
2013 status	Poor	Poor	Good	Good	Moderate
Objective	Good Status by 2027	Good Status by 2027	High status by 2015	NA	2015: Moderate (Disproportionately expensive (P1b))

Figure 10: GIS SIMCAT map of Didcot discharge location.

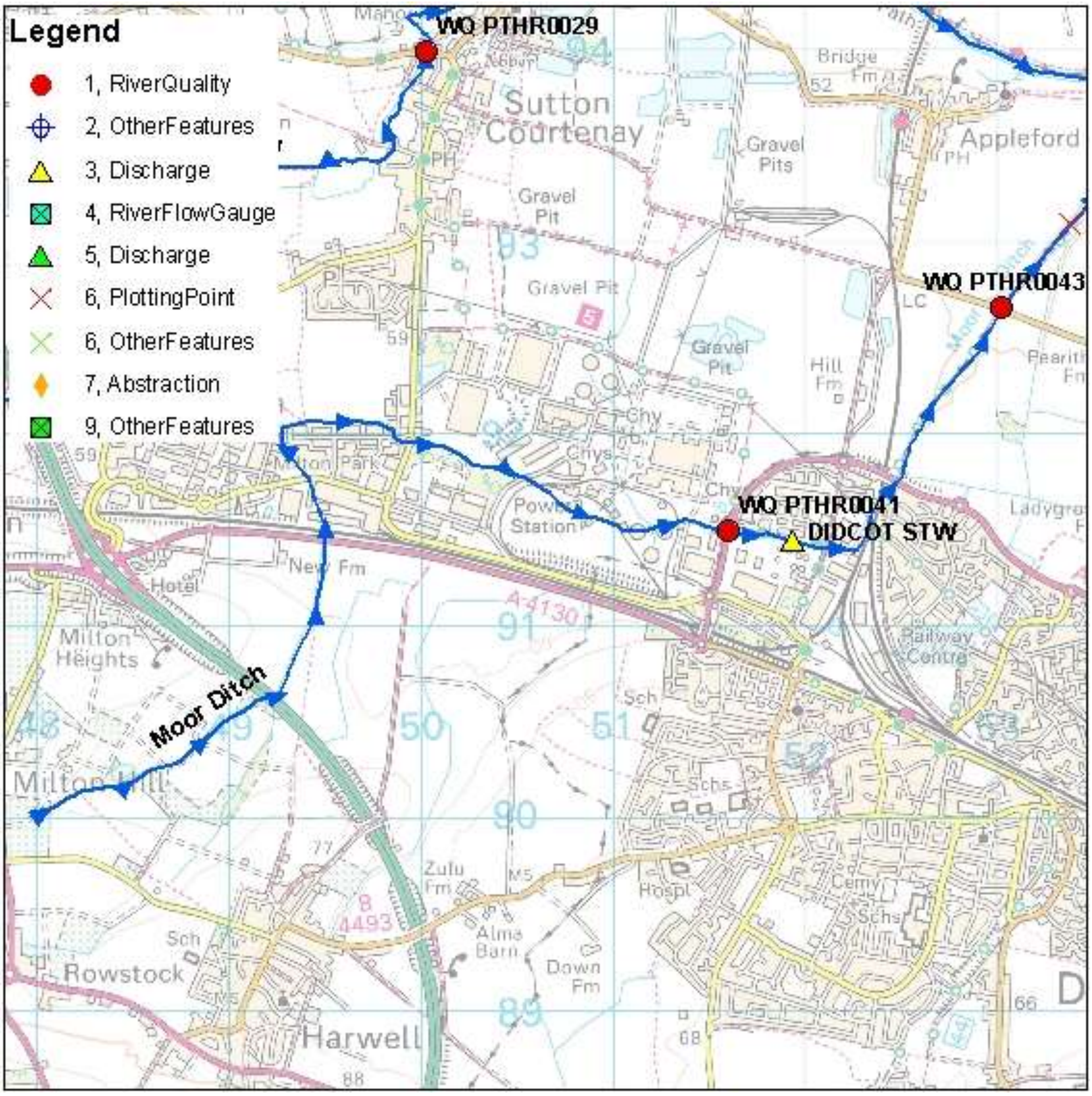


Table 17 shows the input data and RQP results for Didcot. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its consent but it will be close to its current capacity for BOD. The RQP tool did not allow the 95%ile provided by Thames Water for ammonia (2.8mg/l) to be entered, and therefore the highest value accepted (2.7mg/l) was used instead as reported in the summary table.

Table 17: input data and RQP results for Didcot STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	9.64	SIMCAT calculated value just upstream STW	10	Thames Water	NA	10.86	Thames Water	NA	11.81	Thames Water	NA
	SD			3.33			3.62			3.94		
	5%ile	2.42										
BOD (mg/l)	Mean	1.87	U/s WQ point PTHR0041 from SIMCAT	3	Thames Water	3.56	3.3	Thames Water	3.84	3.8	Thames Water	4.33
	SD	1.05										
	95%ile			5			5.5			6.3		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.06	U/s WQ point PTHR0041 from SIMCAT	0.7	Thames Water	0.93 (95% used =2.7)	1.1	Thames Water	1.53 (95% used =4.2)	2.1	Thames Water	2.9 (95% used =8.1)
	SD	0.05										
	95%ile			2.8			4.4			8.3		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	U/s WQ point PTHR0041 from SIMCAT	1.14	Thames Water	1.42	1.14	Thames Water	1.46	1.14	Thames Water	1.5
	SD	0.056		1.06			1.14			1.06		
	Target Mean	0.086	2013 WFD									

The upstream WQ point is 0.36km from the discharge point and the table below shows the statistics used in SIMCAT and those derived from the observed data provided:

Table 18: statistics used in SIMCAT and those derived from the observed data for WQ point PTHR0041.

			SIMCAT model				Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Distribution	Mean	SD	Samples	Data period
PTHR0041	0.36	BOD	1.868	1.051	35	Log-Normal				no data
PTHR0041	0.36	Amm	0.058	0.048	38	Log-Normal	0.079	0.071	17	09 and 13
PTHR0041	0.36	P	0.180	0.056	38	Log-Normal	0.137	0.044	17	09 and 13

Due to the low number of samples for the period 09-13 the SIMCAT data were used. Because of the close distance to the discharge point the effect of the natural purification is negligible.

Figure 11 and Figure 12 show the 2009 SIMCAT results where phosphate is the only pollutant that breaches the target. The RQP results confirm that phosphate is still not reaching its target for the present-day situation and the future scenarios and indicate that ammonia also fails to reach its targets all scenarios.

There is an 8% and 22% deterioration for BOD for 2019/20 and 2030/31 respectively; 65% and 212% for ammonia for 2019/20 and 2030/31 respectively; 3% and 6% deterioration for phosphate for 2019/20 and 2030/31 respectively.

SIMCAT shows that phosphate is failing its target upstream of the STW. The RQP function to calculate the required discharge quality in order to meet the river target using the present-day situation for all the pollutants (see Table 17) as input data gives the following results:

Table 19: STW discharge quality required to meet WFD targets - Didcot STW

Pollutant	Target	Mean	SD	95%ile
Amm	0.6	0.43	0.95	1.73
P	0.09	0.02	0.01	0.05

In order to prevent a water quality deterioration at Didcot for future scenarios, sewage treatment would have to be improved to meet higher standards for BOD and Ammonia. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 20 must be met.

Table 20: 'No deterioration' consent values for Didcot STW

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Consent values required to meet "no-deterioration"		
			Mean Quality	Standard Deviation	95th Percentile
BOD	30/31	3.55	3.04	0.99	4.85
Ammonia	30/31	0.93	1.01	0.3	1.55
Phosphate	-	-	-	-	-

Figure 11: SIMCAT result for flow and phosphate.

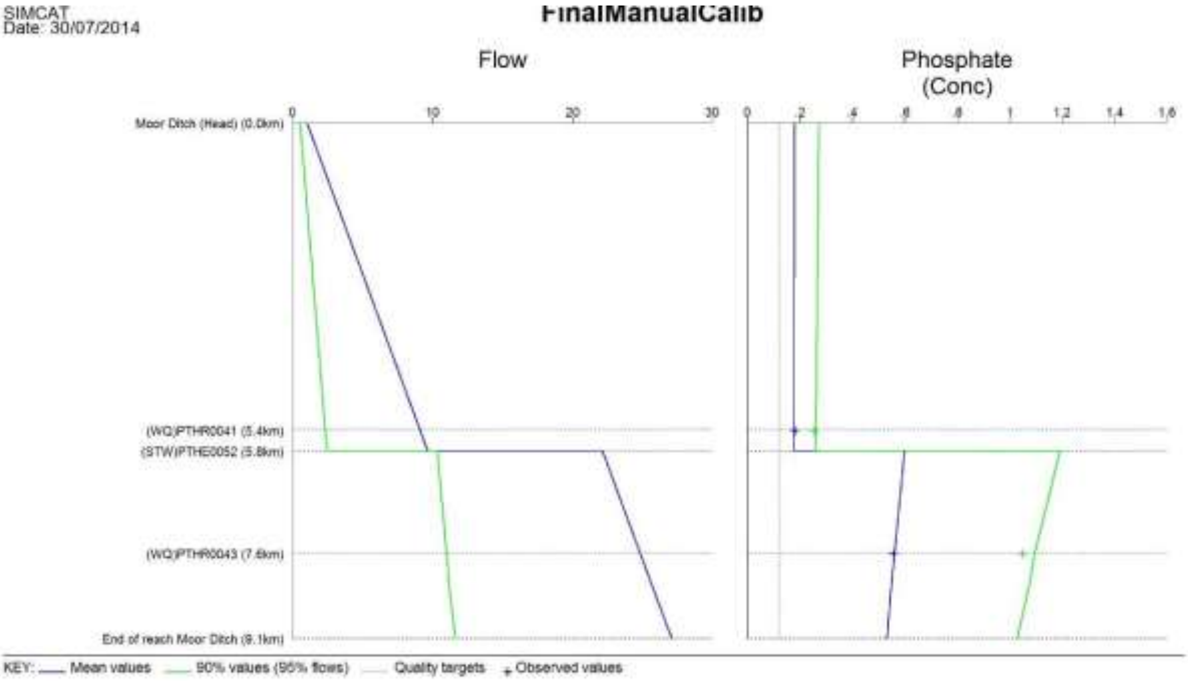
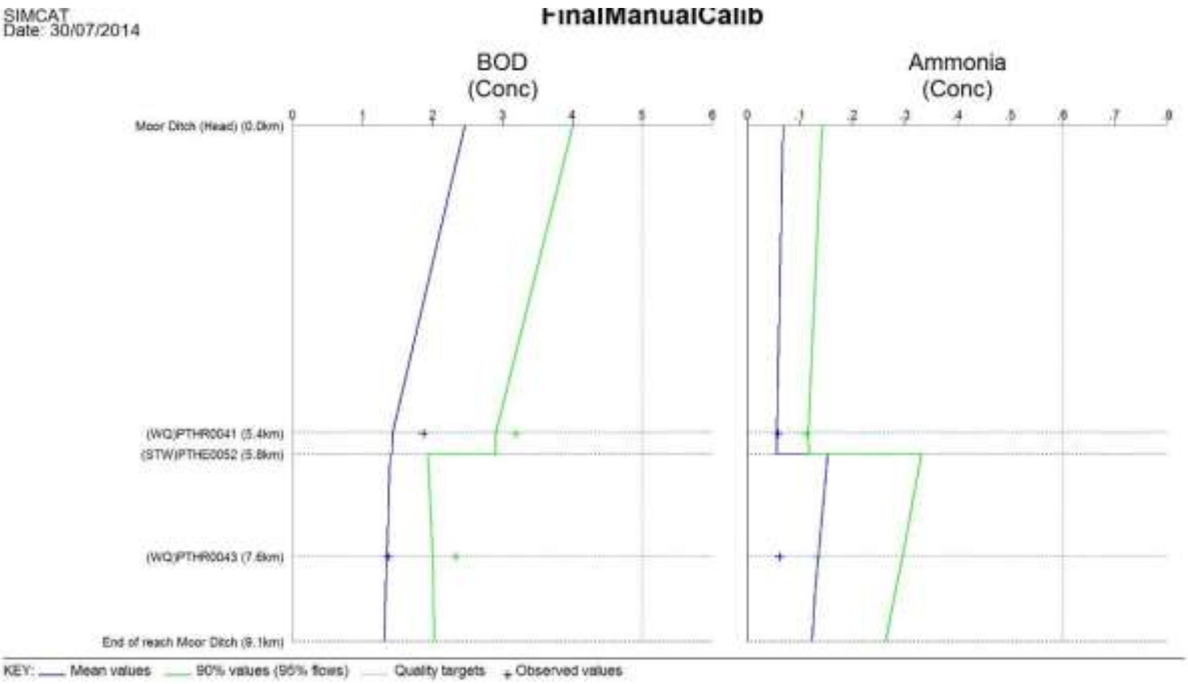


Figure 12: SIMCAT result for BOD and Ammonia.



B.6.7 Drayton STW

Drayton STW discharges into the Ginge Brook as shown in Figure 13.

The status of the receiving watercourse is summarised in the Table 21 below:

Table 21: Ginge Brook status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Good	Good	Not available	High	Good
2013 status	Poor	Poor	Not available	High	Poor
Objective	Good Status by 2015	Good Status by 2015	NA	NA	NA

Figure 13: GIS SIMCAT map of Drayton discharge location.

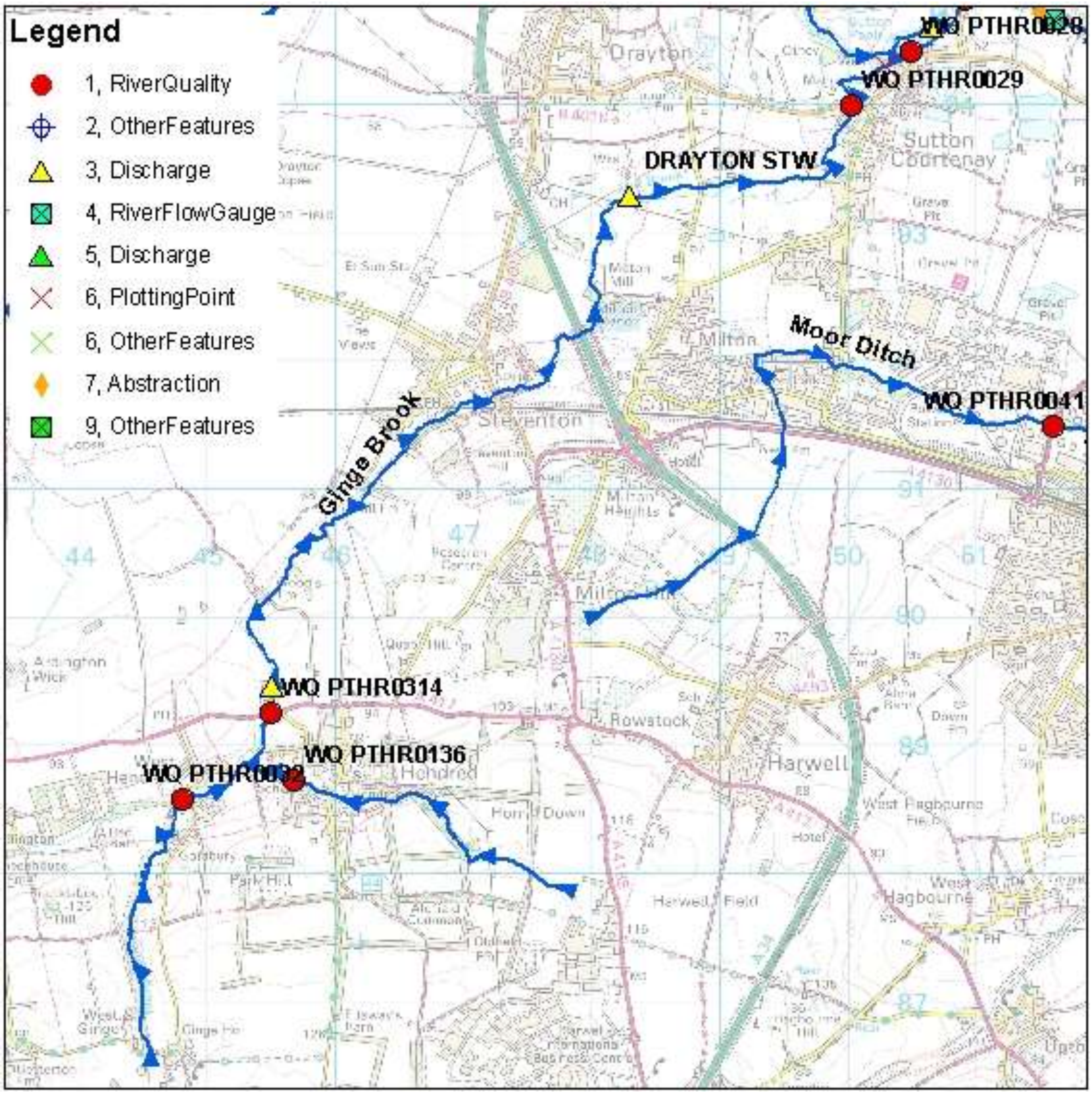


Table 22 shows the input data and RQP results for Drayton. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will be working above such values for BOD with upgrades required from 2019/20 scenario and below such values for ammonia reaching its capacity in 2019/20 scenario and with upgrades required from 2030/31 scenario.

Table 22: input data and RQP results for Drayton STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	22	SIMCAT calculated value just upstream STW	1.4	Thames Water	NA	1.68	Thames Water	NA	1.52	Thames Water	NA
	SD			0.47			0.56			0.51		
	5%ile	10.6										
BOD (mg/l)	Mean	1.27	SIMCAT calculated value just upstream STW	10.3	Thames Water	2.73	11.3	Thames Water	2.98	11.4	Thames Water	2.89
	SD	0.57										
	95%ile			19.1			20.9			21.1		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.05	SIMCAT calculated value just upstream STW	2.5	Thames Water	0.38	3.7	Thames Water	0.63	3.8	Thames Water	0.59
	SD	0.02										
	95%ile			6.4			9.5			9.8		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	5.93	SIMCAT observed values	0.67	5.93	SIMCAT observed values	0.78	5.93	SIMCAT observed values	0.71
	SD	0.019		1.5			1.5			1.5		
	Target Mean	0.086	2013 WFD									

There is no WQ point upstream of the STW and the river quality data were taken from the SIMCAT calculated values just upstream of the discharge point. The model presents a good calibration with the WQ point PTHR0314 upstream of the industrial discharge as shown in Figure 14 and Figure 15 and indicates a failure of the target for phosphate.

The RQP results show as well that phosphate fails its target for the present-day situation and the future scenarios and ammonia fails its target for the 2019/20 scenario. There is a 9% and 6% deterioration for BOD for 2019/20 and 2030/31 respectively; 66% and 55% for ammonia for 2019/20 and 2030/31 respectively; 16% and 6% deterioration for phosphate for 2019/20 and 2030/31 respectively.

The RQP function to calculate the required discharge quality in order to achieve no deterioration and meet the river target using the 2019/20 scenarios for ammonia, and the present-day situations for phosphate (see Table 22) as input data gives the following results:

Table 23: STW discharge quality required to meet WFD targets - Drayton STW

Pollutant	Target	Mean	SD	95%ile
Amm	0.38	2.14	1.72	5.45
P	0.09	0.31	0.08	0.46

To achieve no deterioration for BOD for future scenarios, improvements to the STW would be required.

Figure 14: SIMCAT result for flow and phosphate.

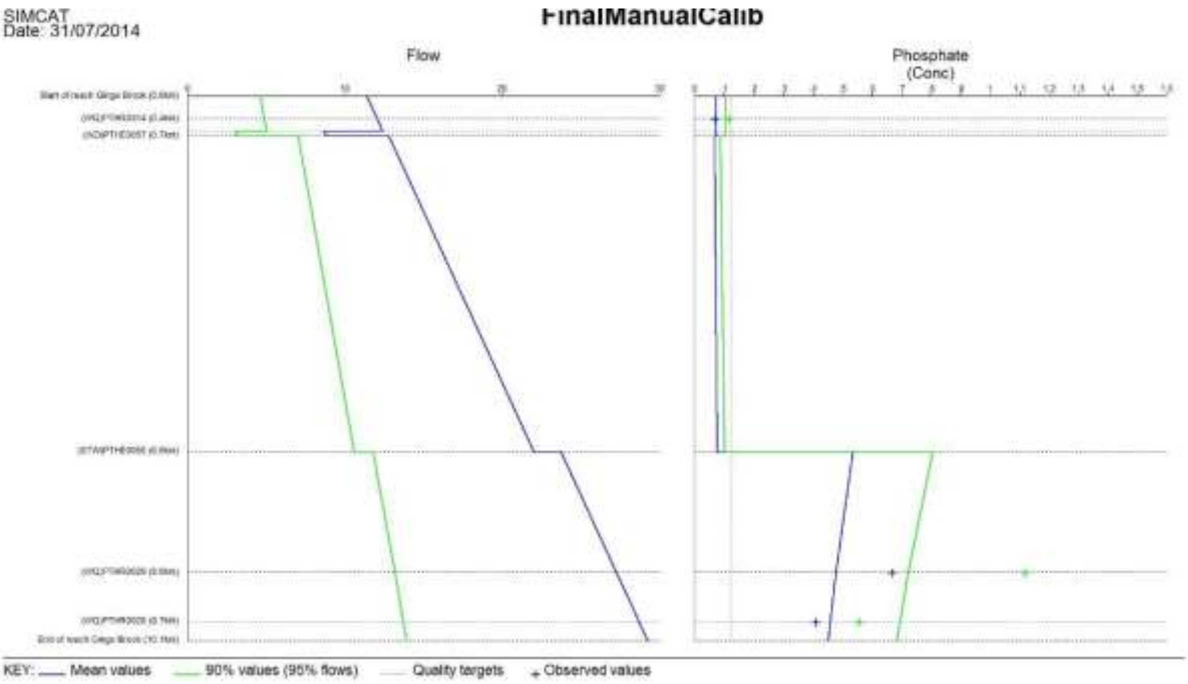
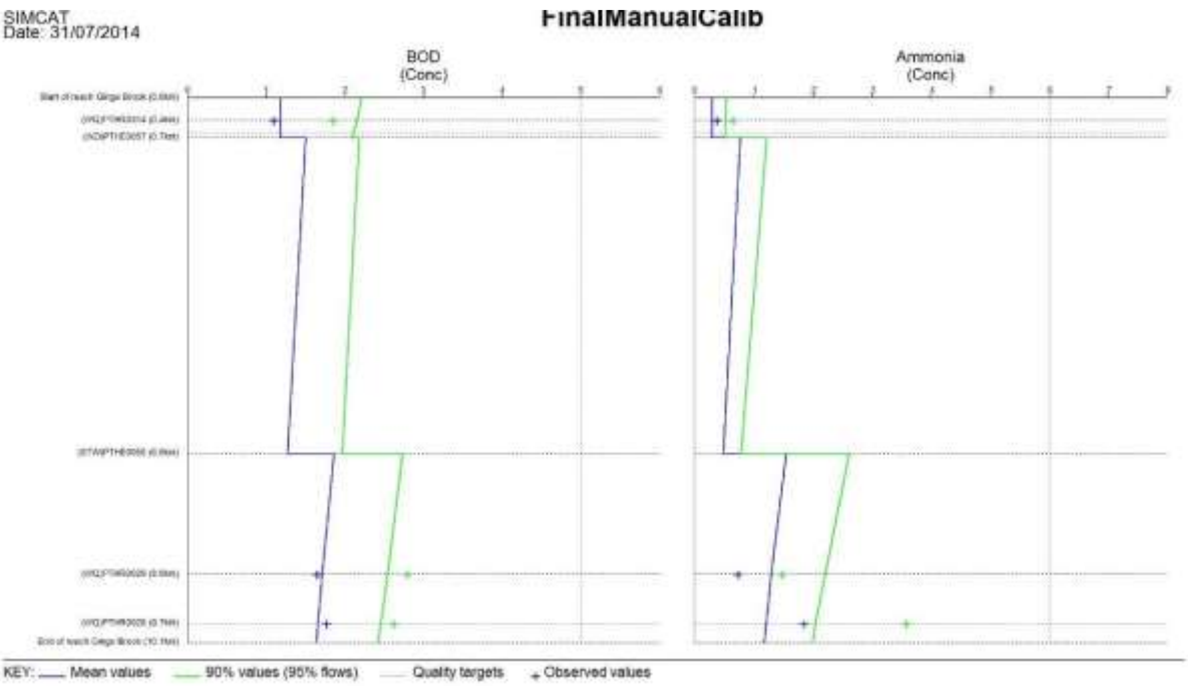


Figure 15: SIMCAT result for BOD and Ammonia.



B.6.8 Faringdon STW

Faringdon STW discharges into the Faringdon Brook as shown in Figure 16.

The status of the receiving watercourse is summarised in the Table 24 below:

Table 24: Faringdon status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Good	High	Moderate
2013 status	Moderate	Moderate	Fail	High	Moderate
Objective	Good Status by 2017	Good Status by 2017	High Status by 2015	NA	2015: Moderate (Disproportionately expensive (P1c))

Figure 16: GIS SIMCAT map of Faringdon discharge location.

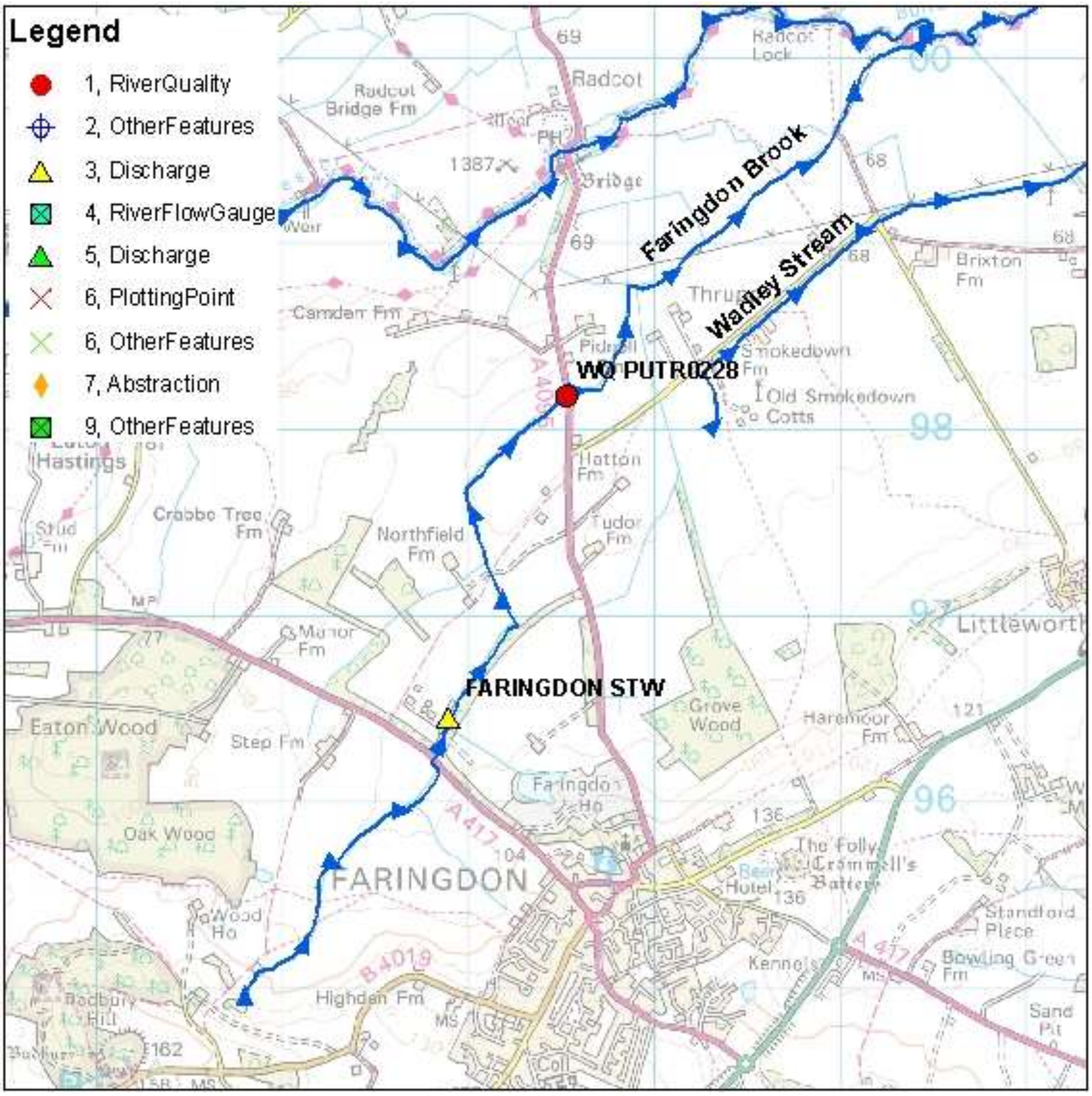


Table 25 shows the input data and RQP results for Faringdon. The works has consent values for BOD (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its consent but it will be close to its consented capacity for BOD.

Table 25: input data and RQP results for Faringdon STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	2.84	SIMCAT calculated value just upstream STW	1.39	Thames Water	NA	1.74	Thames Water	NA	1.58	Thames Water	NA
	SD			0.46			0.58			0.53		
	5%ile	0.9										
BOD (mg/l)	Mean	0.51	SIMCAT calculated value just upstream STW	10	Thames Water	6.97	11.2	Thames Water	8.77	11.4	Thames Water	8.45
	SD	0.18										
	95%ile			20			22.5			22.8		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.03	SIMCAT calculated value just upstream STW	4.3	Thames Water	2.97	6.9	Thames Water	5.36	7.4	Thames Water	5.49
	SD	0.06										
	95%ile			9			14.5			15.5		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	5.33	SIMCAT observed values	3.76	5.33	SIMCAT observed values	3.96	5.33	SIMCAT observed values	3.87
	SD	0.35		0.62			0.62			0.62		
	Target Mean	0.08	2013 WFD									

There is no WQ point upstream of the STW and the river quality data were taken from the SIMCAT calculated values just upstream of the discharge point. The model presents a good calibration for ammonia and phosphate but overestimates the concentration for BOD as shown in Table 25 and Table 29 and indicates a failure of the target for all pollutants.

The RQP results indicate that the watercourse fails its targets for BOD, NH4 and P for the present-day situation and the future scenarios. There is a 26% and 21% deterioration for BOD for 2019/20 and 2030/31 respectively; 80% and 85% for ammonia for 2019/20 and 2030/31 respectively; 5% and 3% deterioration for phosphate for 2019/20 and 2030/31 respectively.

SIMCAT shows that phosphate is failing its target upstream of the STW. The RQP function to calculate the required discharge quality in order to meet the river target using the present-day situation for all the pollutants (see Table 25) as input data gives as result the following results for BOD and ammonia:

Table 26: STW discharge quality required to meet WFD targets - Faringdon STW

Pollutant	Target	Mean	SD	95%ile
BOD	5	7.18	3.66	14.19
Amm	0.6	0.86	0.48	1.78

For phosphate the RQP tool reports that "the river quality target is not achievable without improving the upstream water quality".

In order to prevent a water quality deterioration at Faringdon for future scenarios, sewage treatment would have to be improved to meet higher standards for BOD and Ammonia. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 27 must be met.

Table 27: 'No deterioration' consent values for Farringdon STW

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Consent values required to meet "no-deterioration"		
			Mean Quality	Standard Deviation	95th Percentile
BOD	19/20	6.97	9.87	3.29	15.97
Ammonia	30/31	2.97	4.58	1.5	7.31
Phosphate	-	-	-	-	-

Figure 17: SIMCAT result for flow and phosphate.

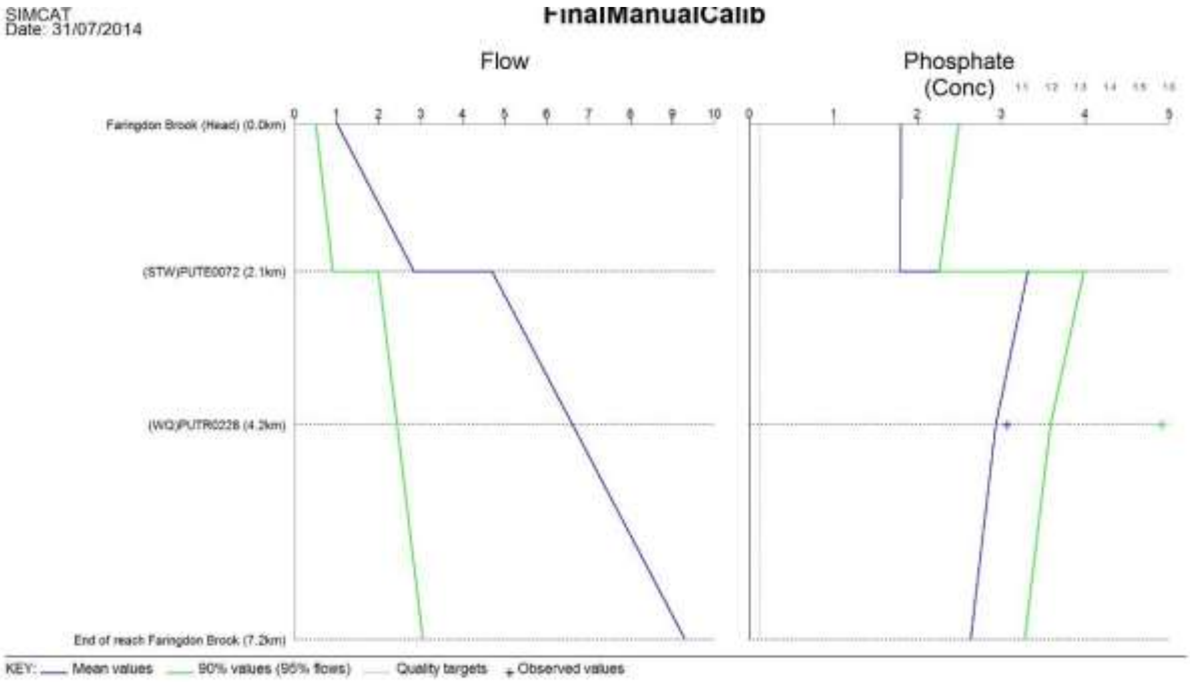
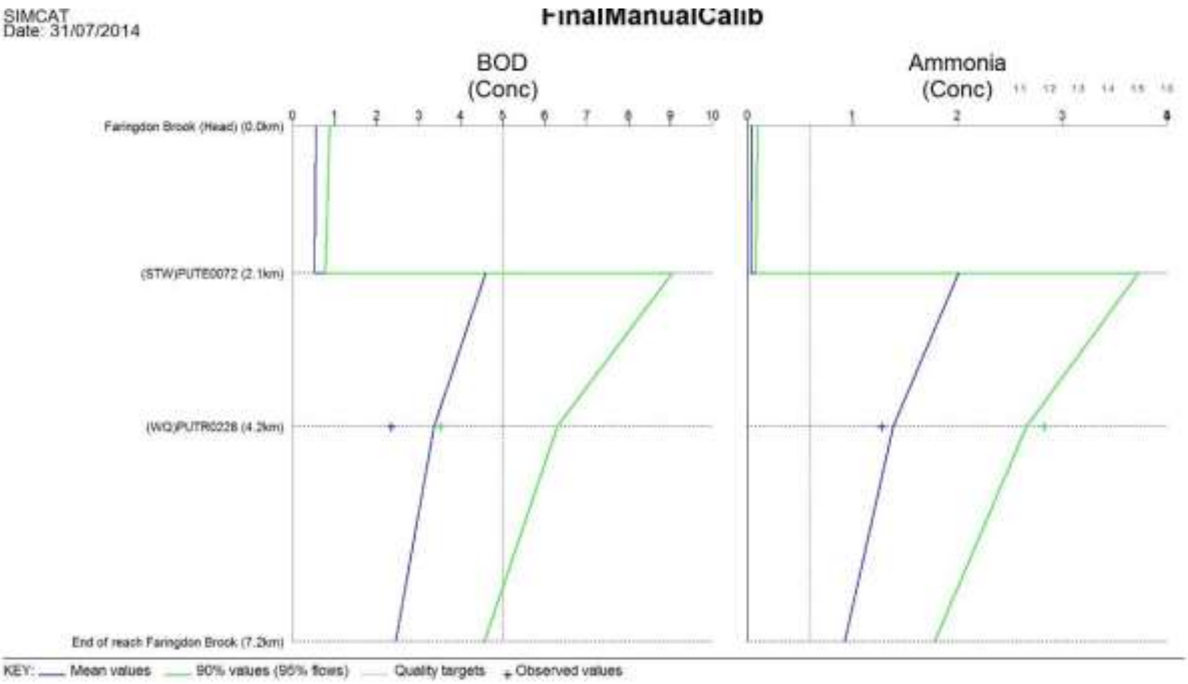


Figure 18: SIMCAT result for BOD and Ammonia.



B.6.9 Kingston Bagpuize STW

Kingston Bagpuize STW discharges into the River Ock as shown in Figure 19.

The status of the receiving watercourse is summarised on the Table 28 below:

Table 28: River Ock status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Good	High	Moderate
2013 status	Moderate	Moderate	Good	High	Poor
Objective	Good Status by 2027	Good Status by 2027	High Status by 2015	NA	2015: Moderate (Disproportionately expensive (P1a))

Figure 19: GIS SIMCAT map of Kingston Bagpuize discharge location.

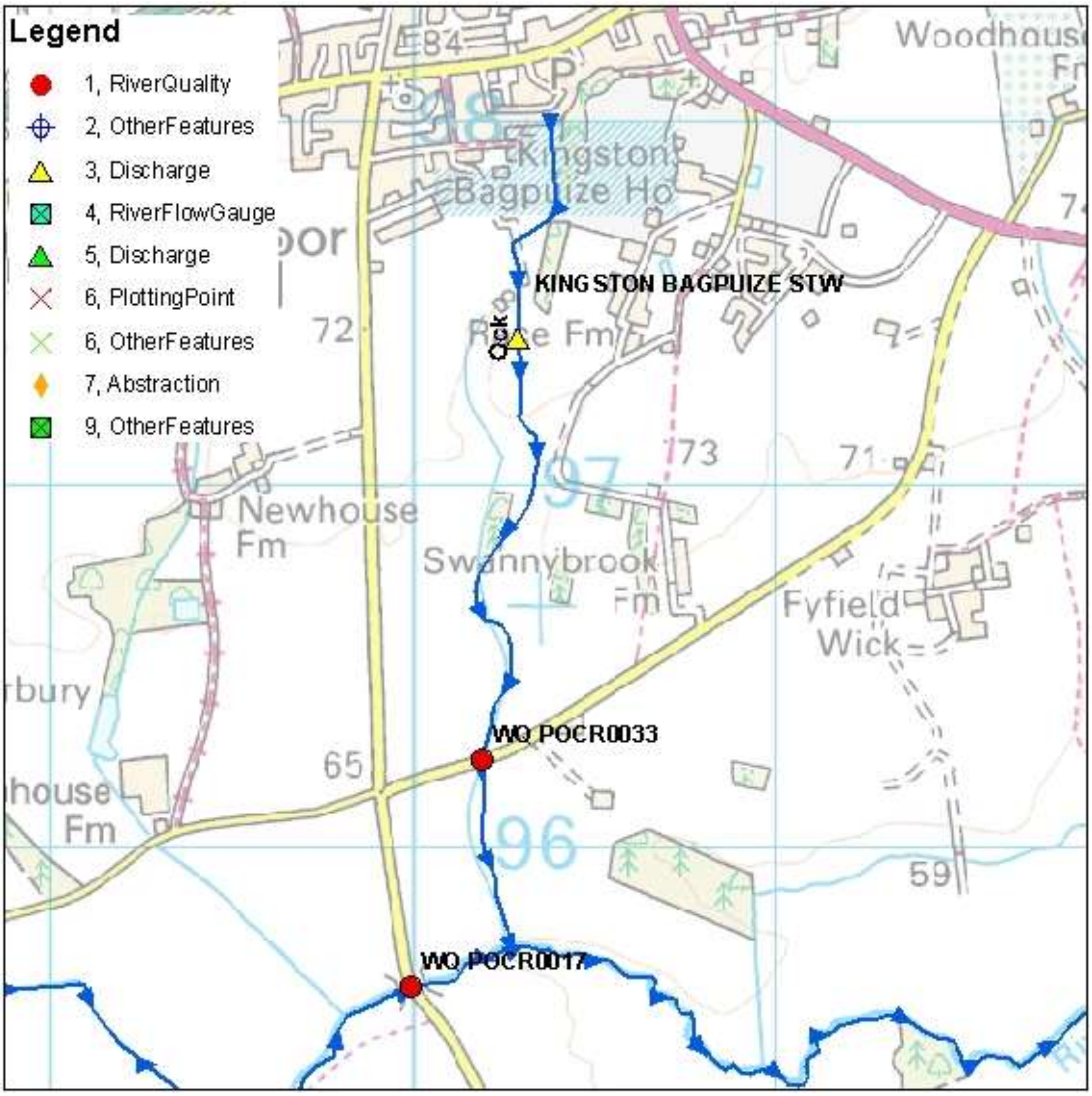


Table 29 shows the input data and RQP results for Kingston Bagpuize without contingency sites. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will be working below such values for BOD and above for ammonia from 2019/20 scenario. Upgrades are needed for ammonia from 2019/20 scenario. The STW is also predicted to reach its hydraulic capacity by 2019/20.

Table 29: input data and RQP results for Kingston Bagpuize STW without contingencies sites.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	1.3	SIMCAT calculated value just upstream STW	0.68	Thames Water	NA	0.75	Thames Water	NA	0.7	Thames Water	NA
	SD			0.23			0.25			0.23		
	5%ile	0.56										
BOD (mg/l)	Mean	0.66	SIMCAT calculated value just upstream STW	6	Thames Water	3.85	6.4	Thames Water	4.29	6.5	Thames Water	4.23
	SD	1.34										
	95%ile			9.3			9.9			10.1		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.03	SIMCAT calculated value just upstream STW	1.3	Thames Water	1.11	1.7	Thames Water	1.55	1.9	Thames Water	1.69
	SD	0.02										
	95%ile			5			6.5			7.2		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	6.39	SIMCAT observed values	4.77	6.39	SIMCAT observed values	4.87	6.39	SIMCAT observed values	4.81
	SD	1.65		1.02			1.02			1.02		
	Target Mean	0.08	2013 WFD									

There is not a WQ point upstream of the STW and the river quality data were taken from the SIMCAT calculated values just upstream of the discharge point. The model underestimates the concentration for ammonia as shown in Figure 20 and Figure 21 and indicates a failure of the target for ammonia and phosphate.

The RQP results also indicate that ammonia and phosphate fail to meet their target for the present-day situation and the future scenarios. There is a 11% and 10% deterioration for BOD for 2019/20 and 2030/31 respectively; 40% and 52% for ammonia for 2019/20 and 2030/31 respectively; 2% and 1% deterioration for phosphate for 2019/20 and 2030/31 respectively.

Table 30 shows the input data and RQP results for Kingston Bagpuize with the contingencies sites included (note: the RQP tool did not allow to enter the 95%ile provided by Thames Water for ammonia and the highest value accepted was used instead as reported in the summary table). In this case future scenarios predict that the STW will be working below consent values for BOD and above for ammonia from 2019/20 scenario. The work will reach its capacity for BOD in 2030/31 whilst it will need upgrades for ammonia from 2019/20 scenario. It will exceed its hydraulic capacity from 2019/20.

The RQP results show that the extra discharge flow also causes BOD to fail its target for the 2030/31 scenario with an increase in deterioration for all the pollutants. There is an 18% and

33% deterioration for BOD for 2019/20 and 2030/31 respectively; 71% and 160% for ammonia for 2019/20 and 2030/31 respectively; 3% and 5% deterioration for phosphate for 2019/20 and 2030/31 respectively.

Table 30: input data and RQP results for Kingston Bagpuize STW with the contingencies sites added.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	1.3	SIMCAT calculated value just upstream STW	0.68	Thames Water	NA	0.8	Thames Water	NA	0.87	Thames Water	NA
	SD			0.23			0.27			0.29		
	5%ile	0.56										
BOD (mg/l)	Mean	0.66	SIMCAT calculated value just upstream STW	6	Thames Water	3.86	6.6	Thames Water	4.56	7.3	Thames Water	5.12
	SD	1.34										
	95%ile			9.3			10.3			11.3		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.03	SIMCAT calculated value just upstream STW	1.3	Thames Water	1.11	2	Thames Water	1.9	2.9	Thames Water	2.89 (95% used =11)
	SD	0.02										
	95%ile			5			7.6			11.3		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	6.39	SIMCAT observed values	4.77	6.39	SIMCAT observed values	4.92	6.39	SIMCAT observed values	5.01
	SD	1.65		1.02			1.02			1.02		
	Target Mean	0.08	2013 WFD									

SIMCAT shows that the watercourse is failing its target for phosphate upstream of the STW. The RQP tool was used to calculate the discharge quality for the future scenario including the contingency sites that would be required in order to meet the river target for ammonia:

Table 31: STW discharge quality required to meet WFD targets - Kingston Bagpuize STW

Pollutant	Target	Mean	SD	95%ile
Amm	0.6	0.68	1.45	2.72

For phosphate the RQP tool reports that "the river quality target is not achievable without improving the upstream water quality".

In order to prevent a water quality deterioration at Kingston Bagpuize for future scenarios, sewage treatment would have to be improved to meet higher standards for BOD and Ammonia. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 32 must be met.

Table 32: 'No deterioration' consent values for Kingston Bagpuize STW with the contingencies sites added

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Values required to meet consent		
			Mean Quality	Standard Deviation	95th Percentile
BOD	19/20	3.85	5.3	1.75	8.54
Ammonia	30/31	1.11	1.68	0.56	2.72
Phosphate	-	-	-	-	-

Figure 20: SIMCAT result for flow and phosphate.

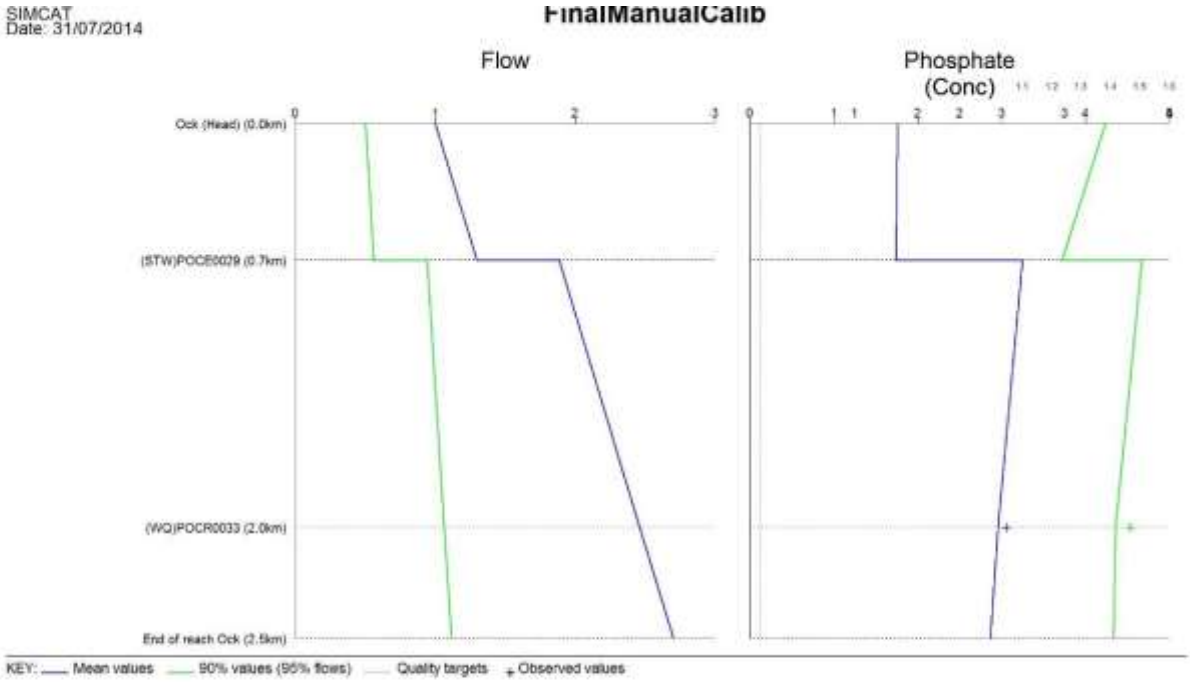
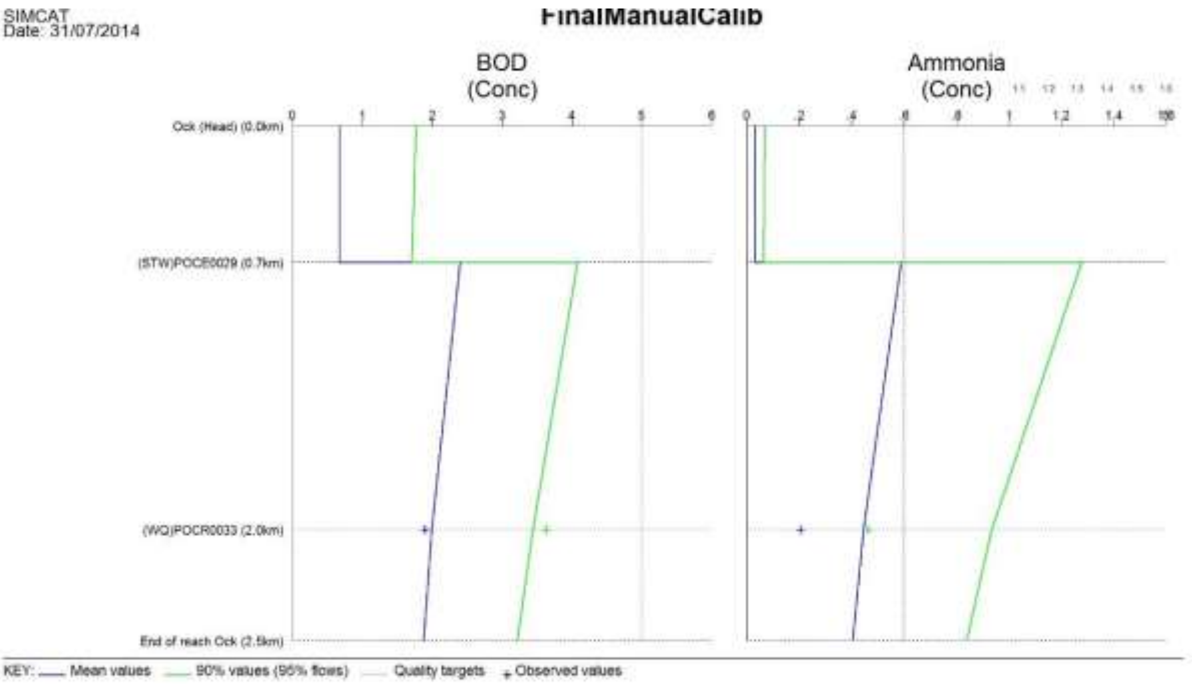


Figure 21: SIMCAT result for BOD and Ammonia.



B.6.10 Oxford STW

Oxford STW discharges into the Northfield Brook as shown in Figure 22.

The status of the receiving watercourse is summarised in the Table 33 below:

Table 33: Northfield Brook status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Not available	Good	Poor
2013 status	Moderate	Moderate	Good	Poor	Poor
Objective	Good Status by 2027	Good Status by 2027	Not available	NA	2015: Poor (Disproportionately expensive (P1a))

Figure 22: GIS SIMCAT map of Oxford discharge location.

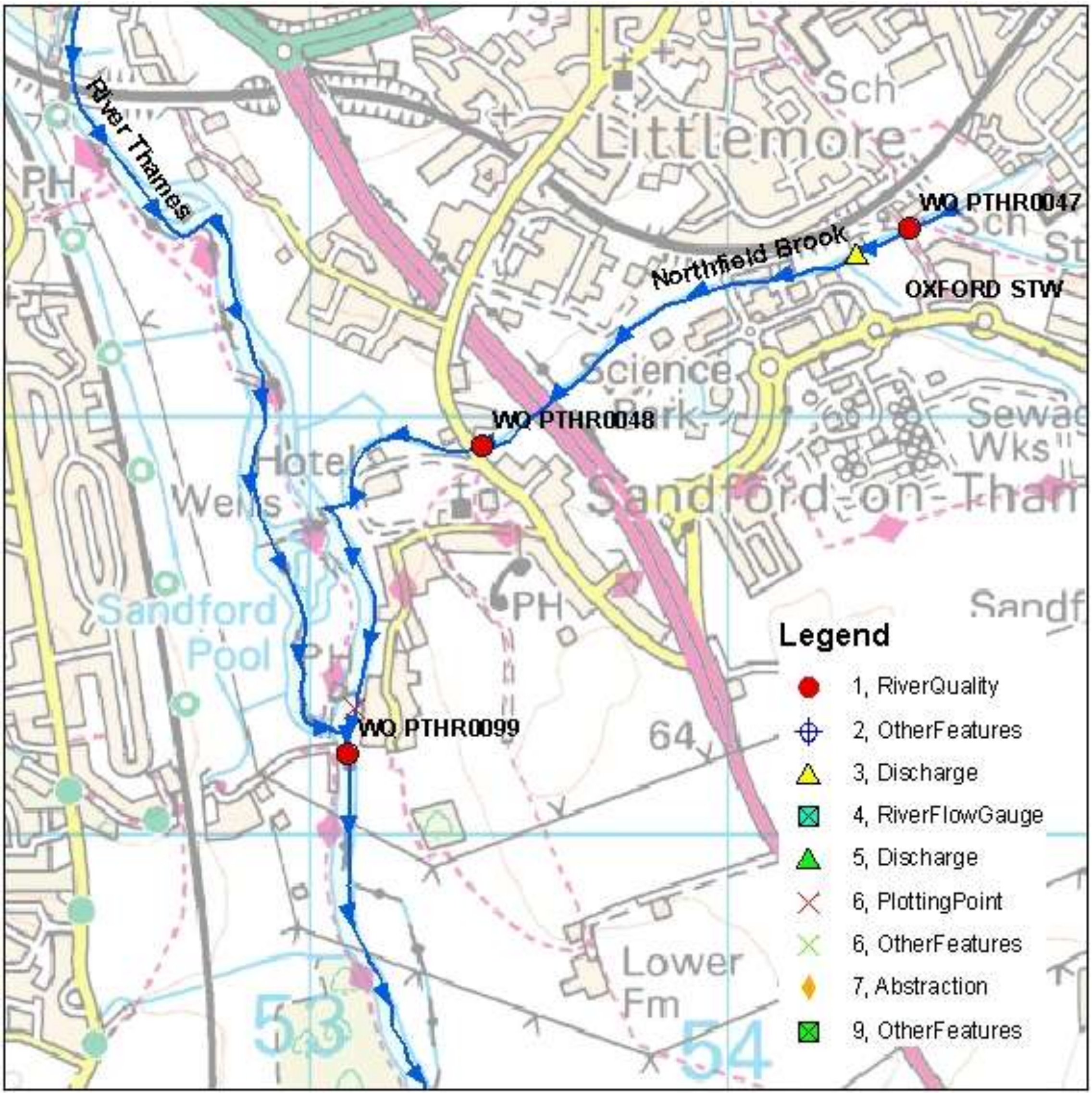


Table 34 shows the input data and RQP results for Oxford. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its BOD consent, but will exceed its ammonia consent by the 2019/20 scenario. Upgrades are needed for ammonia from 2019/20 scenario. The works also gets close to its flow consent in the 2019/20 scenario, but the flow headroom is predicted to improve by 2030/31 as the impacts of reduced water consumption are felt. As deterioration is less than 10%, no changes to consents are required.

Table 34: input data and RQP results for Oxford STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	6.42	SIMCAT calculated value just upstream STW	59.81	Thames Water	NA	59.05	Thames Water	NA	54.66	Thames Water	NA
	SD			19.94			19.68			18.22		
	5%ile	0.94										
BOD (mg/l)	Mean	1.86	SIMCAT calculated value just upstream STW	3.5	Thames Water	5.02	3.5	Thames Water	5.02	3.5	Thames Water	5.02
	SD	1.29										
	95%ile			6			6			6		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.03	SIMCAT calculated value just upstream STW	1	Thames Water	2.06	1.1	Thames Water	2.23	1.1	Thames Water	2.2
	SD	0.03										
	95%ile			3			3.2			3.2		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.14	SIMCAT calculated value just upstream STW	0.83	Thames Water	1.3	0.83	Thames Water	1.29	0.83	Thames Water	1.29
	SD	0.003		0.44			0.44			0.44		
	Target Mean	0.08	2013 WFD									

There is a WQ point 0.14km upstream of the STW called PTHR0047 that now is called PTHE0144. There are no observed values in SIMCAT for this WQ point. The river quality data were taken from the 2009-13 observed data for BOD and ammonia. Phosphate statistics were taken from the SIMCAT calculated values just upstream of the discharge point since there are no observed data. Table 35 below summarises the statistics calculated in Aardvark (see Figure 23 and Figure 24).

Table 35: Aardvark statistics for PTHE0144.

			Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Data period
PTHE0144	0.14	BOD	3.276	1.854	175	09-13
PTHE0144	0.14	Amm	0.736	1.422	58	09-13
PTHE0144	0.14	P				no data

The Aardvark analysis has shown no seasonality, trends or step changes and a good fit with the LogNormal plot for both pollutants as shown on Figure 25 and Figure 26. Because of the close distance to the discharge point the effect of the natural purification is negligible.

The SIMCAT model underestimates the concentration for BOD, overestimates the concentration for ammonia and gives a good calibration for phosphate as shown in Figure 27 and Figure 28 and indicates that ammonia and phosphate fail their targets.

The RQP results show that all the pollutants are failing their targets for the present-day situation and the future scenarios. There is no deterioration for BOD for both scenarios; 8% and 4% deterioration for ammonia for 2019/20 and 2030/31 respectively and a 1% improvement for phosphate for both scenarios.

The RQP tool was used to calculate the discharge quality for the future scenario that would be required in order to meet the river target for BOD, ammonia and P:

Table 36: STW discharge quality required to meet WFD targets - Oxford STW

Pollutant	Target	Mean	SD	95%ile
BOD	5	3.43	1.28	5.83
Amm	0.6	0.24	0.26	0.72
P	0.08	0.08	0.04	0.17

Figure 23: Aardvark summary for BOD for PTHE0144.

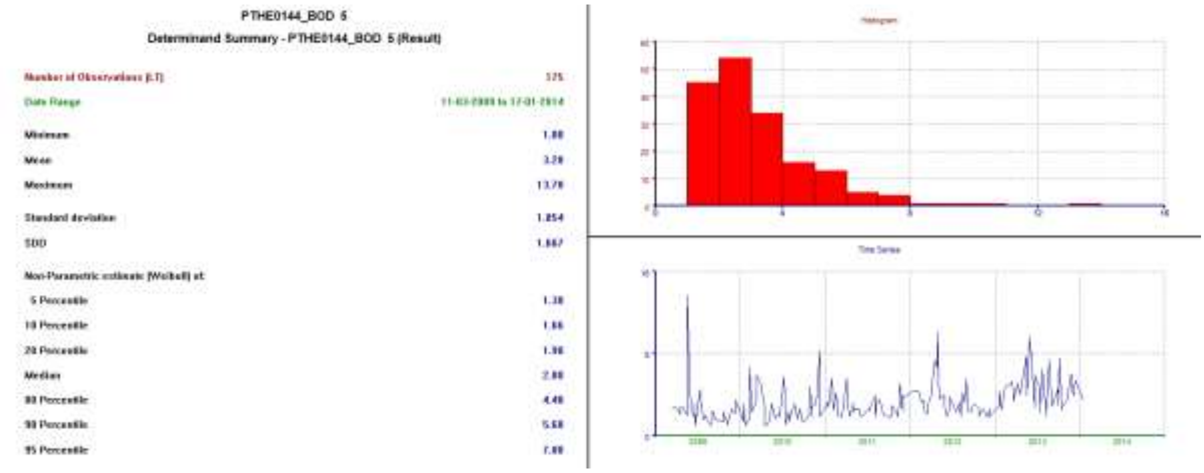


Figure 24: Aardvark summary for ammonia for PTHE0144.

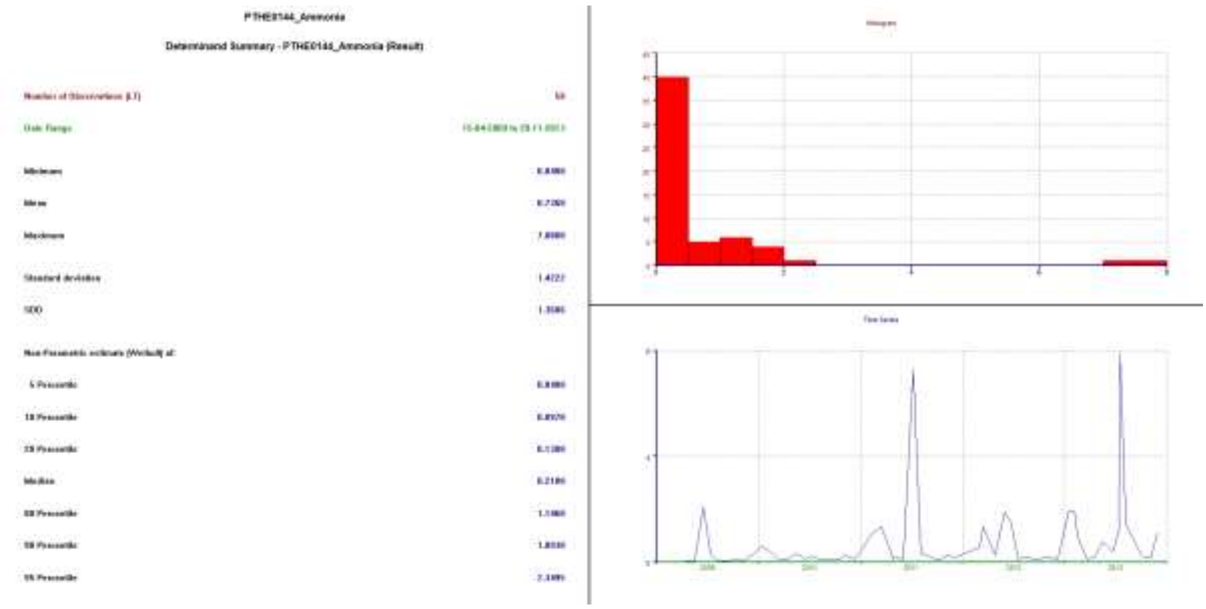


Figure 25: Aardvark LogNormal plot for BOD for PTHE0144.

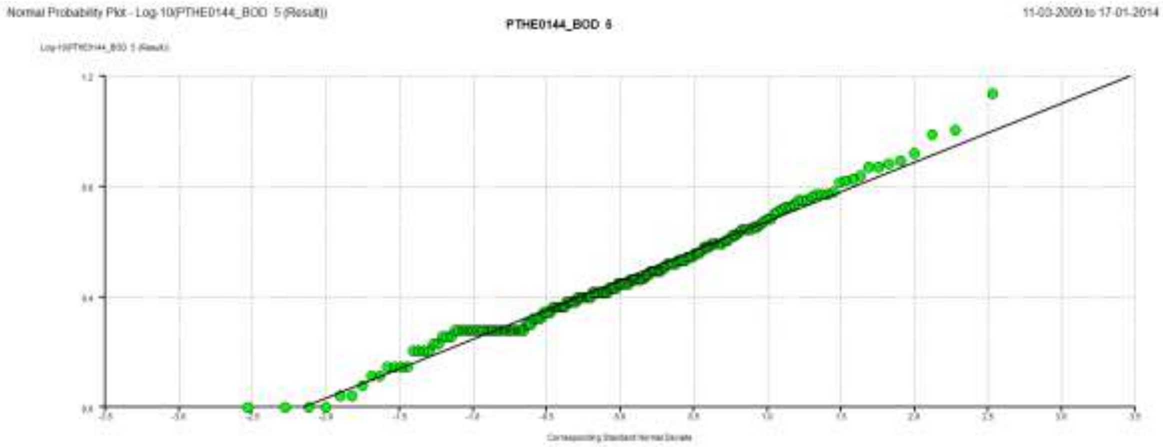


Figure 26: Aardvark LogNormal plot for ammonia for PTHE0144.

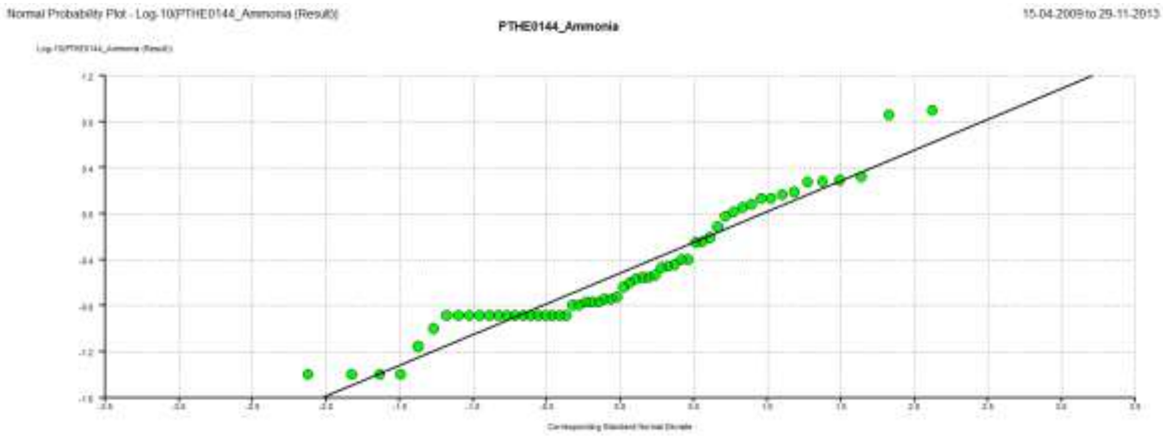


Figure 27: SIMCAT result for flow and phosphate.

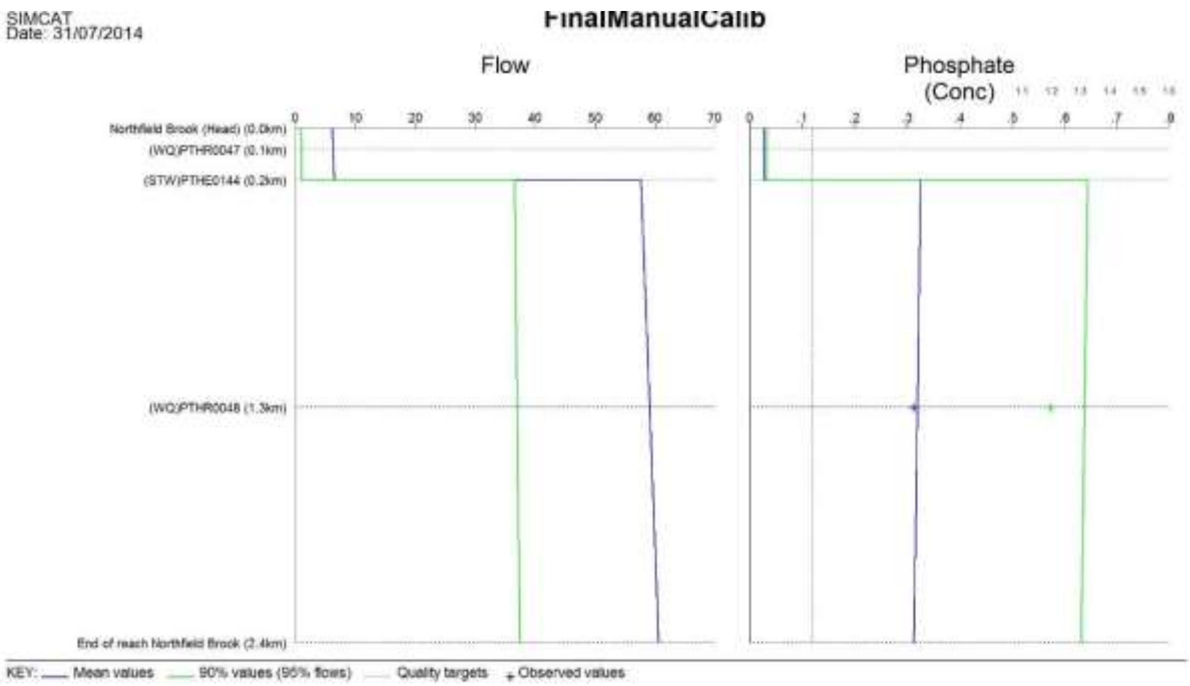
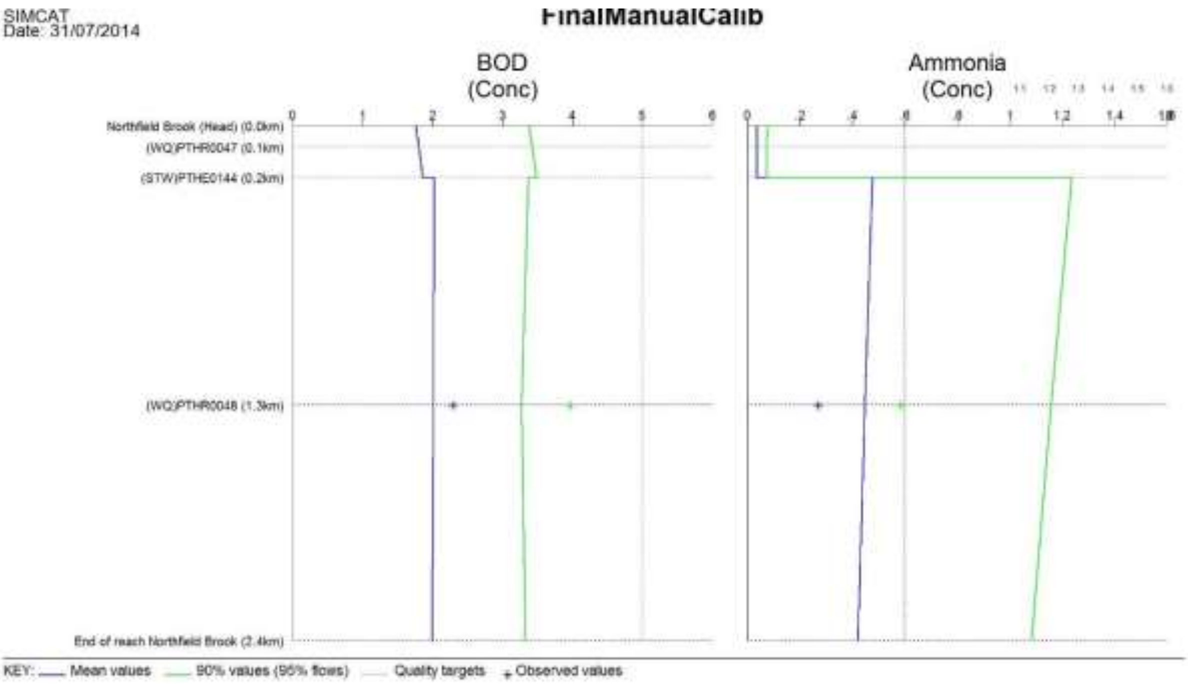


Figure 28: SIMCAT result for BOD and Ammonia.



B.6.11 Shrivenham STW

Shrivenham STW discharges into the Tuckmill Brook as shown in Figure 29. The status of the receiving watercourse is summarised in the Table 37 below:

Table 37: Tuckmill Brook status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Not available	High	Moderate
2013 status	Moderate	Moderate	Not available	High	Poor
Objective	Good Status by 2027	Good Status by 2027	Not available	NA	2015: Moderate (Disproportionately expensive (P1b))

Figure 29: GIS SIMCAT map of Shrivenham discharge location.

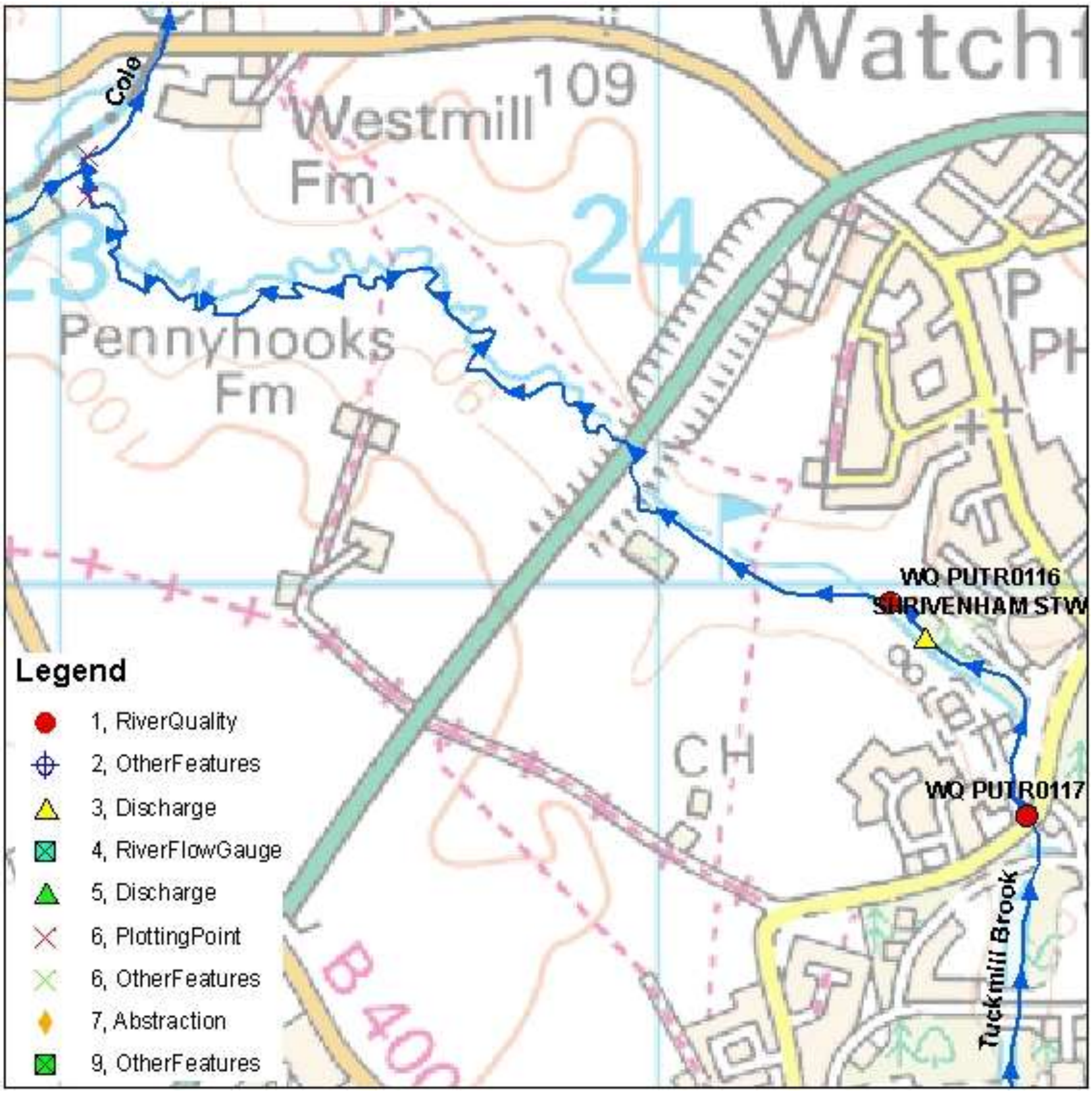


Table 38 shows the input data and RQP results for Shrivenham. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will be exceeding its consent for Ammonia by 2019/20 and for BOD by 2030/31. Upgrading of the works would therefore be required by 2019/20.

Table 38: input data and RQP results for Shrivenham STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	11.41	SIMCAT calculated value just upstream STW	1.77	Thames Water	NA	2.06	Thames Water	NA	1.97	Thames Water	NA
	SD			0.59			0.69			0.66		
	5%ile	1.82										
BOD (mg/l)	Mean	1.39	U/s WQ point PUTR0117 from SIMCAT	3.4	Thames Water	2.73	4.5	Thames Water	3.22	4.8	Thames Water	3.32
	SD	0.65										
	95%ile			6.5			8.5			9.1		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.11	U/s WQ point PUTR0117 from SIMCAT	0.3	Thames Water	0.29	0.8	Thames Water	0.53	1	Thames Water	0.64
	SD	0.11										
	95%ile			0.9			2.3			3.1		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.085	U/s WQ point PUTR0117 from SIMCAT	2.83	SIMCAT observed values	1.21	2.83	SIMCAT observed values	1.32	2.83	SIMCAT observed values	1.29
	SD	0.039		1			1			1		
	Target Mean	0.075	2013 WFD									

The upstream WQ point is 0.41km from the discharge point and Table 39 below shows the statistics used in SIMCAT and those derived from the observed data provided:

Table 39: statistics used in SIMCAT and those derived from the observed data for WQ point PUTR0117.

			SIMCAT model				Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Distribution	Mean	SD	Samples	Data period
PUTR0117	0.41	BOD	1.391	0.652	27	Normal				no data
PUTR0117	0.41	Amm	0.109	0.112	29	Log-Normal	0.061	0.045	10	13 only
PUTR0117	0.41	P	0.085	0.039	29	Log-Normal	0.057	0.033	10	13 only

Due to the low number of samples for the period 09-13 the SIMCAT data were used. Because of the close distance to the discharge point the effect of the natural purification is negligible. The model presents a good calibration for all pollutants as shown in Figure 30 and Figure 31 and indicates a failure of the target for phosphate.

The RQP results confirm that the target for phosphate is not reached for the present-day situation and the future scenarios and also indicate that the watercourse will fail its target for ammonia by 2030/31. There is a 18% and 22% deterioration for BOD for 2019/20 and 2030/31 respectively; 83% and 120% for ammonia for 2019/20 and 2030/31 respectively; 9% and 7% deterioration for phosphate for 2019/20 and 2030/31 respectively.

SIMCAT shows that phosphate is failing its target upstream of the STW. The RQP tool was used to calculate the discharge quality for the future scenario that would be required in order to meet the river target for P:

Table 40: STW discharge quality required to meet WFD targets - Shrivenham STW

Pollutant	Target	Mean	SD	95%ile
P	0.075	0.01	0.01	0.02

In order to prevent a water quality deterioration at Shrivenham for future scenarios, sewage treatment would have to be improved to meet standards for BOD and Ammonia. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 32 must be met.

Table 41: 'No deterioration' consent values for Shrivenham STW

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Consent values required to meet "no-deterioration"		
			Mean Quality	Standard Deviation	95th Percentile
BOD	30/31	2.73	3.52	1.16	5.64
Ammonia	30/31	0.29	0.41	0.13	0.64
Phosphate	-	-	-	-	-

Figure 30: SIMCAT result for flow and phosphate.

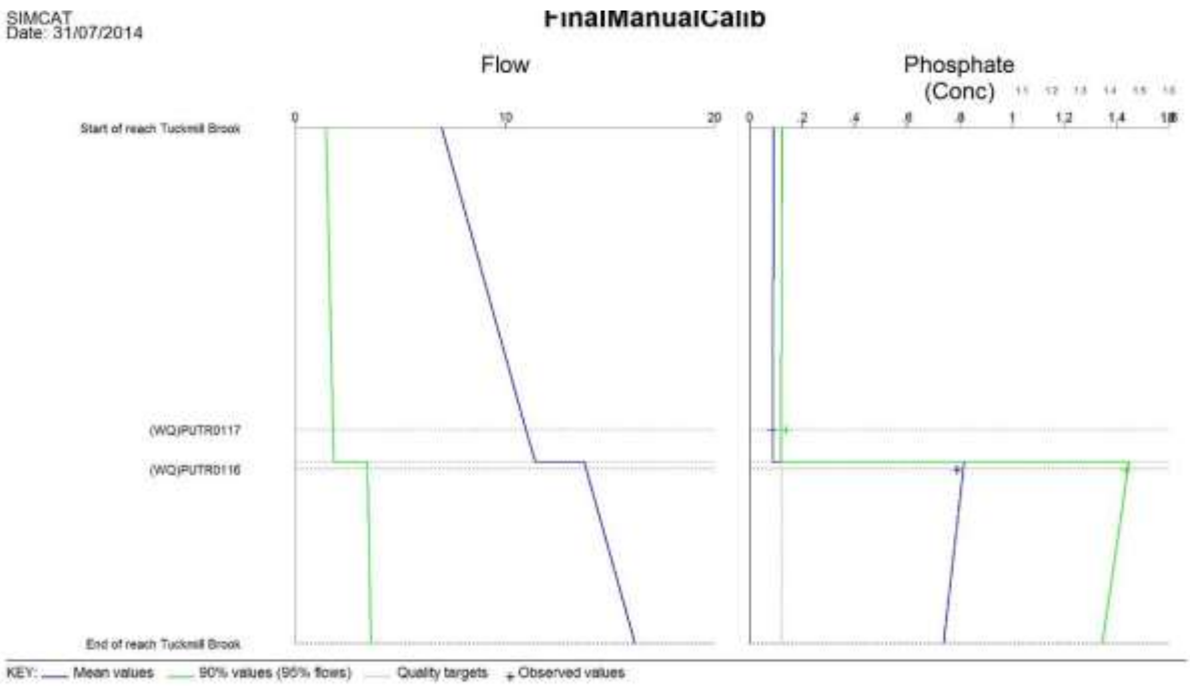
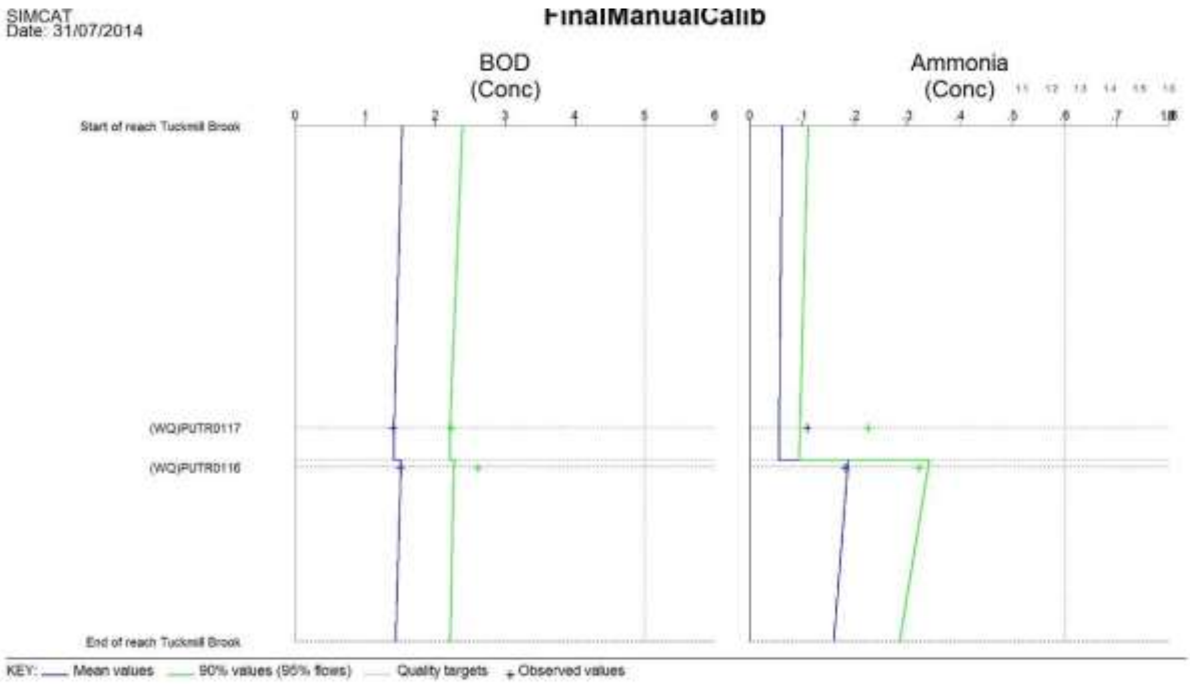


Figure 31: SIMCAT result for BOD and Ammonia.



B.6.12 Stanford in the Vale STW

Stanford in the Vale STW discharges into the River Ock as shown in Figure 32.

The status of the receiving watercourse is summarised in Table 42 below:

Table 42: River Ock status.

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Not available	High	Moderate
2013 status	Moderate	Moderate	Not available	High	Moderate
Objective	Good Status by 2027	Good Status by 2027	Not available	NA	2015: Moderate (Disproportionately expensive (P1a))

Figure 32: GIS SIMCAT map of Stanford in the Vale discharge location.

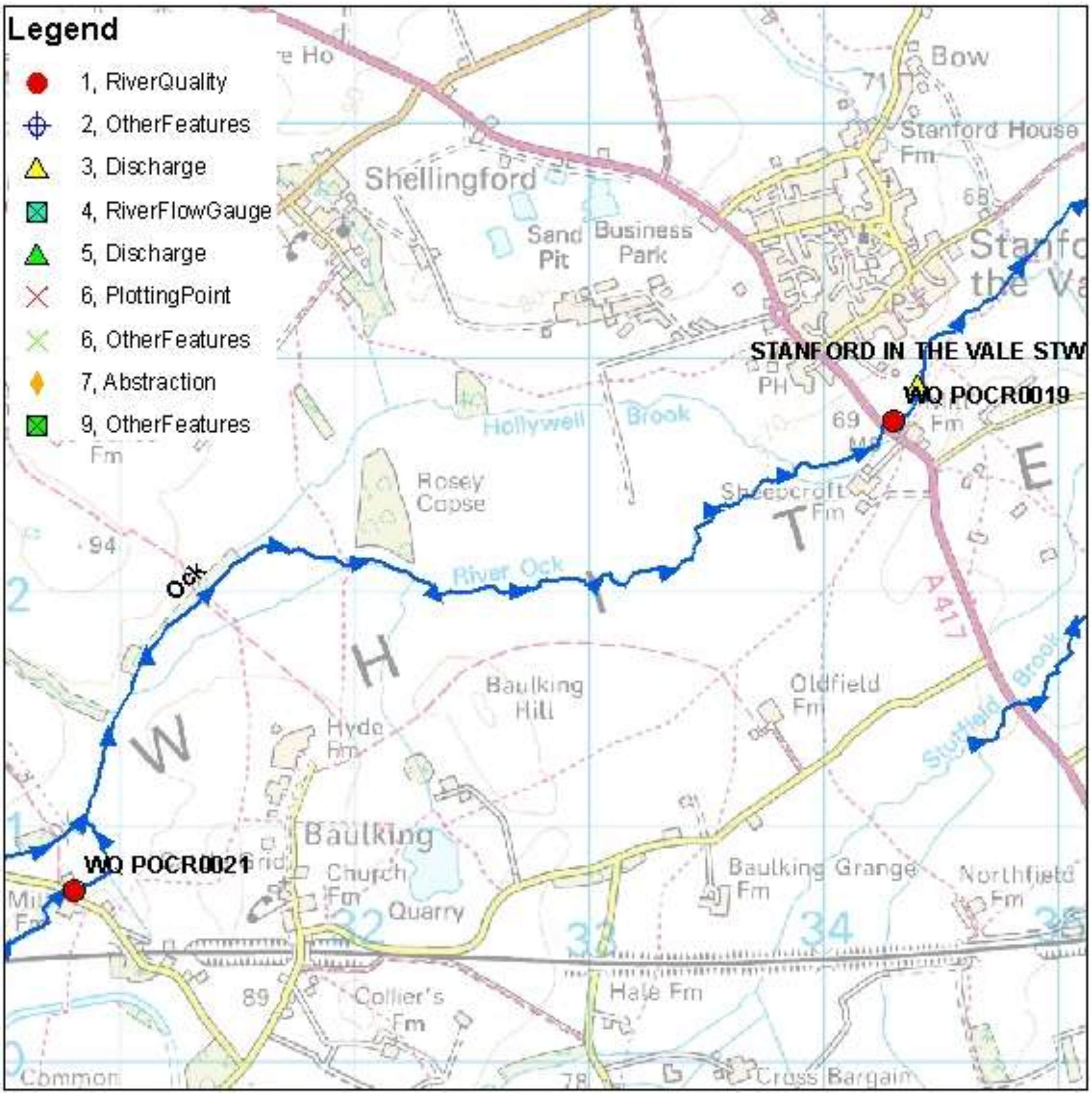


Table 43 shows the input data and RQP results for Stanford in the Vale. The works has a consent for BOD only (see Table 4) and currently it is operating within its consent. Future scenarios predict that the STW will continue to operate within its consent.

Table 43: input data and RQP results for Stanford in the Vale STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	15.64	SIMCAT calculated value just upstream STW	0.39	Thames Water	NA	0.49	Thames Water	NA	0.47	Thames Water	NA
	SD			0.13			0.16			0.16		
	5%ile	3.46										
BOD (mg/l)	Mean	1.14	U/s WQ point POCR0019 from SIMCAT	2.3	Thames Water	2.14	3.1	Thames Water	2.17	3.3	Thames Water	2.17
	SD	0.87										
	95%ile			3.6			4.8			5.2		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.04	U/s WQ point POCR0019 from 08-13 data	0.08	Thames Water	0.08	0.2	Thames Water	0.08	0.2	Thames Water	0.09
	SD	0.037										
	95%ile			0.13			0.3			0.3		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.178	U/s WQ point POCR0019 from SIMCAT	4.91	SIMCAT observed values	0.53	4.91	SIMCAT observed values	0.6	4.91	SIMCAT observed values	0.58
	SD	0.074		1.32			1.32			1.32		
	Target Mean	0.081	2013 WFD									

The upstream WQ point is 0.2km from the discharge point and Table 44 below shows the statistics used in SIMCAT and those derived from the observed data provided:

Table 44: statistics used in SIMCAT and those derived from the observed data for WQ point POCR0019.

			SIMCAT model				Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Distribution	Mean	SD	Samples	Data period
POCR0019	0.2	BOD	1.141	0.873	33	Log-Normal				no data
POCR0019	0.2	Amm	0.038	0.035	36	Log-Normal	0.04	0.037	58	08-13
POCR0019	0.2	P	0.167	0.067	36	Log-Normal	0.1	0.038	26	08-10 and 13

Due to the low number of samples for the period 2009-13 the SIMCAT data were used for BOD and phosphate. The statistics from the data period 2009-13 which were used for ammonia (see Aardvark summary on Figure 33) were virtually identical to the values used in SIMCAT. The Aardvark analysis has shown no seasonality, trends or step changes and a good fit with the LogNormal plot as shown on Figure 34. Because of the close distance to the discharge point the effect of the natural purification is negligible.

The model presents a good calibration for all pollutants as shown on Figure 35 and Figure 36, and indicates a failure of the target for phosphate and for ammonia for a short length of reach downstream the discharge point.

The RQP results also predict that the watercourse fails its target for phosphate for the present-day situation and the future scenarios. There is a 1% deterioration for BOD for both scenarios; 13% deterioration for ammonia for 2030/31 scenario; 13% and 9% deterioration for phosphate for 2019/20 and 2030/31 respectively.

SIMCAT shows that phosphate fails its target upstream of the STW. The RQP tool was used to calculate the discharge quality for the future scenario including the contingency sites that would be required in order to meet the river targets for P, but reported that "the river quality target is not achievable without improving the upstream water quality".

In order to prevent a water quality deterioration at Stanford in the Vale for future scenarios, sewage treatment would have to be improved to meet standards for Ammonia and Phosphate. In order to meet the 'No deterioration' consent, the revised consent values shown in Table 45 must be met.

Table 45: 'No deterioration' consent values for Stanford in the Vale STW

Parameter	**Scenario with highest consent**	**Present day 90 percentile (the "no-deterioration" target)**	**Consent values required to meet "no-deterioration"**		
			Mean Quality	**Standard Deviation**	**95th Percentile**
BOD	-	-	-	-	-
Ammonia	30/31	0.08	0.15	0.05	0.24
Phosphate	19/20	0.53	3.9	1.3	6.31

Figure 33: Aardvark summary for ammonia for POCR0019.

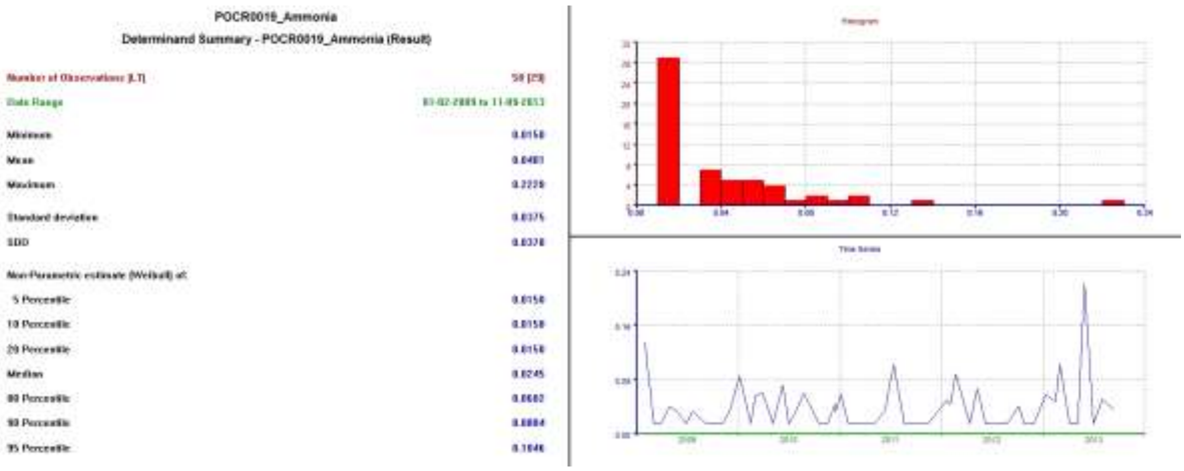


Figure 34: Aardvark LogNormal plot for ammonia for POCR0019.

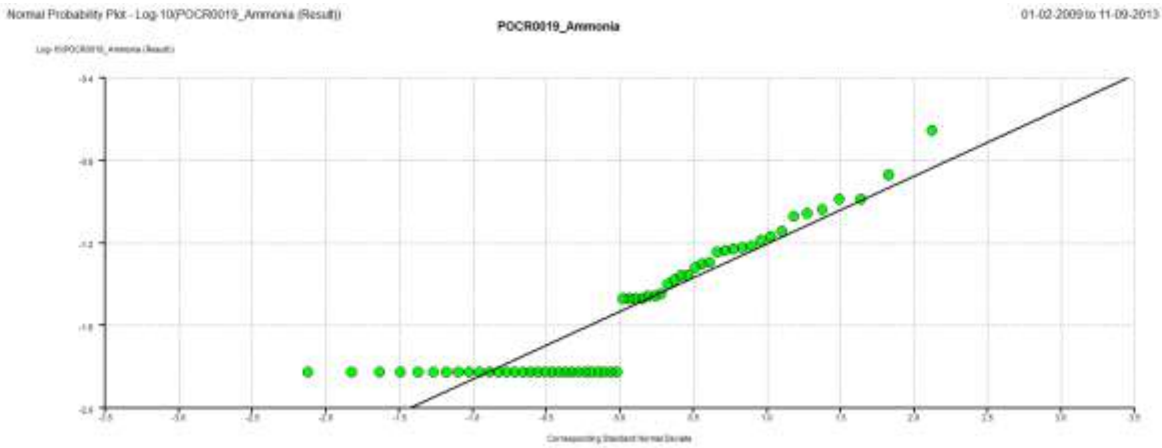


Figure 35: SIMCAT result for flow and phosphate.

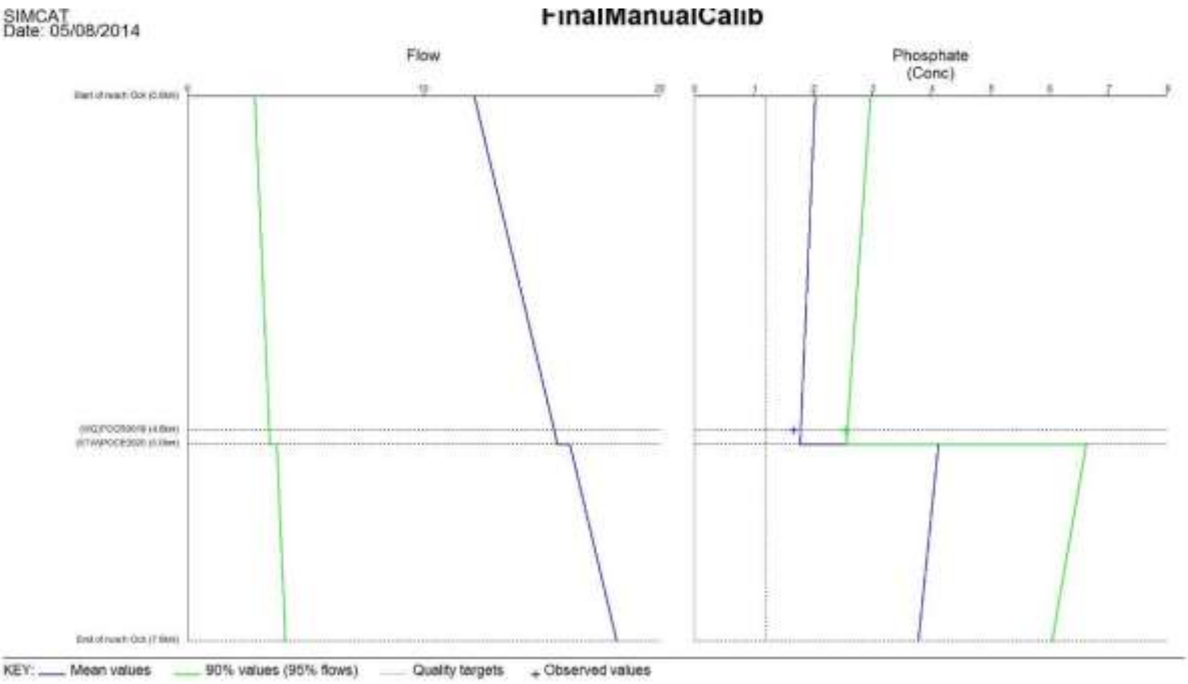
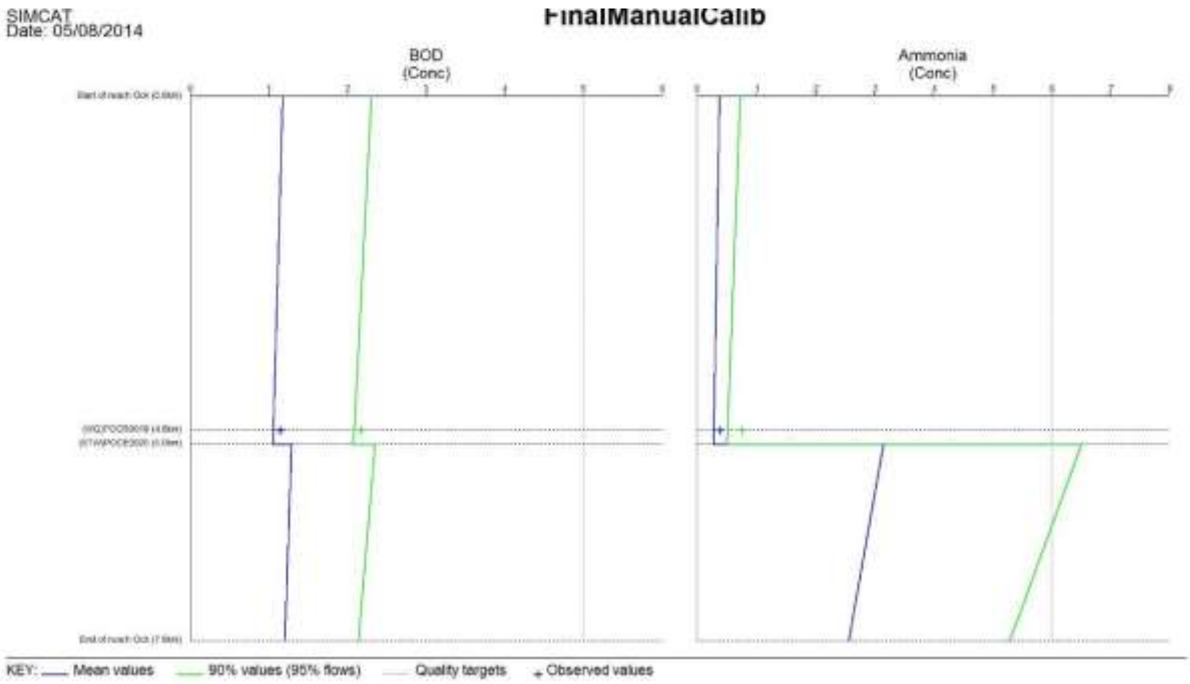


Figure 36: SIMCAT result for BOD and Ammonia.



B.6.13 Wantage STW

Wantage STW discharges into the Letcombe Brook as shown in Figure 37.

The status of the receiving watercourse is summarised in the table below:

	Overall	Ecological	Chemical	Ammonia	Phosphate
Baseline status	Moderate	Moderate	Not available	High	Moderate
2013 status	Moderate	Moderate	Not available	High	Moderate
Objective	Good Status by 2027	Good Status by 2027	Not available	NA	2015: Moderate (Disproportionately expensive (P1a))

Figure 37: GIS SIMCAT map of Wantage discharge location.

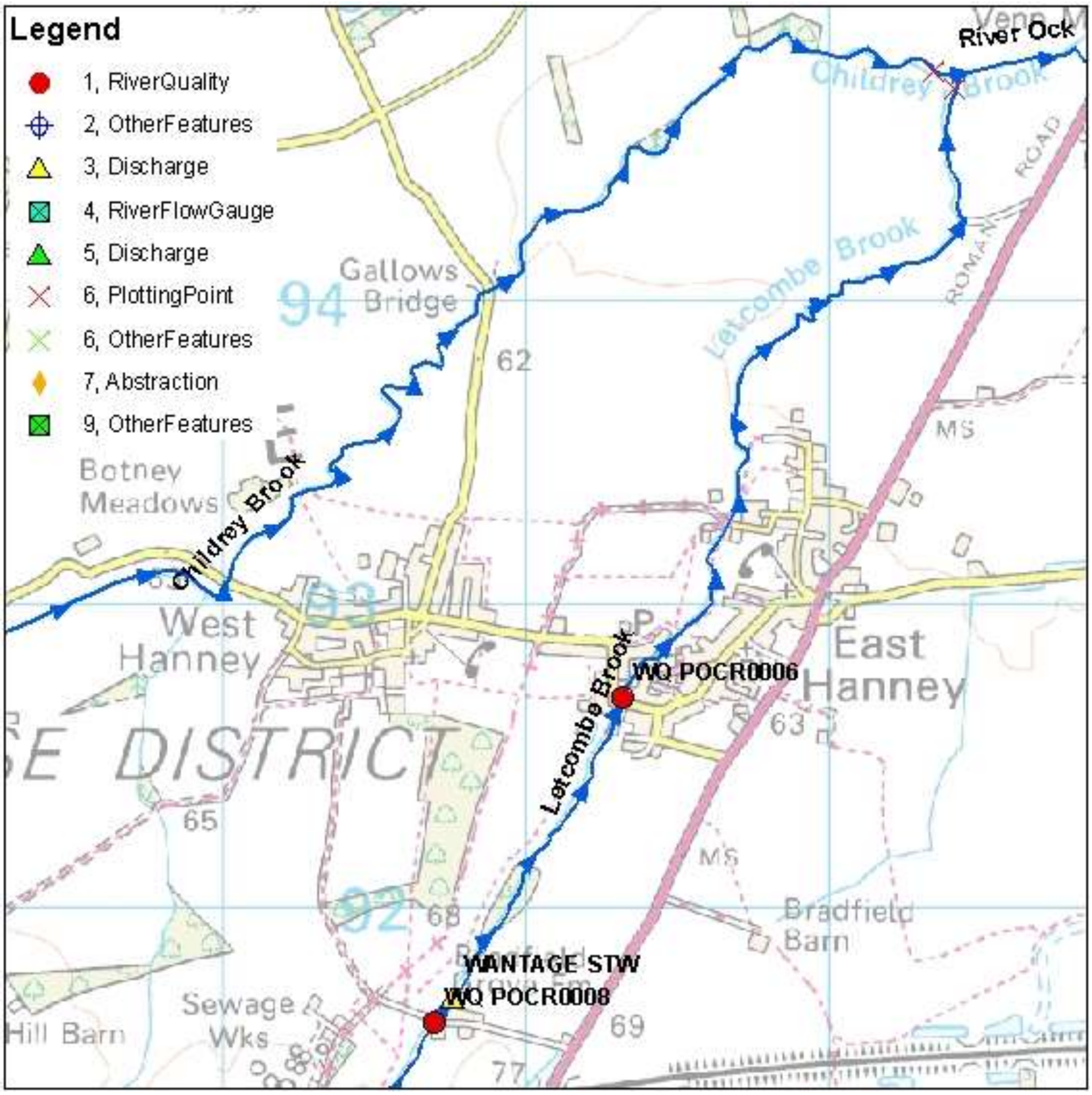


Table 46 shows the input data and RQP results for Wantage. The works has consent values for BOD and ammonia (see Table 4) and currently it is operating within its consents. Future scenarios predict that the STW will continue to operate within its consents, but will be close to its capacity for ammonia by the 2030/31 scenario.

Table 46: input data and RQP results for Wantage STW.

Parameter	Statistic	River	Source	Present day (2013)			2019/20			2030/31		
				STW	Source	RQP Result	STW	Source	RQP Result	STW	Source	RQP Result
Flow (Ml/d)	Mean	38.61	SIMCAT calculated value just upstream STW	6.19	Thames Water	NA	6.98	Thames Water	NA	7.68	Thames Water	NA
	SD			2.06			2.33			2.56		
	5%ile	5.54										
BOD (mg/l)	Mean	1	U/s WQ point POCR0008 from SIMCAT	6	Thames Water	3.57	6.5	Thames Water	3.95	7.3	Thames Water	4.53
	SD	0.57										
	95%ile			12			13			14.6		
	Target 90%ile	5	2013 WFD									
Amm (mg/l)	Mean	0.02	U/s WQ point POCR0008 from SIMCAT	0.7	Thames Water	0.37	1	Thames Water	0.57	1.6	Thames Water	0.96
	SD	0.01										
	95%ile			1.8			2.6			4.1		
	Target 90%ile	0.6	2013 WFD									
P (mg/l)	Mean	0.35	U/s WQ point POCR0008 from SIMCAT	1.38	Thames Water	0.85	1.38	Thames Water	0.88	1.38	Thames Water	0.91
	SD	0.15		0.36			0.36			0.36		
	Target Mean	0.08	2013 WFD									

The upstream WQ point is 0.1km from the discharge point and the Table 47 below shows the statistics used in SIMCAT and those derived from the observed data provided:

Table 47: statistics used in SIMCAT and those derived from the observed data for WQ point POCR0008

			SIMCAT model				Data 09-13			
WQ point	Distance	Pollutant	Mean	SD	Samples	Distribution	Mean	SD	Samples	Data period
POCR0008	0.1	BOD	1.002	0.575	28	Log-Normal				no data
POCR0008	0.1	Amm	0.019	0.009	28	Log-Normal	0.025	0.02	9	2013
POCR0008	0.1	P	0.053	0.024	28	Log-Normal	0.046	0.023	9	2013

Due to the low number of samples for the period 09-13 the SIMCAT data were used. Because of the close distance to the discharge point the effect of the natural purification is negligible. The model presents a good calibration for all pollutants as shown in Figure 38 and Figure 39 and indicates a failure of the target for phosphate.

The RQP results also predict the watercourse to fail its target for phosphate for the present-day situation and the future scenarios and ammonia fails its target for the 2030/31 scenario. There is a 11% and 27% deterioration for BOD for 2019/20 and 2030/31 respectively; 54% and 159%

deterioration for ammonia for 2019/20 and 2030/31 respectively; 4% and 7% deterioration for phosphate for 2019/20 and 2030/31 respectively.

The RQP tool was used to calculate the discharge quality for the future scenario including the contingency sites that would be required in order to meet the river targets for P, but reported that "the river quality target is not achievable without improving the upstream water quality".

In order to prevent a water quality deterioration at Wantage for future scenarios, sewage treatment would have to be improved to meet standards for Ammonia and Phosphate. In order to meet the 'No deterioration' consent, the revised consent values shown in **Error! Reference source not found.**must be met.

Table 48: 'No deterioration' consent values for Wantage STW

Parameter	Scenario with highest consent	Present day 90 percentile (the "no-deterioration " target)	Consent values required to meet "no-deterioration"		
			Mean Quality	**Standard Deviation**	**95th Percentile**
BOD	-	-	-	-	-
Ammonia	30/31	0.37	0.73	0.24	1.17
Phosphate	30/31	0.85	1.25	0.36	1.89

Figure 38: SIMCAT result for flow and phosphate.

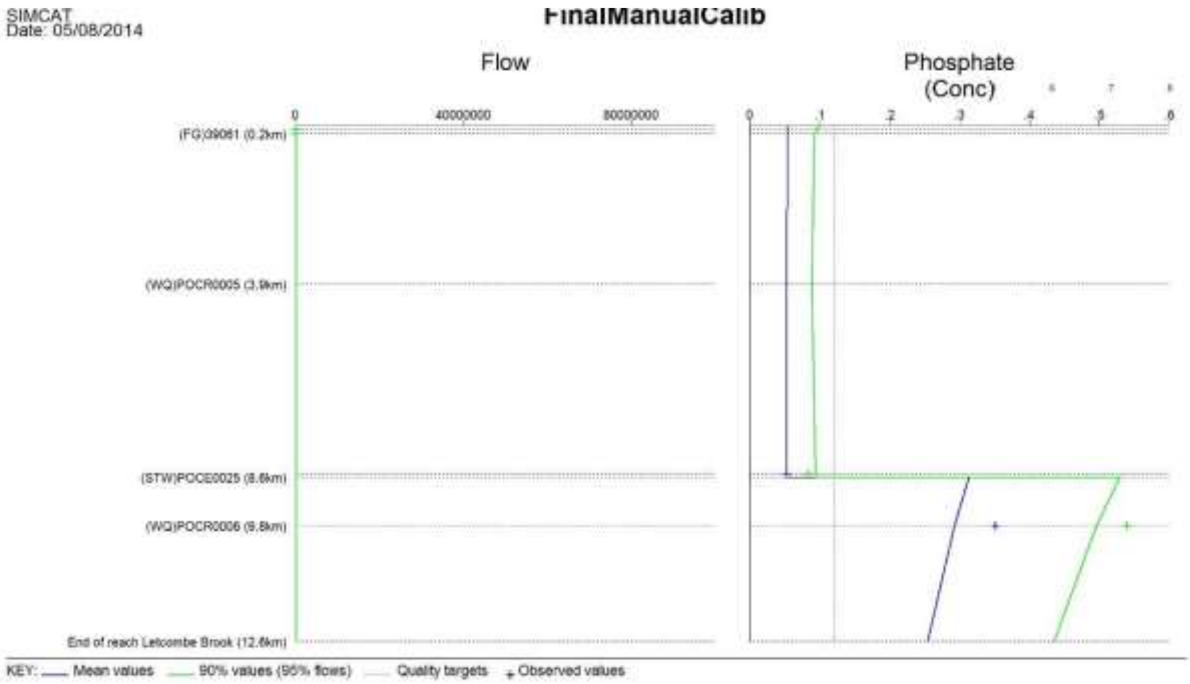
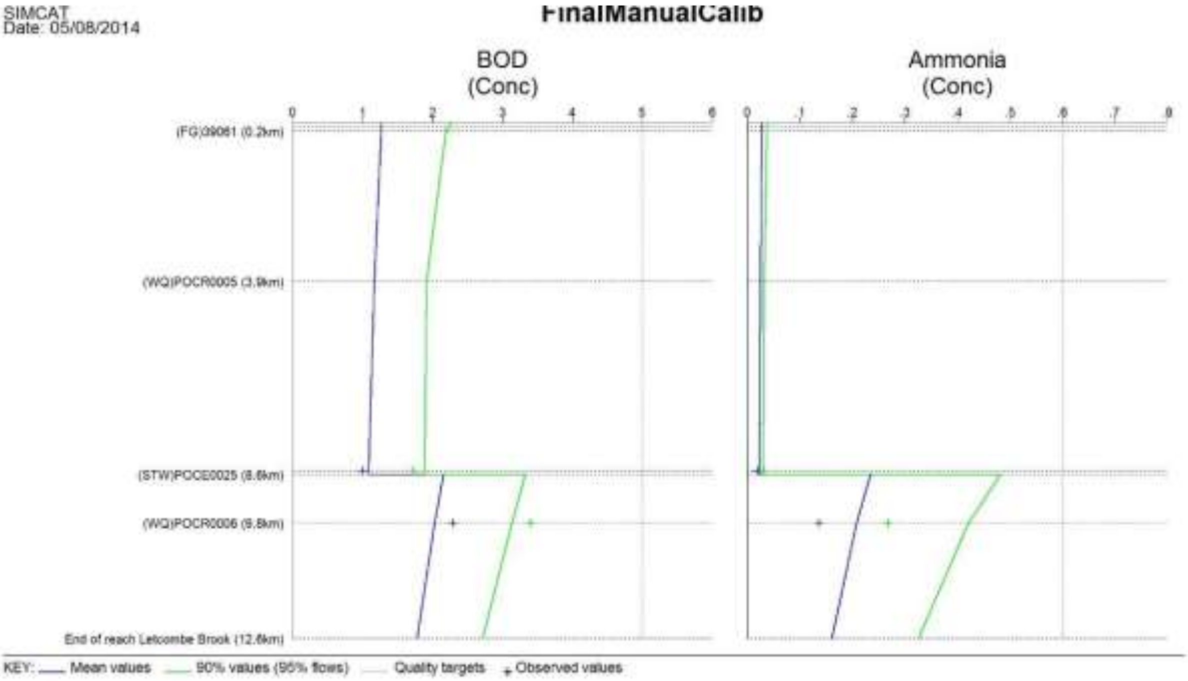


Figure 39: SIMCAT result for BOD and Ammonia.



B.7 Climate change

The National Planning Policy Framework practice guidance[2] states that "addressing climate change is one of the core land use planning principles which the National Planning Policy Framework expects to underpin both plan-making and decision-taking. To be found sound, Local Plans will need to reflect this principle and enable the delivery of sustainable development in accordance with the policies in the National Planning Policy Framework."

Likewise the Environment Agency's Water Cycle Study Guidance states that the development of water infrastructure should contribute "to the shift to a low carbon economy."

The Thames RBMP Annex H includes an assessment of the evidence on climate change to 2050 and the potential impacts this will have on achieving WFD good ecological status. Key issues relevant to this water quality assessment are:

- higher summer temperatures leading to lower background levels of dissolved oxygen,
- reduced summer rainfall leading to lower mean summer flows, meaning that there will be reduced dilution of treated effluent, and
- requirements for higher standards of treatment (in particular for P removal) can lead to increased carbon emissions.

The EA's "Water Quality Planning: no deterioration and the Water Framework Directive" and "Horizontal guidance" make no mention of how to account for climate change in water quality planning. Various studies by UK Water Industry Research (UKWIR)[3,4] and the Environment Agency[5] do however provide some background to how to approach this issue. CEH's Future Flows and Groundwater Levels work provides an assessment at a number of gauges (including the Ock at Abingdon) as well as a methodology for how to apply climate change assessments to river flows at other sites[6].

This assessment has not specifically modelled the impacts of climate change on the status and deterioration of the watercourses and it would be advisable to address this issue at a local level when considering consent changes to STWs. It is likely that this would require as a minimum consideration of changes to river water temperature and flows.

The RBMP encourages us to look for win-win" actions, and integrated and catchment-based approaches are encouraged. One example here could be catchment based land management and river restoration projects could be used to both reduce diffuse P inputs and to help maintain summer base flows in watercourses. The RBMP cautions that taking actions for specific pressures may be counter-productive. So for example the carbon costs of increased treatment standards need to be assessed against the environmental benefits they will achieve.

B.8 Phosphate

The Thames RBMP indicates that phosphates (along with diatoms, macrophytes, fish and invertebrates) is one of the main individual elements which the EA assesses as leading to good ecological status not being achieved, with only around 35% of water bodies achieving their good status target for phosphate. Phosphate has been assessed as a major cause of biological failures (e.g. diatoms and macrophytes). Recent research on the Thames basin[7] has indicated that WFD targets can only be achieved by a combination of measures to reduce P both through agricultural management practices and removal at STWs. This paper found that a combined approach requiring 20% reduction in agricultural inputs and P removal at STWs to meet a

[2] Department of Communities and Local Government (2014) National Planning Policy Framework Practice Guidance: Climate Change.

[3] UKWIR (2007) Climate Change, the Aquatic Environment and the Water Framework Directive. Ref: 07/CL/06/5

[4] UKWIR (2005) Effects of Climate Change on River Water Quality. Ref: 05/CL/06/4

[5] Environment Agency (2007) Preparing for climate change impacts on freshwater ecosystems (PRINCE). Ref SC030300/SR. Accessed on 01/09/2014 at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/291081/scho0507bmoj-e-e.pdf

6 Accessed on 01/09/2014 at

http://www.ceh.ac.uk/sci_programmes/water/future%20flows/ffgwlsites.html#Background

[7] Whitehead PG et al (2013) A cost-efectiveness analysis of water security and water quality: impacts of climate and land-use change on the River Thames system. Phil Trans R Soc A 371: 20120413. http://dx.doi.org/10.1098/rsta.2012.0413

discharge concentration of P of 0.3mgl^{-1} total P would be the most cost-effective approach for the Thames basin. Notably however this study did not take into account the high carbon costs of treating wastewaters to this standard.

The RBMP aims to tack this via the following measures:

- Agriculture and rural land management. A range of approaches are in use including promotion of best-practice, partnership working pilots and Water Protection Zones (WPZs). One large-scale project underway in South Oxfordshire is the River of Life project on the River Thames[8]. Here the Earth Trust are restoring wetland features and habitat along 2km of river bank and floodplain. This type of restoration and the use of buffer zones have the potential to reduce P inputs to the watercourse; the Whitehead et al (2013) paper found these to be the most cost-effective measure but not on their own sufficient to tackle the P issue in the Thames basin.
- Legislative and regulatory measures.
- Water industry measures, in particular P removal at STWs where the economic and carbon costs can be justified. The water industry is also increasingly seeking to play a role in catchment-based approaches with the aim of achieving WFD P targets at a lower economic and carbon cost. Thames Water are undertaking a catchment sensitive farming trial to address P[9].

B.9 Summary and conclusions

B.9.14 Method

The increased discharge of effluent due to an increase in the population served by a Sewage Treatment Works (STW) may impact on the quality of the receiving water. The Water Framework Directive (WFD) does not allow a watercourse to deteriorate from its current class (either water body or element class).

It is Environment Agency policy to model the impact of increasing effluent volumes on the receiving watercourse. Where the scale of development is such that a deterioration is predicted, a new consent may be required for the STW to improve the quality of the final effluent, so that the extra pollution load will not result in a deterioration in the water quality of the watercourse. This is known as a “no deterioration” or “load standstill".

During the preparation of the phase I Water Cycle Study (WCS) the Environment Agency advised that it would be necessary to undertake an assessment of the water quality impact of development in the 11 STW catchments which will receive the majority of additional flows in the Vale of White Horse District (12 outfalls as Abingdon has 2 outfalls to different watercourses).

The assessment was undertaken using the EA's River Quality Planning (RQP) tool which enables a Monte-Carlo analysis to be undertaken at a single point of discharge to a watercourse. This was supplemented by results from their SIMCAT model of the Thames River Basin District (RBD).

RQP models were required to be set up and run using the present-day and 2019/20 and 2030/31 growth scenario effluent flows to assess the impact of the increased contaminant loads on the receiving watercourses due to the extra wastewater flows.

Addressing existing diffuse pollution is beyond the remit of the WCS, and therefore the analysis was undertaken following the assumption that that the upstream diffuse sources of pollution had been addressed (i.e. ‘good status’ achieved upstream). This was achieved by setting the upstream quality at the level of ‘good status’ in the model.

B.9.15 Results

Table 49 summarises the modelling results for the 'Good status' and 'No deterioration' targets for each STW. The colour code used for the 'Good status' target is green for achieving it and red for

8 http://www.earthtrust.org.uk/Our-work/waterandwetlands/RiverofLife.aspx

9 Thames Water (2014) Business Plan 2015-2020 Part A - Summary.

failing it. For the 'No deterioration' target is green for no deterioration, amber for <=10% deterioration and red for >10% deterioration.

The comments contained under "Model result for achieving good 'status'" refer to the results from the RQP tool. It does not consider if the discharge requested to achieve the target is achievable by the work and if it is economically acceptable.

Table 49: 'Good status' and 'No deterioration' target summary.

STW	Scenario	Failing 'Good status' target?			Failing 'No deterioration' target?			Model result for achieving good 'status'
		BOD	Amm	P	BOD	Amm	P	
Abingdon Lagoon	Actual	No	No	Yes	NA	NA	NA	The river target for P cannot be achieved without improving the upstream quality of the river
	19/20	No	No	Yes	No	No	No	
	30/31	No	No	Yes	No	No	No	
Abingdon New Stream	Actual	Yes	Yes	Yes	NA	NA	NA	River target can be achieved for all pollutants with improvement to the works
	19/20	Yes	Yes	Yes	2%	10%	No	
	30/31	Yes	Yes	Yes	2%	12%	No	
Appleton	Actual	No	No	Yes	NA	NA	NA	The river target for P cannot be achieved without improving the upstream quality of the river
	19/20	No	No	Yes	15%	48%	5%	
	30/31	No	No	Yes	9%	48%	1%	
Didcot	Actual	No	Yes	Yes	NA	NA	NA	River target can be achieved for Amm and P with improvement to the works
	19/21	No	Yes	Yes	8%	65%	3%	
	30/32	No	Yes	Yes	22%	212%	6%	
Drayton	Actual	No	No	Yes	NA	NA	NA	River target can be achieved for Amm and P with improvement to the works
	19/21	No	Yes	Yes	9%	66%	16%	
	30/32	No	No	Yes	6%	55%	6%	
Faringdon	Actual	Yes	Yes	Yes	NA	NA	NA	River target can be achieved for BOD and Amm with improvement to the works but cannot be achieved for P without improving the upstream quality of the river
	19/21	Yes	Yes	Yes	26%	80%	5%	
	30/32	Yes	Yes	Yes	21%	85%	3%	
Kingston Bagpuize without contingencies sites	Actual	No	Yes	Yes	NA	NA	NA	No calculation was done for this scenario
	19/22	No	Yes	Yes	11%	40%	2%	
	30/33	No	Yes	Yes	10%	52%	1%	
Kingston Bagpuize with contingencies sites	Actual	No	Yes	Yes	NA	NA	NA	River target can be achieved for Amm with improvement to the works but cannot be achieved for P without improving the upstream quality of the river
	19/22	No	Yes	Yes	18%	71%	3%	
	30/33	Yes	Yes	Yes	33%	160%	5%	
Oxford	Actual	Yes	Yes	Yes	NA	NA	NA	River target can be achieved for all pollutants with improvement to the works
	19/22	Yes	Yes	Yes	No	8%	No	
	30/33	Yes	Yes	Yes	No	4%	No	
Shrivenham	Actual	No	No	Yes	NA	NA	NA	River target can be achieved for P with improvement to the works
	19/22	No	No	Yes	18%	83%	9%	
	30/33	No	Yes	Yes	22%	120%	7%	
Standford in the Vale	Actual	No	No	Yes	NA	NA	NA	The river target for P cannot be achieved without improving the upstream quality of the river
	19/23	No	No	Yes	1%	12%	13%	
	30/34	No	No	Yes	1%	12%	9%	
Wantage	Actual	No	No	Yes	NA	NA	NA	The river target for P cannot be achieved without improving the upstream quality of the river
	19/23	No	No	Yes	11%	54%	4%	
	30/34	No	No	Yes	27%	159%	7%	

B.9.16 Technical Feasibility of Work Improvements

As indicated in the previous section, this modelling assessment indicates that the majority of STWs may require treatment to a higher standard in order to avoid class deterioration or to avoid water quality deterioration above 10%. Where this is the case, revised consent values have been calculated. Meeting a higher standard would be anticipated to require capital investment to expand the treatment capacity at most works. However, particularly in cases where significant population growth is planned in a catchment where the STW discharges to a small watercourse with limited dilution, it may not be possible to meet these tighter consents using the existing treatment technologies employed at those works. This may therefore require additional tertiary treatment to be installed, incurring additional capital and operational costs. Table 50 and Table 51 show TW's assessment of a technically feasible standard for Ammonia and BOD, respectively, for a range of treatment works sizes and processes. The mean annual technically feasible phosphate consent is 0.5mg/l. Based on the criteria in the tables, the results from the models should be used to answer the following questions where an improvement would be required to achieve a 'no deterioration' target or to prevent a class deterioration.

- Are the improvements required at STWs technically feasible?
- Are the improvements required at STWs economically feasible?
- Based on the upgrades required, what is the timeline for the improvements?

Table 50: Works Size Ranges for Ammonia Consent

Population Equivalent Range	Ammonia Consent (95-percentile mg/l)	Process Selection
< 5,000	No consent	Percolating filters – single filtration
		Submerged aerated filters
		RBCs – where existing
	>= 4	Percolating filters – single filtration
		Submerged aerated filters
		RBCs (where existing)
	2 – 7	Percolating filters – double filtration
		Percolating filters & nSAF
		SAF & nSAF
		RBCs (where existing) & nSAF
		Crude sewage activated sludge (> 3,500 PE)
		Settled sewage activated sludge (> 3,500 PE)
	< 2	Crude sewage activated sludge
		Settled sewage activated sludge
5,000 – 50,000	>= 4	Percolating filters – single filtration
		SAF - as side stream for < 5,000 PE
		Crude sewage activated sludge (< 25,000 PE)
		Settled sewage activated sludge
	2 – 7	Percolating filters – double filtration
		Percolating filters & nSAF
		Crude sewage activated sludge (< 25,000 PE)
		Settled sewage activated sludge
> 50,001	All consents	Settled sewage activated sludge

Table 51: Process Selection Criteria for BOD Consents

Population Equivalent Range	95-percentile Solids/ BOD	Process	Suspended Solids Removal
< 5,000	10 / 7	Reed Beds	70%
	15 / 10	Land Treatment Area	50%
	10 / 7	Continuous Flow Sand Filters	65%
	13 / 8	Disc Filters	60%
5,000 – 50,000	10 / 7	Reed Beds	70%
	10 / 7	Continuous Flow Sand Filters	65%
	13 / 8	Disc Filters	60%
	8 / 6	Rapid Gravity Sand Filter	65%
> 50,000	13 / 8	Disc Filters	60%
	8 / 6	Rapid Gravity Sand Filter	65%

Table 52 considers the technical feasibility of the STWs where an improvement would be required to achieve a 'No deterioration' target, as highlighted in Table 49. Here, the type of process in each STW, found on the TW STW assessment spreadsheets, was taken into account to assess whether a WwTW upgrade might be achieved with an extension of the existing process, the addition of a new but standard process (for example activated sludge) or would be beyond the capabilities of existing "Best Available Technologies". In the latter case, this could require use of drinking water treatment technologies, adding significant capital and operational costs. The population equivalent range has been compared against the expected population for each time scenario.

Table 52: Summary of technical feasibility of STW improvements to achieve the 'No deterioration' and "Good status" targets

Outfall	STW Process	>10% Deterioration	New Consent Required	Technically Feasible
Abingdon (New outfall)	Percolating Filter	No	No	No upgrade required
Abingdon (Lagoon)	Percolating Filter	Yes	No	Existing problem. Predicted consent value cannot be met using any current standard treatment technologies
Appleton	Percolating Filter	Yes for BOD and NH4	Yes	Predicted consent value cannot be met using any current standard treatment technologies
Didcot	Activated Sludge Plant	Yes for BOD and NH4	Yes	Predicted consent value cannot be met using any current standard treatment technologies
Drayton	Unknown	Yes	Yes	Upgrade may be required with a change to treatment technology
Faringdon	Filters	Yes for BOD and NH4	Yes	Upgrade may be required using existing treatment technology
Kingston Bagpuize	Rotating Biological Contactor	Yes for BOD and NH4	Yes	Upgrade may be required using existing treatment technology
Oxford	Activated Sludge	No	Yes	Existing problem. Predicted consent value cannot be met using any current standard treatment technologies

Outfall	STW Process	>10% Deterioration	New Consent Required	Technically Feasible
Shrivenham	Aeration	Yes for BOD and NH4	Yes	Predicted consent value cannot be met using any current standard treatment technologies
Stanford in the Vale	Unknown	Yes for NH4 and P	Yes	Upgrade may be required with a change to treatment technology
Wantage	Sludge	Yes for NH4 and P	Yes	Upgrade may be required using existing treatment technology

B.9.17 Conclusions

There are numerous failures of WFD standards throughout the study reaches, with some very high concentrations of phosphate. In summary:

- All the STWs fail their phosphate targets for the present-day situation, and at Abingdon Lagoon, Appleton, Kingston Bagpiuze, Stanford in the Vale and Wantage the P load from the upstream catchment is such that the P target for the watercourse could not be achieved by increased treatment at the works on its own. This is indicative of a wider issue with P in the Thames basin.
- At six STW outfalls the watercourse is predicted to fail its ammonia target for the present-day situation and other two will fail it for future scenarios.
- At three STW outfalls the watercourse is predicted to fail their BOD targets for the present-day situation and another will fail for future scenarios.
- At Abingdon New Stream, Faringdon and Oxford STWs the watercourse is predicted to fail its targets for all pollutants for the present scenarios.
- The analysis reported here cannot comment conclusively on the apportionment of pollutant loads between point and diffuse sources, but in many cases the introduction of additional loads frequently results in significant deterioration (>10%). Only the Thames at Abingdon STW (Lagoon Stream) is predicted to not be at risk from significant deterioration in either of the future scenarios.

The implications for achieving the proposed growth within the Vale of White Horse are that:

- Ignoring phosphate, Abingdon STW's Lagoon Stream is the only STW in the District where it is predicted that the watercourse will meet good status (for sanitary determinands) and where significant deterioration is not predicted within either of the future scenarios. Therefore development at Abingdon could be achieved without significant investment at the STW.
- At Appleton, Stanford in the Vale and Wantage, the receiving watercourses are predicted to meet their targets for sanitary determinands, however all are predicted to experience significant deterioration and therefore some upgrading of the STW will be required to prevent environmental deterioration.
- Of the remaining STWs (Abingdon (New Stream), Didcot, Drayton, Faringdon, Kingston Bagpuize and Shrivenham), the watercourse is predicted to fail its targets and significant deterioration is also predicted in the future scenarios. Again, upgrading of these STWs will be required to ensure that the receiving watercourses can meet their targets and are not subject to significant deterioration.
- Phosphate is an issue that will need to be addressed across the Thames River basin. This is likely to require a combination of further P removal at STWs along with agricultural practices (e.g. reductions in P application) and catchment-sensitive farming including riparian buffer zones. .
- More detailed studies should consider accounting for the effects of climate change on the capacity of the receiving waters to receive wastewater effluents. At Kingston Bagpuize and Wantage the predicted future consent could be achieved with an upgrade using the existing treatment processes employed at that site. At Stanford in the Vale it may be necessary to move to a new treatment process to meet the future consent.

- In order to prevent a water quality deterioration at Appleton, Didcot and Shrivenham, sewage treatment would have to be improved to meet standards for sanitary determinands which are higher than currently considered to be possible using standard wastewater treatment technologies. Meeting such targets could require investment in non-standard technologies which would significantly raise the costs of treatment. Therefore the ability to treat wastewater arising from Appleton, Didcot and Shrivenham may represent a constraint to growth.
- A predicted WFD class failure or deterioration by 2020/21 means that the works would require upgrade during AMP6. Therefore if no upgrade is scheduled during AMP6 there could be timing issues which would require either additional funding or phasing of development after 2020/21.
- A predicted WFD class failure or deterioration between 2021 and 2030/31 could be addressed in AMP7 or 8 and so would not require phasing of development.

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