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WRc

RIVER LODDON/BASINGSTOKE STW SIMCAT MODELLING: FINAL REPORT

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EA-Thames Water Quality RIV

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Thames Water Utilities Limited

WRc - Authors

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SUMMARY

The Environment Agency has agreed to co-operate with Thames Water Utilities Limited (TWUL) to carry out detailed, auditable modelling studies of the effects of increases in flows from Basingstoke STW on the effluent receiving watercourses. The main question that the modelling has to answer is "What are the standards required at the STW to meet the river standards required by the Agency with the proposed increase in flow?". The Agency operates a load standstill and no deterioration policy, interpreted as meaning that the quality in the river downstream that would be delivered by the current consent must be maintained after the population increases.

WRc carried out this study by building, calibrating and applying a SIMCAT model to the River Loddon and key tributaries. The study outcome can be summarised as follows:

1. Under current operation, RE2 standards are achieved in the Loddon. Bow Brook / Vyne Stream fails to meet RE3. Salmonid standards are met on the Loddon except for DO.

2. Under current consents for flow and quality, RE2, Salmonid and operational standards will not be achieved downstream of Basingstoke STW. Bow Brook fails to achieve RE3. The Loddon downstream of Bow Brook will achieve RE2 and Salmonid standards.

3. A revised consent for Sherfield STW, based on the current actual flow, has been calculated to achieve the same downstream impact as the current consent.

4. Three future population scenarios have been represented for 2001, 2006 and 2011. Considerable population growth and increase in effluent is predicted over this period. The modelling study has shown that planned river quality can be maintained if consents are tightened (to the highest proposed standard) and flows are transferred from Basingstoke to Sherborne and Sherfield. The rivers cannot sustain further effluent inputs beyond the 2011 discharge estimates without better effluent quality consents.

5. A Total Ammonia consent of less than 1.0 (as a 95 %ile) is required to meet river quality objectives on the Loddon if future flows are routed through Basingstoke (rather than transferred to Sherborne and Sherfield)

1. INTRODUCTION

1.1 Background

Several major sewage treatment works in Thames Region are situated in the headwaters of river catchments where there are proposals for significant housing developments in the towns served by these major works. Thus, Thames Water Utilities have been asked to consider increasing the populations served at these works by significant amounts. The resultant increases in flow will put further pressure on watercourses. As the Environment Agency will not accept any degradation in quality, particularly in watercourses designated under the EU Fish Directive, any increases in flow due to the proposed population increases at these works may require tightening of consent standards. The problems of works at or close to headwaters in Thames Region is one that has been recognised by the Agency and some of these works already have the tightest discharge consent standards in England and Wales. Thames Water Utilities Limited (TWUL) are concerned that increases in population could lead to the imposition of consent standards that cannot be met without too great a risk of failure or with too high a cost.

The Agency has agreed to co-operate with TWUL to carry out detailed, auditable modelling studies of the effects of increases in flows from these sewage works on the effluent receiving watercourses. The main question that the modelling has to answer is "What are the standards required at the STW to meet the river standards required by the Agency with the proposed increase in flow?". The Agency operates a load standstill and no deterioration policy, interpreted as meaning that the quality in the river downstream that would be delivered by the current consent must be maintained after the population increases.

Basingstoke STW discharges to the River Loddon, which is a designated Salmonid Fishery (RE2), and is seen as the highest priority in responding to development pressures. Currently, Basingstoke STW has a consent of 10/2 for BOD and Total Ammonia and a maximum consented flow of 65 Ml/day.

Smaller STWs at Sherborne and Sherfield on Loddon (Sherfield) discharge to the Vyne Stream/Bow Brook which is a tributary of the Loddon, below Basingstoke. The Vyne Stream/Bow Brook is classified as RE3 and is not a designated fishery. Current consents for Sherborne and Sherfield are equivalent to 8/7.5[1] and 30/7 mg/l for BOD and Total Ammonia respectively. The Total Ammonia consent for Sherborne is seasonal and is represented for modelling purposes as an average of winter and summer 95%iles. The consented flow at Sherfield is exceeded under current operation. Figure 1.1 shows the locations of the catchment features that are referred to in later sections of this Report.

[1] The Sherbourne consent is 8 (as P95) for BOD and a seasonal consent of 10 and 5 (as P95) for total ammonia. It is conventional to interpret the seasonal consent as an annual equivalent of 7.5 for modelling purposes.

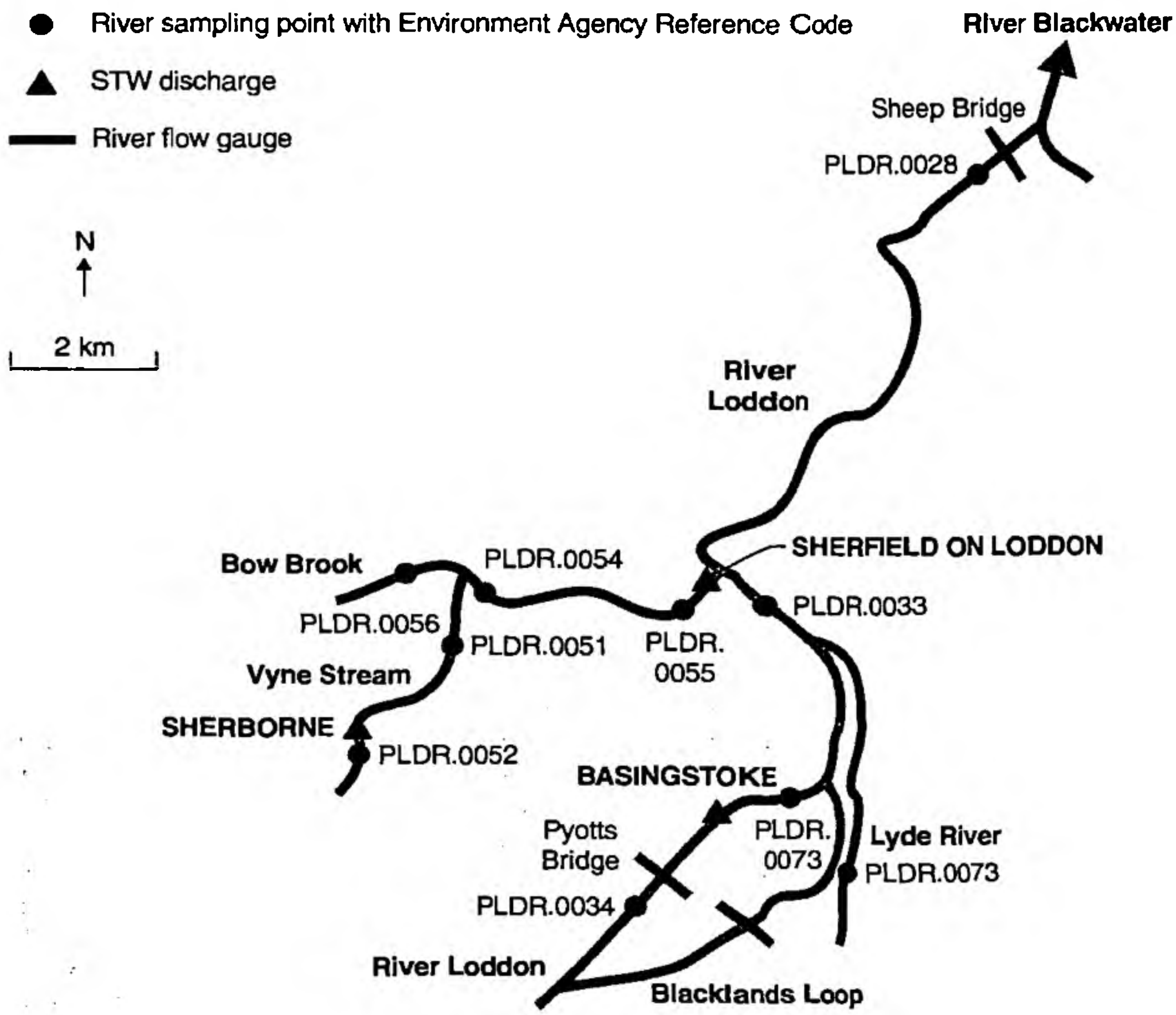


Figure 1.1 River Loddon Catchment: Location of SIMCAT Model Features

The Environment Agency SIMCAT stochastic-deterministic consent setting river quality model has been selected to carry out the investigation. The use of a catchment scale river quality model allows the effects of downstream inputs and river quality changes to be considered in setting consents at a catchment scale. These cannot be taken into account using single site Monte Carlo consent setting techniques.

1.2 Study Objectives

1.2.1 Overall Objective

To develop a SIMCAT river quality model for Basingstoke STW and to predict the effects of future population increases on river quality in the Loddon catchment.

1.2.2 Specific Objectives

i) To collate water quality, flow and catchment data provided by the Agency and TWUL.

ii) To screen and assess the quality of the data using standard statistical techniques to remove outliers from the data sets and to choose the most suitable data periods to provide inputs to the model.

iii) To build and calibrate the SIMCAT model for the parameters - DO, BOD, Total Ammonia (Ammonia) and Chloride.

iv) To undertake specified "what if scenarios".

v) To produce a report detailing the results from SIMCAT modelling work.

1.2.3 Modelling Requirements

Un-ionised Ammonia will not be modelled directly as a SIMCAT parameter. Model predictions for Total Ammonia will be converted to Un-ionised Ammonia using the Environment Agency 'Ammonia' conversion programme with inputs of site specific pH and temperature distributions.

Flow calibration will be established from gauged river flow data in the catchment, and Micro Low Flows estimates for ungauged catchments and naturalised flows at key locations. These estimates can be "corrected" with gauged data further downstream. Where possible, Chloride, modelled as a conservative determinand, will be used to support the flow calibration

The model will start upstream of Basingstoke STW at Pyotts Bridge and will include Sherborne STW and Sherfield STW. It will continue to Kings Bridge on the Loddon which is just upstream of the Blackwater confluence. The model will include the Lyde River as a tributary. Other inputs will be represented as diffuse inputs to give a manual calibration of flow and quality prior to auto-calibration.

1.3 <u>River Quality targets and Modelling Scenarios</u>

The study requires a series of SIMCAT simulations to represent variations on the current pattern of consents and flows, plus predicting the effects of future scenarios incorporating increased flows to represent proposed population growth. The basic output from the scenarios is the prediction of river quality against specified targets and associated discharge consents for the STWs.

1.3.1 River Quality Classification

The study requires demonstration of compliance against RE, EU Fishery and 'operational' river quality targets, as specified below. Compliance must be assessed at the boundaries and within (at the control sampling point) each classified reach.

RE classified reaches

Reach boundaries and control sampling points are:

LODDON

Source to upstream Basingstoke STW - *sampling point pldr.0034*	RE2
Downstream Basingstoke STW to confluence with Lyde (NGR 692576) - *sampling point pldr.0073*	RE2
Confluence with Lyde to Stanford End Bridge (NGR701628) - *sampling point pldr.0033 (above Bow conf.)*	RE2
Stanford End Bridge to confluence with Blackwater - *sampling point pldr.0028*	RE2

VYNE STREAM

Sherborne St John to Bow Brook - *sampling point (pldr.0051)*	RE3

BOW BROOK

Confluence with Vyne Stream to confluence with Loddon - *sampling point (pldr.0055)*	RE3

Fisheries Directive

The Loddon downstream of Basingstoke STW is a designated Salmonid Fishery

Fisheries 'operational' standard

On the Loddon at pldr.0033 (upstream of Bow Brook confluence).

1.3.2 RIVER QUALITY TARGETS

The numerical river quality targets in Table 1.1 were used for compliance assessment for classified reaches.

Table 1.1 River Quality Targets

Parameter	RE2	RE3	Salmonid	Operational
BOD (90 %ile) mg/l	4	6		
BOD (95 %ile) mg/l				3
DO (10 %ile)	70%	60%		
DO (50 %ile) mg/l			9	9
DO (1 %ile) mg/l			6	7
Un.Amm. (95 %ile) mg/l	0.021	0.021	0.021	0.004
Amm. (90 %ile) mg/l	0.6	1.3		
Amm.(95 %ile) mg/l			0.78	0.195

These are the values not to be exceeded. The DO % satn. values will be converted to mg/l using a typical summer river temperature for each sampling point and interpolation between sampling points for reach boundaries, if required. The 99 %ile exceedance values (1%iles) for DO are specified as minimum values in the EU Fishery Classification Salmonid criteria and operational criteria provided by the Environment Agency. The proposed operational standards were derived by the Environment Agency for 1995-1997.

1.3.3 Modelling Scenarios

A large number of simulations were carried out in the execution of this study to explore a variety of options. The final assessment, however, can be summarised in the three stages described below:

i) Use the calibrated SIMCAT model results to assess compliance with river quality standards as the system is currently operated.

ii) Use the calibrated SIMCAT model (in 'what-if' mode) to assess compliance with river quality standards when all STWs are operating at current consented flow and quality. The predicted water quality is the 'planned' water quality for the catchment.

iii) Use calibrated SIMCAT model (in 'what-if' mode) to determine permissible future consented flow and quality at STWs to meet RE classification AND show no deterioration over 'planned' water quality as defined in ii) above. Flows that cannot be treated at Basingstoke are transferred to Sherborne, then Sherfield. This assessment is repeated to reflect predicted population changes by 2001, 2006 and 2011.

1.4 Report Structure and Contents

The SIMCAT modelling approach and data analysis are described in Section 2. Sections 3 and 4 describe the SIMCAT model conceptualisation, building and calibration. The details of the modelling scenarios and results are presented in Section 5. The study is summarised in Section 6.

2. OVERVIEW OF SIMCAT MODELLING APPROACH

2.1 SIMCAT

SIMCAT is a mathematical model which describes the quality of river water throughout a catchment. It is used to help to identify the effluent discharge consents (expressed as 95 %iles) required to meet river water quality targets. This is achieved by predicting the behaviour of the summary statistics of river and effluent quality, such as the mean and 90 or 95 percentile. Hence, the model recognises the fact that predictions must be defined as statistics in order to allow a correct assessment of compliance with quality objectives, while also recognising the variability of river and effluent flow and quality.

SIMCAT has special features, such as auto-calibration, which enables it to produce reliable results quickly. It also controls the effect of the statistical uncertainties associated with water quality data on decision making. SIMCAT has been widely used in the UK over a number of years and is recognised as being a cost-effective, practical water quality management tool to support catchment management and discharge control decision making on a routine basis.

The advantages of the SIMCAT approach are:

i) proven Environment Agency software;

ii) is readily applied at a catchment scale;

iii) makes best use of existing available, but often limited, data; and,

iv) allows rapid assessment of management options.

SIMCAT offers a significant insight into catchment behaviour based on the use of existing data from routine monitoring of river and effluent quality for continuous discharges. SIMCAT is designed to minimise the recognised limitations of these data and produce results with identified confidence levels for comparison against water quality standards and planning criteria. SIMCAT also produces pollutant source load results, in addition to predicted river concentrations.

Inputs to SIMCAT can be defined as:

- point source inputs, such as river headwaters, tributaries, and STW discharges;
- diffuse inputs;
- abstractions; and
- unknown inputs.

Each type of input is represented by summary statistics, based on available data for the period represented by the model; for example, the mean and the standard deviation. Inputs are represented as selected probability distributions; for example, Normal or Lognormal distributions, based on the results of distribution fitting to the original data. Unknown inputs (or losses) are calculated by the model during auto-calibration to represent the difference between the input data from all sources, known abstractions, self-purification and the measured flows and pollutant loads at points in the catchment.

SIMCAT represents self-purification in the river (the loss of a pollutant; decay of BOD) by an exponential decay function of the form:

$$C = C_0 e^{-kt}$$

where C_0 is the initial concentration (t=0) and k is a temperature dependent rate constant. Modelling of dissolved oxygen (DO) includes the effects of surface aeration on losses due to the decay of BOD. At a discharge (input) point SIMCAT uses a Monte-Carlo simulation approach to mix the flow and quality distributions of the discharge with the upstream river flow and quality distributions. This produces downstream flow and quality distributions which are routed down the model applying a decay to pollutant concentrations, as appropriate.

Further details of SIMCAT are provided in "SIMCAT 6.0 - A GUIDE FOR USERS, October 1998" which is available from the Environment Agency.

2.2 Modelling Approach

The approach adopted for the application of SIMCAT to the River Loddon covers five stages, as illustrated in Figure 2.1, which indicates the output from each stage.

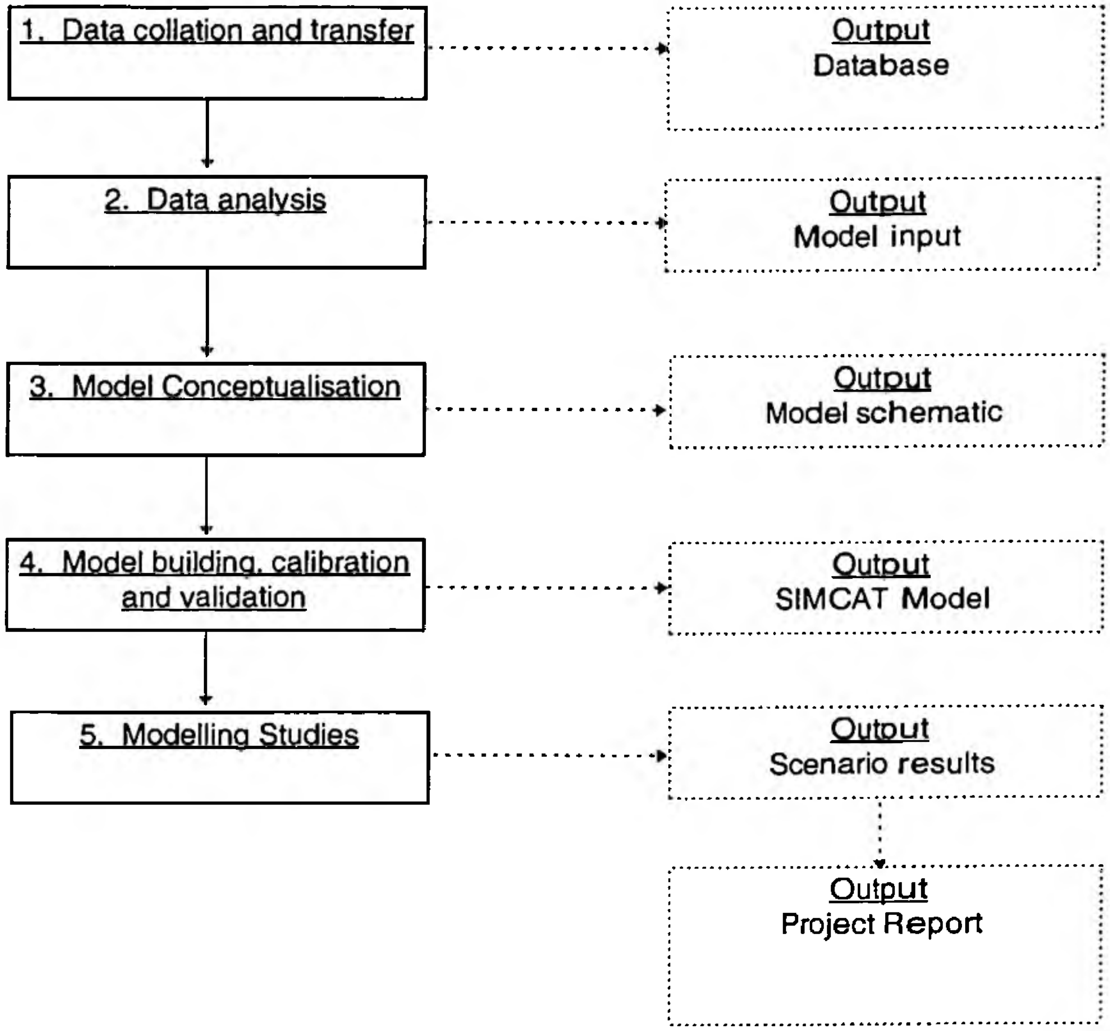


Figure 2.1 Study methodology

Previous SIMCAT modelling work undertaken by WRc has resulted in the development of a procedure called Pre SIMCAT Investigation (PSI). This procedure is based around a suite of software tools which form the standard data analysis protocol developed by WRc for the Environment Agency. PSI is operated in accordance with WRc's quality assurance procedures and the Environment Agency's Codes of Practice for Data Analysis.

Figure 2.2 shows how the PSI methodology is applied. The LAPWING element, the spatial analysis of water quality trends, most commonly used as an initial screening tool for large catchments has been omitted.

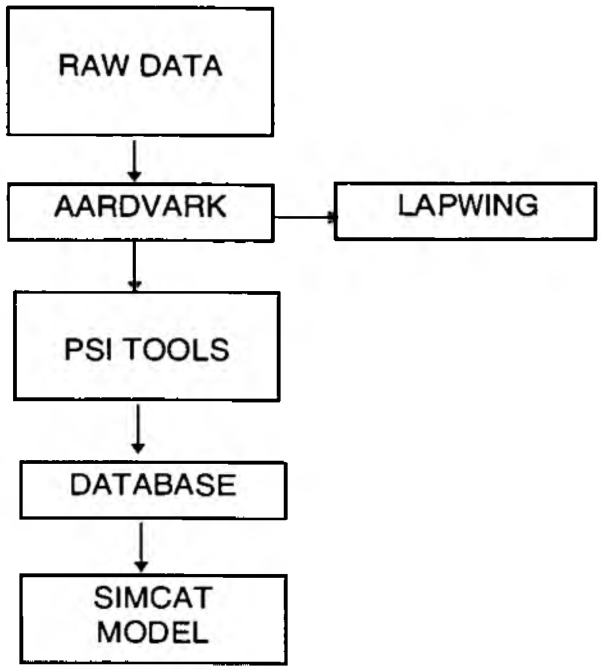


Figure 2.2 Application of PSI methodology

Detailed analysis of river and discharge quality data is performed using WRc's AARDVARK software. A number of automatic AARDVARK analyses are carried out using the PSI tools to perform statistical tests on all the data sets in rapid succession. The first of these is the Multiple Outlier Test (MOT) which automatically detects and flags statistical outliers. If appropriate, agreed outliers will be removed from the data sets. The second tool is Steps Automatically Detected (SAD) which uses cumulative sum (cusum) methods to identify sudden changes in the distribution of the data to allow consistent data to be used to generate input for SIMCAT. By following this approach, there is greater confidence in the final summary statistics generated by TOAD (Testing Of Assorted Distributions) which outputs the mean, standard deviation and distribution type (normal;, log normal or shifted log normal) for each determinand. Flow data are analysed in a similar way.

The results from PSI are stored in a database for ease of reporting and input to the SIMCAT model. PSI is described further in Section 2.3.

2.3 Data Analysis

2.3.1 River Flow Data

Observed flow data were available from two gauges on the Loddon:

i) at Pyotts Bridge (upstream of Basingstoke STW); and

ii) at Sheep Bridge (close to the end of the modelled catchment).

Another gauge located at Pyotts Bridge measures flows of a tributary of the Loddon, the Blacklands Loop which joins the Loddon 1.4km downstream of Basingstoke STW, as shown in Figure 1.1.

Table 2.1 shows flow statistics for the period 1995 to 1998 for these three gauges. The Table also shows Micro-Low-Flow estimates for headwaters, tributaries and subcatchments.

Table 2.1 River flow statistics (Ml/d)

Name	Mean	95%ile low flow	Shift
Pyotts Bridge Gauge (95-98) (Loddon)	37.30	17.7	6.7
Sheep Bridge Gauge (95-98)	183.00	85.30	76.6
Pyotts Bridge Gauge (95-98) (Blacklands Loop)	55.60	30.70	23.0
Head of Loddon (Pyotts Bridge) estimate	37.10	13.00	0
Lyde tributary estimate	23.95	6.38	0
Head of Vyne Stream estimate	3.68	1.27	0
Vyne Stream subcatchment estimate	10.72	1.89	0
Bow Brook tributary estimate	18.51	2.84	0
Bow Brook subcatchment estimate	34.37	4.64	0

2.3.2 River Quality Data

Summary statistics were calculated using routinely monitored data collected across the catchment from 1989 to 1998. A full Pre SIMCAT Investigation (PSI) ,excluding LAPWING, was carried out for Chloride, BOD, Total Ammonia, Dissolved Oxygen, pH and Temperature.

The data were influenced by a large number of 'less than' values. This was complicated by changes in the limit of detection for Total Ammonia and BOD. A standard protocol was adopted whereby less than values were taken as 0.5L, where L is the limit of detection.

Standard methods were applied to screen for statistical outliers (Test Data Facility MOT program) and step changes (Test Data Facility SAD program). Summary statistics were calculated using the Test Data Facility TOAD program. TOAD produces all the input statistics required for SIMCAT.

Screening for statistical outliers

The presence of statistical outliers in a dataset can affect the summary statistics to such an extent that they no longer adequately describe the 'average' value and variability of values for that determinand. Table 2.2 lists outliers detected using the Test Data Facility MOT program that have t statistic greater than 4 or less than -4. All these data observations were excluded from further analysis.

Screening for step changes

Step changes occur in water quality data following the opening (or closure) of STW plant or changes in treatment technology. For SIMCAT models it is important to exclude older data from summary statistics when they are not representative of current operating conditions. The Test Data Facility SAD program performs an automatic cusum analysis that identifies statistically significant step changes.

Unfortunately, step changes also occur when changes in the limit of detection for parameters occur. In the Loddon catchment, this effect was highly evident. Limits of detection for Total Ammonia and BOD were reduced at the beginning of 1995 at many sites along the Loddon.

Generating summary statistics

In consultation with the Agency, it was agreed to restrict summary statistic generation to the period 1995 to 1998. Where this period yielded too few data (or the only data available were from outside this period) summary statistics were calculated from all available data.

Table 2.3 contains the summary statistics calculated using the Test Data Facility TOAD program. The Table lists each monitoring station and gives the site name, Agency code and an abbreviated code used by WRc for this study. At each monitoring station statistics are reported for Chloride, BOD, Ammonia, Dissolved Oxygen, Temperature and pH. Distribution shape identifies whether the data are Normal (1), logNormal (2) of shifted logNormal (3). If the distribution shape is 3, a shift value is also given. The mean and standard deviation are reported together with the number of values (n) and the date range. The determinands Chloride, BOD, Ammonia and Dissolved Oxygen are reported in mg/l. Temperature is reported in degrees centigrade.

The restricted date range and small number of values should be noted at PLDR0056 (Bow Brook above Vyne Stream) and PLDR0054 (Bow Brook at Locks Bridge)

Table 2.2 River quality data outliers

Site	Determinand	Date	Outlier Value	Type	Median	n	t-stat	Out:Med ratio
Loddon at Pyotts Bridge, Basing (B1)	Log_Chloride	27/ 3/1996	54.00	high	25	145	5.6	2.2
Loddon at Pyotts Bridge, Basing (B1)	Log_Chloride	27/ 3/1996	58.00	high	25	145	6.1	2.3
Loddon at Pyotts Bridge, Basing (B1)	Log_Chloride	27/ 3/1996	60.01	high	25	145	6.4	2.4
Loddon at Pyotts Bridge, Basing (B1)	Log_Chloride	15/11/1991	68.99	high	25	145	7.4	2.8
Loddon at Pyotts Bridge, Basing (B1)	Log_Ammonia	28/ 2/1995	0.50	high	0.08	149	4.2	6.3
Loddon at Pyotts Bridge, Basing (B1)	Log_Ammonia	27/ 8/1998	9.00	high	0.08	149	10.7	112.5
Loddon at Keepers Cottage, Wildmoor (B3)	Log_Chloride	27/ 3/1996	18.00	low	58	134	-4.4	3.2
Loddon at Keepers Cottage, Wildmoor (B3)	Log_Chloride	27/ 3/1996	15.00	low	58	134	-5.0	3.9
Loddon at Keepers Cottage, Wildmoor (B3)	Log_Chloride	11/12/1991	10.00	low	58	134	-6.6	5.8
Loddon at Keepers Cottage, Wildmoor (B3)	Log_BOD (ATU)	19/ 1/1994	11.70	high	1.4	130	4.7	8.4
Lyde at Deanland Farm	Log_Chloride	28/ 9/1994	88.00	high	20	129	4.5	4.4
Lyde at Deanland Farm	Log_Chloride	12/12/1989	146.00	high	20	129	6.1	7.3
Loddon at Long Bridge, Sherfield (B4)	Log_Chloride	27/ 3/1996	13.00	low	43	202	-5.7	3.3
Vyne Stream below Vyne, Sherfield (B8)	D.O. (mg/l)	18/ 5/1998	18.40	high	9.76	101	4.3	1.9
Vyne Stream below Vyne, Sherfield (B8)	D.O. (mg/l)	14/ 6/1994	18.70	high	9.76	101	4.4	1.9
Vyne Stream below Vyne, Sherfield (B8)	pH	30/ 3/1995	9.70	high	8.1	103	4.4	1.2
Loddon above Blackwater at Kings Bridge (B5)	Log_Chloride	30/10/1992	4.00	low	43	183	-9.9	10.7
Loddon above Blackwater at Kings Bridge (B5)	Log_BOD (ATU)	1/12/1993	14.80	high	2	177	5.2	7.4
Loddon above Blackwater at Kings Bridge (B5)	pH	15/ 2/1990	6.70	low	8	185	-4.9	1.2

Table 2.3 Water quality summary statistics

WRc code	EA code	Site name	determinand	dist. shape	mean	sd	shift	n	date range
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	Chloride	2	26.51	2.46	0	57	1995-1998
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	BOD	2	0.97	0.62	0	58	1995-1998
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	Ammonia	2	0.08	0.05	0	58	1995-1998
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	DO	2	9.74	1.22	0	57	1995-1998
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	Temp	1	10.88	2.76	0	59	1995-1998
B1	PLDR.0034	Loddon At Pyotts Bridge Basing	pH	2	7.68	0.16	0	60	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	Chloride	1	62.81	16.00	0	59	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	BOD	2	1.09	0.66	0	59	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	Ammonia	2	0.12	0.24	0	61	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	DO	2	10.48	1.35	0	55	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	Temp	1	12.42	3.89	0	58	1995-1998
B3	PLDR.0073	Loddon At Keepers Cottage Wildmoor	pH	1	7.94	0.20	0	61	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	Chloride	2	22.50	5.13	0	56	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	BOD	2	1.09	0.58	0	54	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	Ammonia	2	0.10	0.06	0	56	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	DO	2	10.09	1.28	0	55	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	Temp	1	11.62	3.28	0	55	1995-1998
B13	PLDR.0039	Lyde At Deanland Farm	pH	2	7.95	0.13	0	56	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	Chloride	1	42.57	7.50	0	56	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	BOD	2	1.09	0.87	0	56	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	Ammonia	2	0.07	0.06	0	57	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	DO	1	10.60	1.47	0	56	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	Temp	2	11.01	4.25	0	56	1995-1998
B4	PLDR.0033	Loddon At Long Bridge Sherfield	pH	1	8.06	0.21	0	57	1995-1998
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	Chloride	2	30.47	26.10	0	30	1989-1996
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	BOD	2	1.98	2.66	0	29	1989-1996
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	Ammonia	2	0.06	0.10	0	30	1989-1996
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	DO	2	10.06	1.21	0	28	1989-1996

WRc code	EA code	Site name	determinand	dist. shape	mean	sd	shift	n	date range
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	Temp	2	11.04	4.24	0	30	1989-1996
B6	PLDR.0052	Vyne Stream Above Stw Sherborne St John	pH	1	8.02	0.23	0	30	1989-1996
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	Chloride	2	49.06	19.55	0	45	1995-1998
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	BOD	2	3.08	3.44	0	45	1995-1998
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	Ammonia	2	0.06	0.04	0	45	1995-1998
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	DO	2	10.22	1.51	0	43	1995-1998
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	Temp	2	11.40	5.56	0	45	1995-1998
B8	PLDR.0051	Vyne Stream Below The Vyne Sherborne St	pH	2	8.26	0.30	0	44	1995-1998
B9	PLDR.0056	Bow Brook above Vyne Stream	Chloride	2	40.25	10.10	0	8	1989-1992
B9	PLDR.0056	Bow Brook above Vyne Stream	BOD	2	2.10	2.12	0	8	1989-1992
B9	PLDR.0056	Bow Brook above Vyne Stream	Ammonia	2	0.03	0.01	0	8	1989-1992
B9	PLDR.0056	Bow Brook above Vyne Stream	DO	1	9.04	1.55	0	7	1989-1992
B9	PLDR.0056	Bow Brook above Vyne Stream	Temp	2	11.78	5.27	0	8	1989-1992
B9	PLDR.0056	Bow Brook above Vyne Stream	pH	2	7.90	0.33	0	8	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	Chloride	2	56.75	9.19	0	8	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	BOD	2	3.28	2.52	0	8	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	Ammonia	2	0.04	0.03	0	8	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	DO	1	8.82	1.44	0	6	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	Temp	2	11.74	5.23	0	8	1989-1992
B10	PLDR.0054	Bow Brook at Locks Bridge	pH	2	8.00	0.26	0	8	1989-1992
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	Chloride	2	49.02	17.50	0	46	1995-1998
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	BOD	2	3.03	3.89	0	44	1995-1998
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	Ammonia	2	0.05	0.05	0	46	1995-1998
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	DO	1	10.27	2.34	0	45	1995-1998
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	Temp	2	11.71	5.76	0	46	1995-1998
B12	PLDR.0055	Bow Brook At Bow Bridge Sherfield	pH	2	8.07	0.28	0	46	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	Chloride	2	45.07	7.46	0	46	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	BOD	2	1.47	0.92	0	45	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	Ammonia	2	0.07	0.09	0	46	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	DO	1	9.86	1.51	0	47	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	Temp	1	12.71	4.17	0	47	1995-1998
B5	PLDR.0028	Loddon Above Blackwater At Kings Bridge	pH	2	8.16	0.15	0	46	1995-1998

2.3.3 Effluent Flow and Quality

Summary statistics were calculated using measured flow data and routine Agency effluent sample data for Basingstoke, Sherborne and Sherfield STWs (1989-1998). A Pre SIMCAT Investigation (PSI) was carried out for Chloride, BOD, Total Ammonia, Dissolved Oxygen, pH and Temperature by repeating the methods used for river quality data.

Effluent flow

Investigations showed that the most consistent date range to pool STW flow data was the period 1997 to 1998. Flow summary statistics are included in Table 2.5

Screening for statistical outliers

Table 2.4 lists outliers detected using the Test Data Facility MOT program that have t statistic greater than 4 or less than -4. All these data observations were excluded from further analysis.

Screening for step changes

There was no evidence to suggest that it would be inappropriate to choose a period different to that used for water quality data. Therefore, to ensure consistency with the river quality data, the period 1995 to 1998 was selected for further data processing.

Generating summary statistics

Table 2.5 contains the summary statistics calculated using the Test Data Facility TOAD program. The Table lists each STW and gives the site name, Agency code and an abbreviated code used by WRc for this study. At each monitoring station statistics are reported for Chloride, BOD, Ammonia, Dissolved Oxygen, Temperature, pH and flow. Distribution shape identifies whether the data are Normal (1), logNormal (2) of shifted logNormal (3). If the distribution shape is 3 a shift value is also given. The mean and standard deviation are reported together with the number of values (n) and the date range.

Determinands Chloride, BOD, Ammonia and Dissolved Oxygen are reported in mg/l. Flow is reported in Ml/d and temperature in degrees centigrade. The parametric estimates of 95 %ile concentrations for each works actual performance, based on 1995-98 data, were:

	BOD	Total Ammonia
Basingstoke	5.2	1.2
Sherborne	4.1	0.5
Sherfield	9.9	4.2

Further details on the ammonia concentrations in the Final Effluent of Basingstoke are included in Appendix C.

Table 2.4 STW quality data outliers

WWTP	Determinand	Date	Outlier Value	Type	Median	n	t-stat	Out:Med ratio
Basingstoke (B2)	Log_Chloride	19/10/1989	308.00	high	106.0	343	5.4	2.9
Basingstoke (B2)	Log_Chloride	13/11/1997	325.00	high	106.0	343	5.7	3.1
Basingstoke (B2)	Log_Chloride	01/09/1998	8.00	low	106.0	343	-13.1	13.2
Basingstoke (B2)	Log_Chloride	04/11/1993	326.00	high	106.0	343	5.7	3.1
Basingstoke (B2)	Log_BOD (ATU)	19/01/1994	26.90	high	2.0	260	4.2	13.5
Basingstoke (B2)	Log_BOD (ATU)	15/03/1995	39.50	high	2.0	260	4.9	19.8
Basingstoke (B2)	Log_BOD (ATU)	15/03/1995	79.00	high	2.0	260	6.0	39.5
Basingstoke (B2)	pH	16/06/1998	8.59	high	7.5	374	4.3	1.1
Sherfield on Loddon (B15)	Log_Chloride	15/05/1995	28.00	low	112.0	132	-6.2	4.0

Table 2.5 STW effluent flow and quality summary statistics

Site	EA code	Site name	Determinand	Dist	Mean	SD	Shift	N	Date range
B2	PLDE.0012	Basingstoke STW	Chloride	1	114.90	21.03	0	149	1995-1998
B2	PLDE.0012	Basingstoke STW	BOD	2	1.80	1.93	0	143	1995-1998
B2	PLDE.0012	Basingstoke STW	Ammonia	2	0.36	0.60	0	152	1995-1998
B2	PLDE.0012	Basingstoke STW	DO	2	7.11	1.21	0	80	1995-1998
B2	PLDE.0012	Basingstoke STW	Temp	1	15.22	4.02	0	144	1995-1998
B2	PLDE.0012	Basingstoke STW	pH	2	7.62	0.19	0	150	1995-1998
B2	PLDE.0012	Basingstoke STW	Flow	3	27.60	4.50	21.6	541	1997-1998
B7	PLDE.0089	Sherborne St John STW	Chloride	1	208.55	89.34	0	44	1995-1998
B7	PLDE.0089	Sherborne St John STW	BOD	2	2.05	1.10	0	42	1995-1998
B7	PLDE.0089	Sherborne St John STW	Ammonia	2	0.29	0.10	0	44	1995-1998
B7	PLDE.0089	Sherborne St John STW	DO	2	8.90	1.31	0	18	1995-1998
B7	PLDE.0089	Sherborne St John STW	Temp	2	12.86	4.14	0	44	1995-1998
B7	PLDE.0089	Sherborne St John STW	pH	2	7.98	0.14	0	44	1995-1998
B7	PLDE.0089	Sherborne St John STW	Flow	3	1.4	0.6	0.6	497	1997-1998
B15	PLDE.0091	Sherfield on Loddon STW	Chloride	2	108.30	18.44	0	42	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	BOD	2	4.98	2.62	0	42	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	Ammonia	1	2.13	1.23	0	43	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	DO	2	7.10	1.25	0	18	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	Temp	2	13.18	4.01	0	41	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	pH	3	7.80	0.23	7.31	43	1995-1998
B15	PLDE.0091	Sherfield on Loddon STW	Flow	3	2.0	0.4	0.9	371	1997-1998

3. MODEL CONCEPTUALISATION AND BUILDING

3.1 River reaches

A three reach SIMCAT model was built to represent the River Loddon and the Bow Brook/Vyne Stream. The model name of each reach and its length in kilometres are given in Table 3.1. Blacklands Loop and the Lyde River are represented as inputs to the Loddon and the upper Bow Brook is an input to the Vyne Stream reach (note: the actual name below the confluence is the Bow Brook).

Table 3.1 River Reaches

Reach No.	Reach name	Length (km)	Tributaries
1	Upper Loddon	7.4	Blacklands Loop and Lyde River
2	Vyne Stream	8.9	Bow Brook
3	Lower Loddon	10.0	

3.2 Flow gauges

Eight river flow gauges or Micro-Low-Flow estimates were available for river flow calibration. Table 3.2 shows their location in the SIMCAT model. Two of these have been used to define headwater flow for the River Loddon and Vyne Stream and another two have been used to define the tributary flow inputs for the Lyde River and the Bow Brook.

Table 3.2 Flow gauge location

Code	Name	Reach	Distance from head of reach (km)	Comment
F1	Pyotts Bridge gauge (95-98) (Loddon)	1	0.0	Loddon above Basingstoke
F2	Pyotts Bridge gauge (95-98) (Blacklands)	-	-	Tributary flow input
F3	Lyde River tributary estimate	-	-	Tributary flow input
F4	Head of Vyne Stream estimate	2	0.0	
F5	Vyne Stream subcatchment estimate	2	3.0	
F6	Bow Brook tributary estimate	-	-	Tributary flow input
F7	Bow Brook subcatchment estimate	2	8.7	
F8	Sheep Bridge gauge (95-98)	3	9.9	bottom of modelled catchment

3.3 Tributary inputs

Three tributary inputs were included, to represent Blacklands Loop, the Lyde River and the Bow Brook upstream of its confluence with the Vyne Stream. Flow data were available for each of these tributaries, as indicated in Table 3.2. The quality of these inputs is measured at B1 for Blacklands Loop, B13 for the Lyde, and B9 for the Bow Brook. Table 3.3 shows the position of the tributary inputs in the SIMCAT model.

Table 3.3 Tributary input location

Name	Reach	Distance from head of reach (km)
Blacklands Loop	1	1.5
Lyde River	1	4.7
Bow Brook, u/s Vyne confl.	2	3.5

3.4 Water quality monitoring sites

Table 3.4 shows the position of each of the water quality monitoring stations used in the SIMCAT model. The Table uses the Agency code and a WRc abbreviation for each monitoring station.

Table 3.4 Water quality monitoring site location

Site	EA code	Site name	Reach No.	Distance from head of reach (km)
B1	PLDR0034	Loddon At Pyotts Bridge Basing	1	0.0
B3	PLDR0073	Loddon At Keepers Cottage Wildmoor	1	1.0
B13	PLDR0039	Lyde At Deanland Farm	1	Tributary input quality
B4	PLDR0033	Loddon At Long Bridge Sherfield	1	6.3
B6	PLDR0052	Vyne Stream Above Stw Sherborne St John	2	0.0
B8	PLDR0051	Vyne Stream Below The Vyne Sherborne St	2	2.4
B9	PLDR0056	Bow Brook above Vyne Stream	2	Tributary input quality
B10	PLDR0054	Bow Brook at Locks Bridge	2	4.2
B12	PLDR0055	Bow Brook At Bow Bridge Sherfield On Lo	2	8.1
B5	PLDR0028	Loddon Above Blackwater At Kings Bridge	3	9.3

3.5 STWs

Table 3.5 shows the position of each of the STWs represented in the SIMCAT model. The Table uses the Agency code and a WRc abbreviation for each works.

Table 3.5 STW location

Site	EA code	Site name	Reach No.	Distance from head of reach (km)
B2	PLDE.0012	Basingstoke STW	1	0.1
B7	PLDE.0089	Sherborne St John STW	2	0.3
B15	PLDE.0091	Sherfield on Loddon STW	2	8.5

3.6 Model schematic

Figure 3.1 is a schematic representation of the SIMCAT model showing each of the major features.

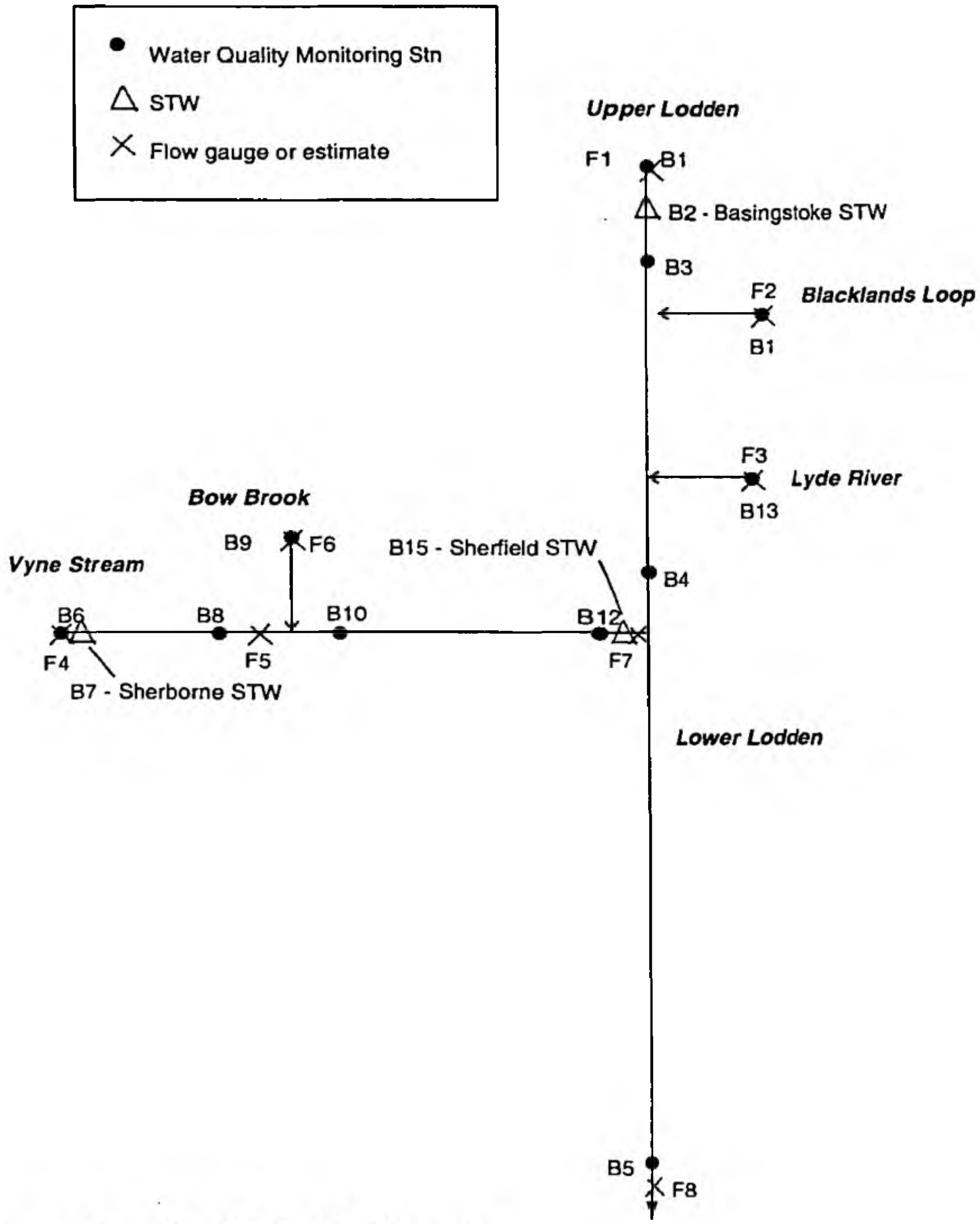


Figure 3.1 SIMCAT Model Schematic

4. MODEL CALIBRATION

The SIMCAT model was built and calibrated using SIMCAT version 6.2 (December 1998). Calibration was in two stages for river flow and river quality:

1. **Manual calibration** - where the modeller optimises user definable variables and boundary conditions (within sensible limits) to achieve the best possible match with observed data.

2. **Auto-calibration** - where SIMCAT automatically makes adjustments to account for inputs or river processes not represented explicitly in the model. This ensures full agreement between observed and modelled river quality statistics.

4.1 Flow calibration

Table 4.1 compares the sum of all headwater, tributary and effluent flow inputs (measured data and estimates) to the model with observed data at Sheep Bridge.

Table 4.1 Initial model results, prior to manual calibration

Name	Calculated flow (Ml/d)		Observed flow (Ml/d)	
	Mean	95%ile	Mean	95%ile
Sheep Bridge Gauge (95-98)	170.3	88.5	183.00	85.30

Manual flow calibration concentrated on obtaining a good match with observed flow data at Sheep Bridge flow gauge (F7). A clean diffuse flow rate was calculated which would account for the difference between the calculated and the observed mean flow at Sheep Bridge flow gauge. SIMCAT includes this diffuse flow per kilometre of all modelled reaches upstream of Sheep Bridge. This was calculated using the following equation:

$$DFR = \frac{F_O - F_S}{L_M}$$

Where:

DFR = Diffuse flow rate (Ml/d/km)

F_O = Observed flow at Sheep Bridge (Ml/d)

F_S = SIMCAT predicted flow at Sheep Bridge (Ml/d)

L_M = Modelled reach length upstream of Sheep Bridge (km)

The 95%ile low flow for this diffuse flow input was calculated by keeping the same distribution shape (mean:95%ile low flow ratio) as the measured distribution at Sheep Bridge.

The calculated clean diffuse input had a mean of 0.49 Ml/d/km and a 95%ile of 0.25 Ml/d/km.

Table 4.2 summarises the flow balance results, prior to flow auto-calibration.

Table 4.2 Manual calibration flow results

Name	Calculated flow (Ml/d)		Observed flow (Ml/d)	
	Mean	95%ile	Mean	95%ile
Sheep Bridge Gauge (95-98)	182.8	95.3	183.00	85.30

The clean diffuse input was given the same quality as that observed at monitoring site B1, which is at the headwater of the Upper Loddon.

Auto-calibration to observed flow at Sheep Bridge resulted in minor adjustments following manual calibration. Figure 4.1 shows plots of modelled (line) and observed (+ symbol) flow throughout the catchment following flow auto-calibration. Flow data for the Vyne Stream are Micro-Low-Flow estimates. These were not used to calibrated flows.

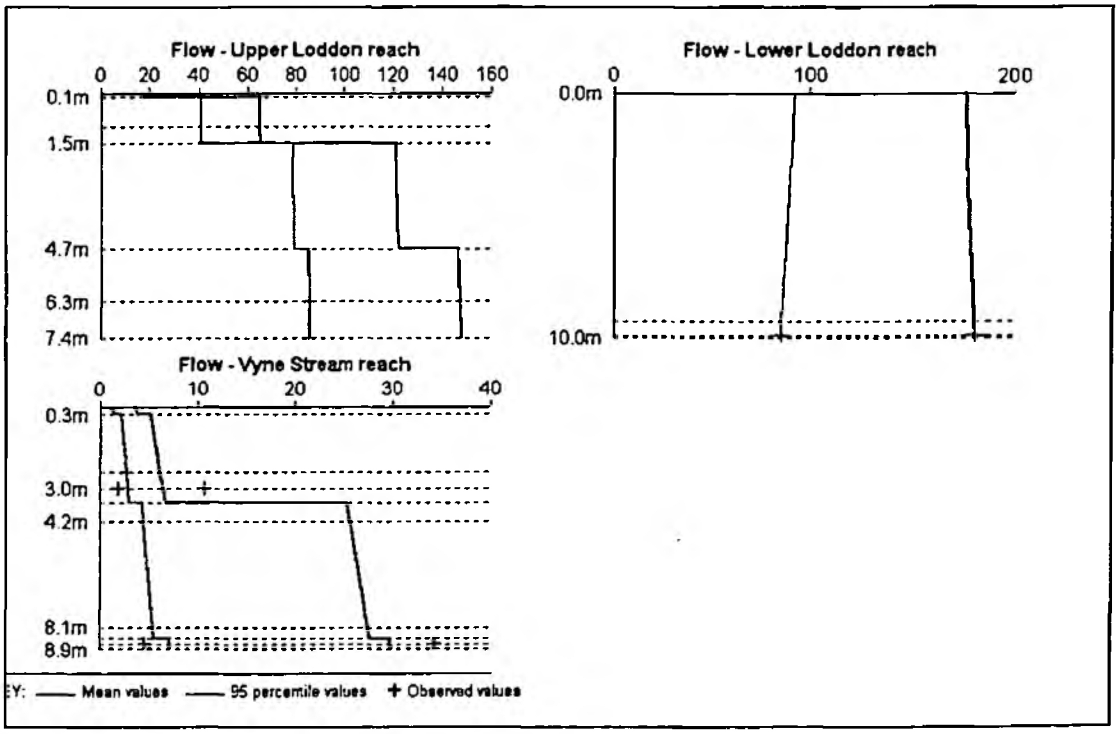


Figure 4.1 Flow calibration

4.2 Quality calibration

River quality was calibrated following flow auto-calibration. Figure 3.1 indicates the river quality sampling site used to provide input data for headwater quality and quality calibration.

Default decay rates for BOD, Ammonia and DO were applied as shown in Table 4.3. Figures 4.2 - 4.5 show the observed and calculated quality when river quality is simulated with auto-calibrated flows.

Table 4.3 Decay rates

Determinand	Decay rate (1/d)
Chloride	0.0
BOD	5.0
Ammonia	10.0
DO*	10.0

*rearation rate

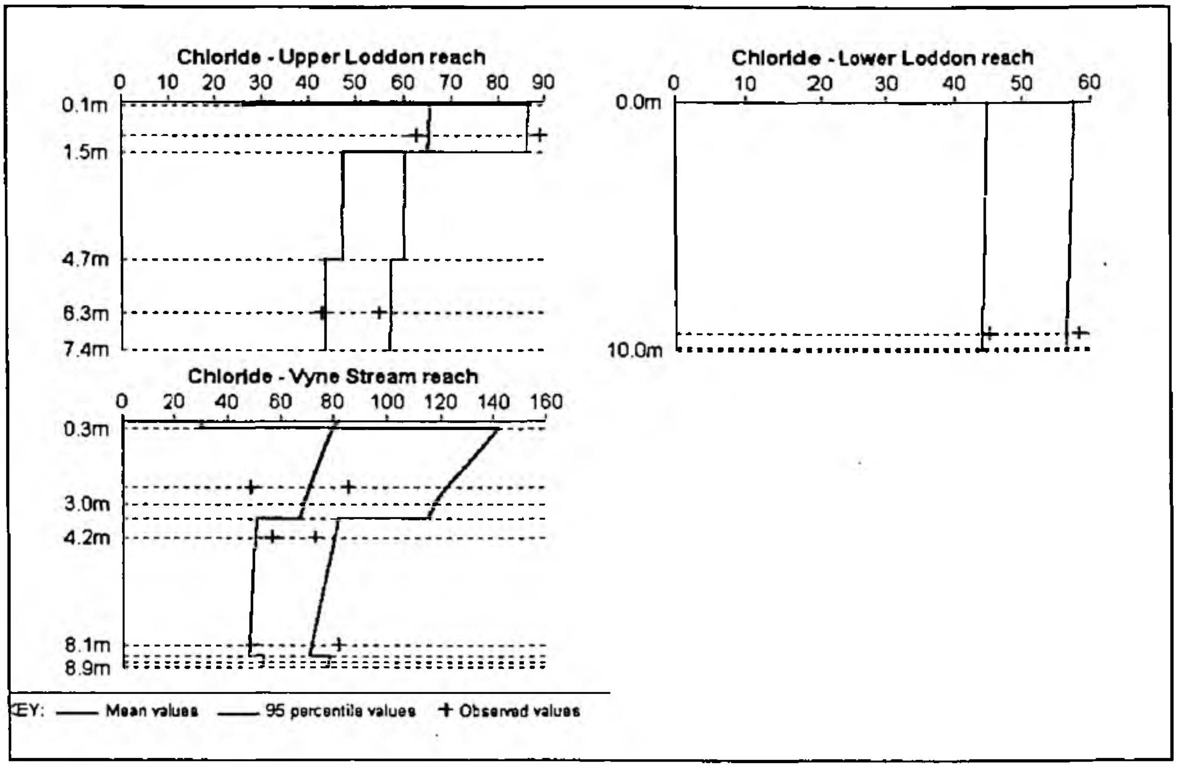


Figure 4.2 Chloride manual calibration (decay rate = 0/d.)

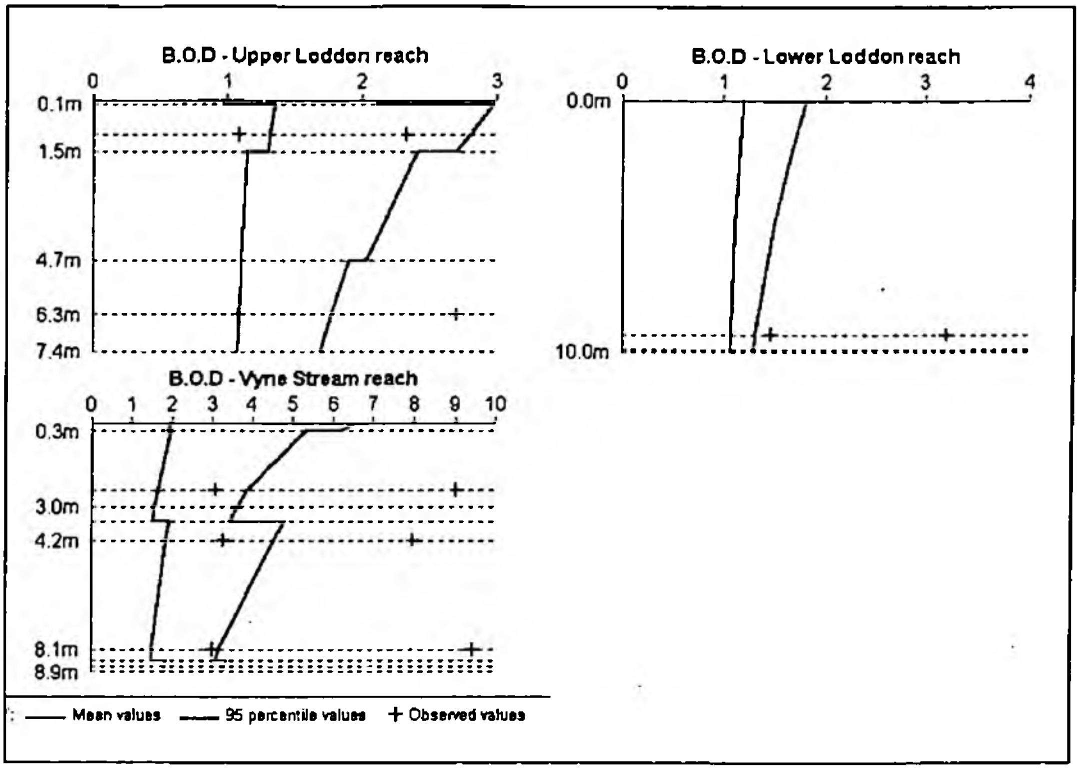


Figure 4.3 BOD manual calibration (decay rate = 5/d.)

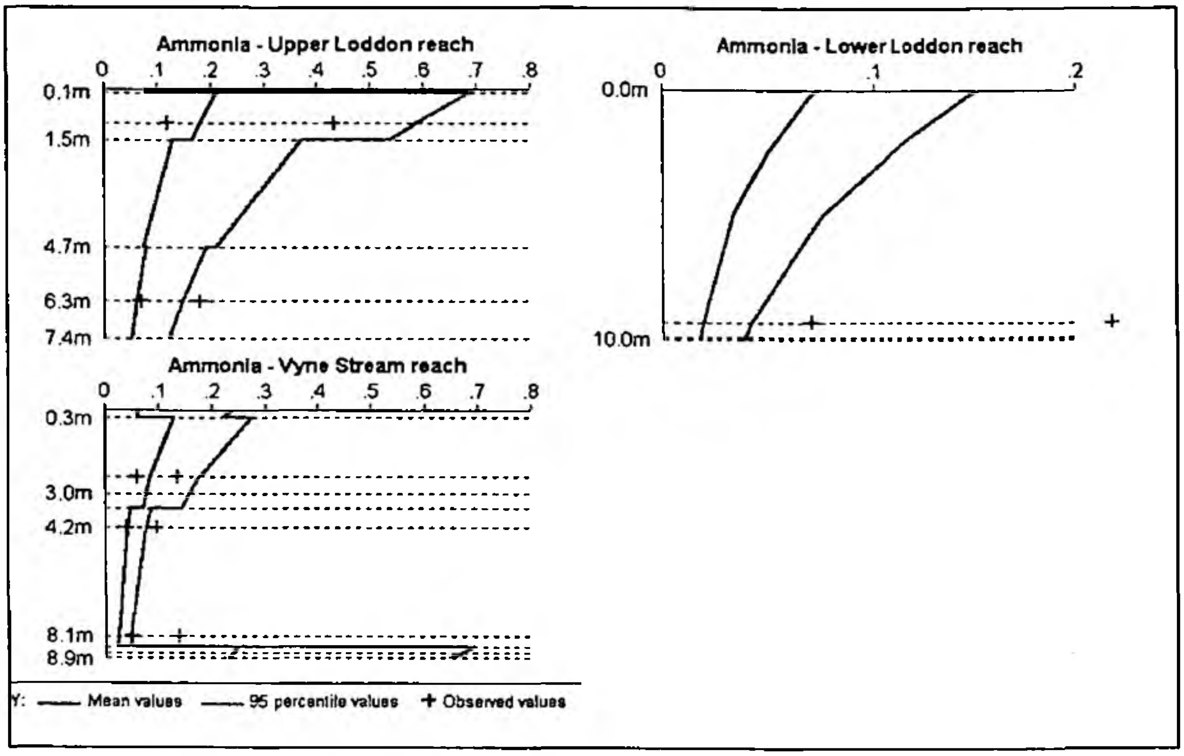


Figure 4.4 Ammonia manual calibration (decay rate = 10/d.)

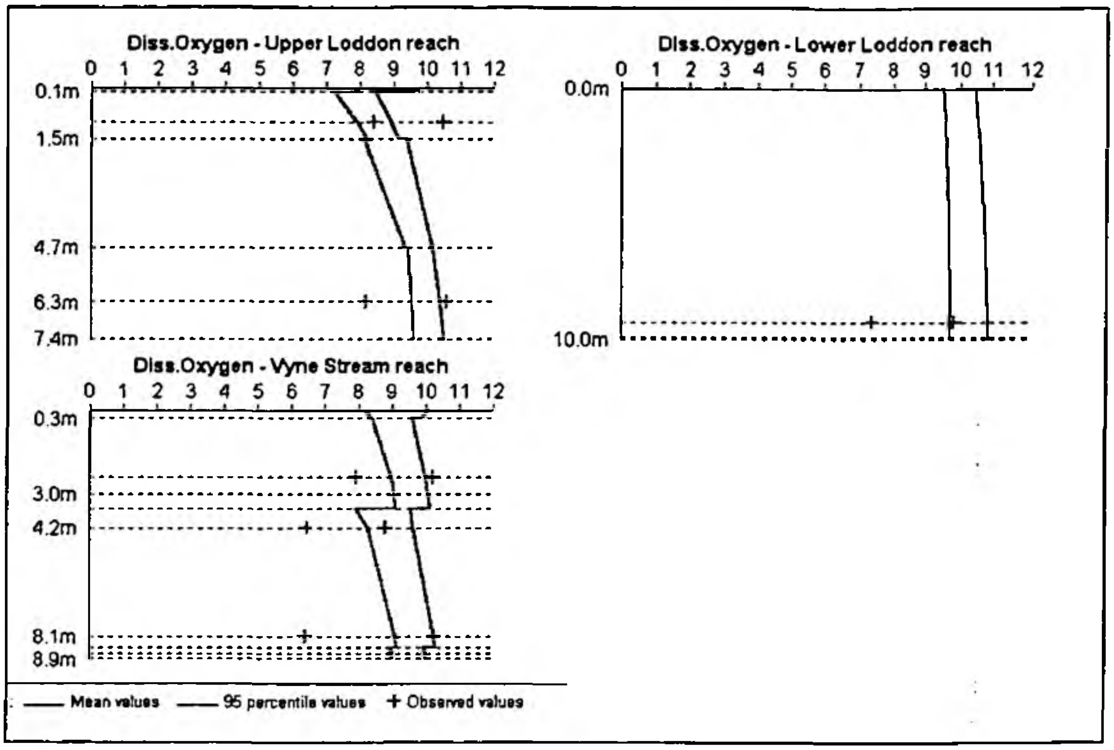


Figure 4.5 Dissolved oxygen manual calibration (rearation rate = 10/d.)

Figures 4.6 - 4.9 show plots of results following quality auto-calibration. Site B10 on the Vyne Stream was not used as an auto-calibration point due to the small number of observations at this site. The plots compare observed and modelled mean and 90%ile concentrations and also show confidence limits about model predictions. Small differences between observed and modelled 90%iles are because SIMCAT auto-calibrates to the observed 95%ile statistic.

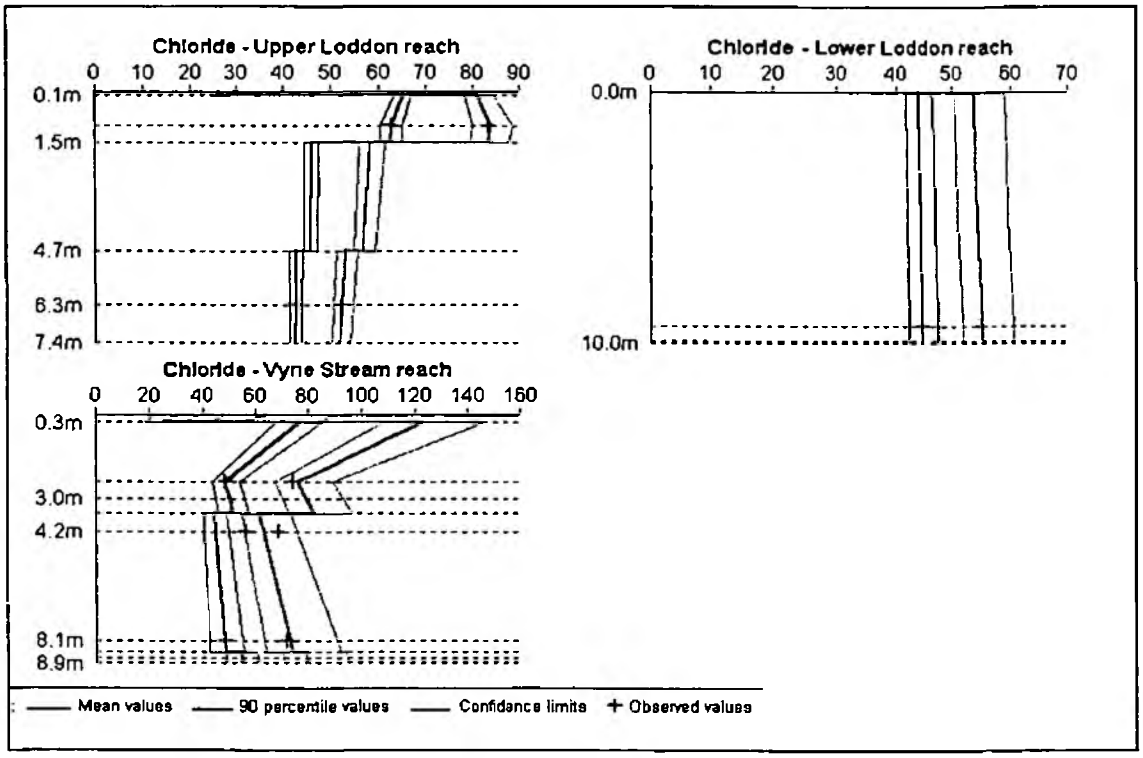


Figure 4.6 Chloride calibration

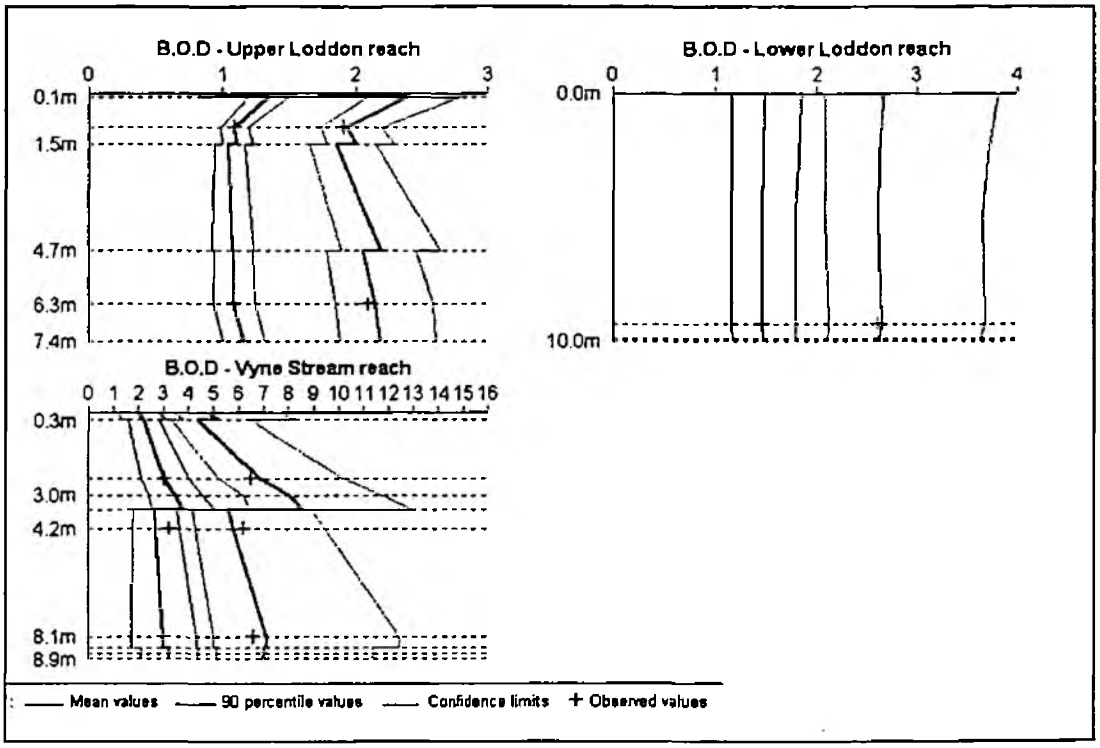


Figure 4.7 BOD calibration

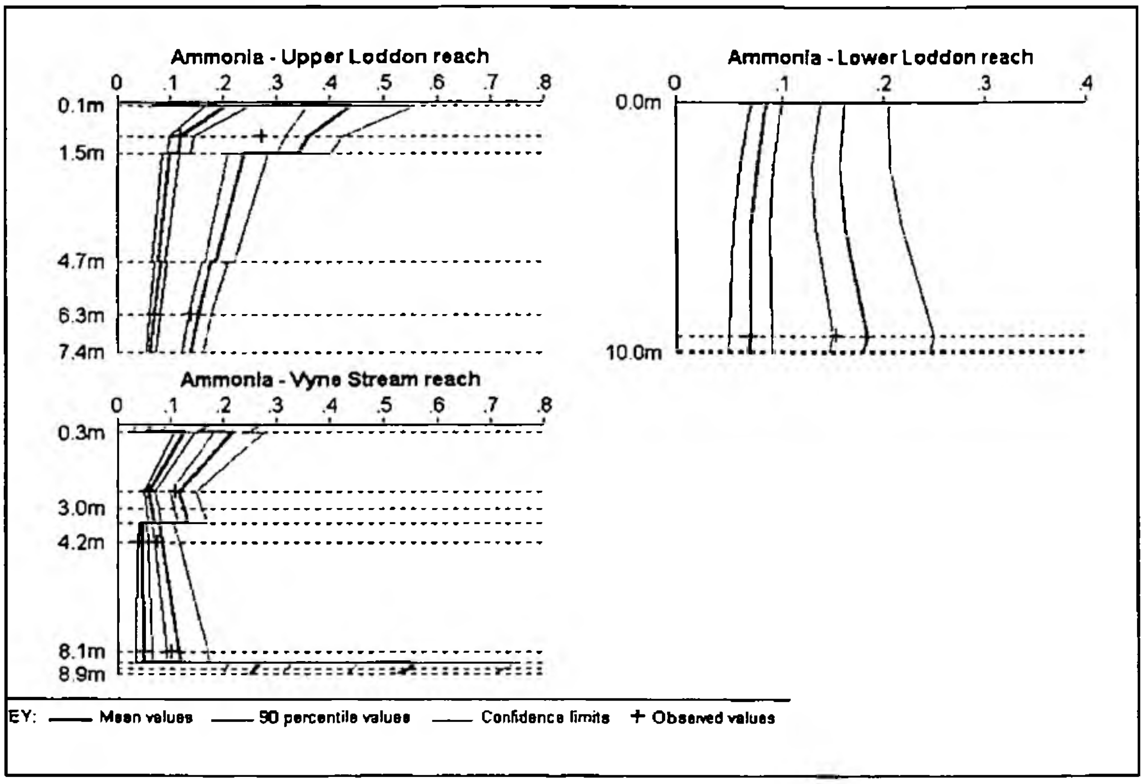


Figure 4.8 Ammonia calibration

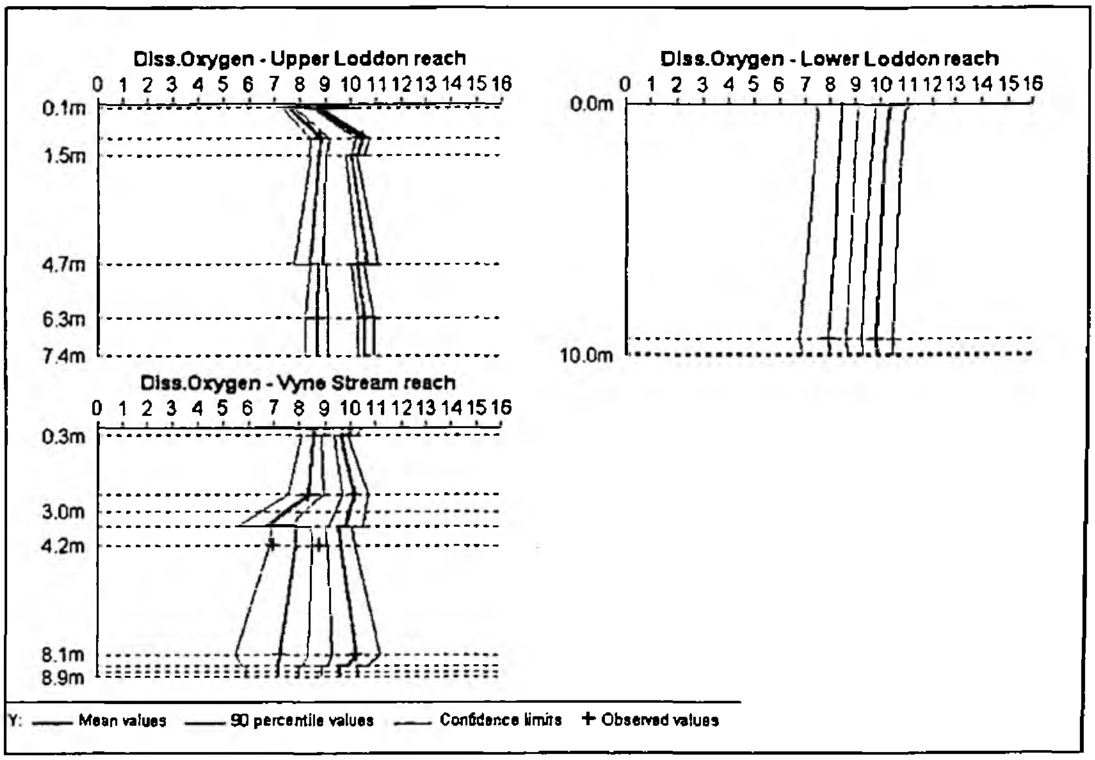


Figure 4.9 Dissolved Oxygen calibration

Table 4.4 contains a load summary for the autocalibrated SIMCAT model of the Loddon for Chloride, BOD and Total Ammonia. The values represent the mean daily load from each source.

Table 4.4 SIMCAT Load Summary for current situation

	Chloride Kg/day	BOD Kg/day	Total Ammonia Kg/day
Loads from boundaries & tributaries	3783.3	178.4	11.1
Loads from clean diffuse sources	341.0	12.6	1.0
Loads introduced by natural purification	0	-142.6	-30.4
Loads introduced by auto inflows	-47.5	-2.4	0.2
Loads introduced by auto quality	228.8	175.3	13.4
Loads introduced by effluent discharges	3661.6	65.3	15.6
Grand total	7967.1	286.5	10.9

5. MODELLING SCENARIO RESULTS

Following auto-calibration, the SIMCAT model was used to represent the specified modelling scenarios based on the current and future flows and consents. The auto-calibration inputs, diffuse inputs and headwater inputs used in calibrating the current situation model against the observed data were maintained for all scenarios.

All scenario results are based on the 'face value' SIMCAT results and take no account the confidence intervals calculated for each statistical output. The reliability of the interpretation of the results to these and other sensitivity issues should be considered as part of any subsequent decision making process. In particular, care should be taken in the interpretation of DO predictions, as these are largely dependent on the assumed DO inputs from the STWs. These were maintained at current observed levels for all scenarios

As described in Section 1.3.3, three broad modelling tasks were carried out as described below.

i) Use the calibrated SIMCAT model results to assess current compliance with river quality standards.

ii) Use the calibrated SIMCAT model (in 'what-if' mode) to assess compliance with river quality standards when all STWs are operating at current consented flow and quality. The predicted water quality is the 'planned' water quality for the catchment.

iii) Use calibrated SIMCAT model (in 'what-if' mode) to determine permissible future consented flow and quality at STWs to meet RE classification AND show no deterioration over 'planned' water quality as defined in ii) above. Flows that cannot be treated at Basingstoke are transferred to Sherborne, then Sherfield. This assessment is repeated to reflect predicted population changes by 2001, 2006 and 2011.

They are considered in detail in Sections 5.1 to 5.3

5.1 'Current' compliance with river quality targets.

The calibrated SIMCAT model was used assess compliance with river quality targets. The different targets used in the catchment are summarised in Table 5.1.

The Upper Loddon (from Basingstoke STW to the confluence with Bow Brook) and the Lower Loddon (from the confluence with Bow Brook to Kings Bridge) are classified as RE2 and as a Salmonid Fishery. Operational standards are also applied.

The Vyne Stream / Bow Brook reach (from Sherborne STW to the confluence with the Loddon) is classified as RE3. No other standards apply.

The Targets for Dissolved Oxygen are conversions from Percent Saturation values. The conversion has been made using standard formula that use the average summer temperature of the water at that location. The resulting targets have been rounded to the nearest integer.

Table 5.1 River Quality Targets

	REC				Salmonid Fishery			Operational Standard			
	90% BOD mg/l	90% NH4N mg/l	10% DO mg/l	95% unzd NH4N mg/l	mean DO mg/l	1% DO mg/l	95% NH4N mg/l	95% BOD mg/l	1% DO mg/l	95% unzd NH4N mg/l	95% NH4N mg/l
d/s Basingstoke STW	4	0.6	7	0.021	9	6	0.78				
B3 (PLDR.0073)	4	0.6	7	0.021	9	6	0.78	3	7	0.004	0.195
d/s Lyde	4	0.6	7	0.021	9	6	0.78				
B4 (PLDR.0033)	4	0.6	7	0.021	9	6	0.78				
End of Upper Loddon	4	0.6	7	0.021	9	6	0.78				
d/s Sherborne STW	6	1.3	6	0.021							
B8 (PLDR.0051)	6	1.3	6	0.021							
d/s Bow Brook	6	1.3	6	0.021							
B10 (PLDR.0054)	6	1.3	6	0.021							
B12 (PLDR.0055)	6	1.3	6	0.021							
d/s Sherfield STW	6	1.3	6	0.021							
End of Bow Brook	6	1.3	6	0.021							
Head of Lower Loddon	4	0.6	7	0.021	9	6	0.78				
B5 (PLDR.0028)	4	0.6	7	0.021	9	6	0.78				
End of Lower Loddon	4	0.6	7	0.021	9	6	0.78				

Note: RE1, 2 and 3 un-ionised ammonia standards are identical to the Salmonid Fishery standard for un-ionised Ammonia applied to the Loddon. The same criteria is applied to the Vyne Stream/Bow Brook which is RE3.

Table 5.1 shows a number of assessment locations within each river reach. For example, the Upper Loddon has assessment points immediately downstream of Basingstoke STW; at the monitoring station PLDR.0073; downstream of the Lyde tributary; at the monitoring station PLDR.0033; and, at the end of the reach. Compliance with targets throughout a reach is required. Un-ionised Ammonia results were calculated from the total Ammonia results produced by SIMCAT and the observed distributions of temperature and pH by using a WRc Monte Carlo simulation program.

Appendix A (A1) contains model the full suite of model results for the simulation. Table 5.2 assesses the compliance of these results with the targets in Table 5.1. These results may be summarised as follows:

Upper Loddon

RE2 river quality target is met. Salmonid Fishery Target is met except for a failure in mean DO immediately downstream of Basingstoke STW. The Operational Standards are met at PLDR.0033.

Vyne Stream / Bow Brook

Reach fails RE3 BOD target.

Lower Loddon

Reach complies with RE2 and Salmonid Fishery target.

Table 5.2 Assessment for current situation

	REC				Salmonid Fishery			Operational Standard			
	BOD	NH4-N	DO	UNZD Amm P95	mean DO	DO P01	Amm P95	BOD P95	DO P01	UNZD Amm P95	Amm P95
d/s Basingstoke STW	PASS	PASS	PASS	PASS	FAIL	PASS	PASS				
B3 (PLDR.0073)	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
d/s Lyde River	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
B4 (PLDR.0033)	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS
End of Upper Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
d/s Sherborne STW	PASS	PASS	PASS	PASS							
B8 (PLDR.0051)	FAIL	PASS	PASS	PASS							
d/s Bow Brook	PASS	PASS	PASS	PASS							
B10 (PLDR.0054)	PASS	PASS	PASS	PASS							
B12 (PLDR.0055)	FAIL	PASS	PASS	PASS							
d/s Sherfield STW	FAIL	PASS	PASS	PASS							
End of Bow Brook	FAIL	PASS	PASS	PASS							
Head of Lower Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
B5 (PLDR.0028)	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
End of Lower Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				

5.2 Compliance with STWs operating at current consents

The current consented flow and quality for each STW in the catchment have been interpreted as distributions in Tables 5.3 and 5.4 and compared with current measured flow and quality. In estimating SIMCAT input statistics for consented flow and quality, the observed Coefficients of Variation and ratios between mean and shift have been maintained. The 95 percentiles have been calculated by Method of Moments.

Table 5.3 Current consent and actual STW flow

	Consented Flow (Ml/d)			Current Observed Flow (Ml/d)		
STW	mean flow	sd flow	shift flow	mean flow	sd flow	shift flow
Basingstoke	27.60	4.50	21.60	27.6	4.5	21.6
Sherborne	1.82	0.78	0.79	1.4	0.6	0.6
Sherfield	1.04	0.21	0.47	2.0	0.4	0.9

Table 5.3 shows that Basingstoke is currently operating at consented flow; Sherborne is operating below consented flow; and, Sherfield is operating above consented flow. Table 5.4 shows that each works is operating within its quality consent.

Table 5.4 Current consent and actual STW quality

STW	mean BOD	sd BOD	95%ile BOD	mean NH4-N	sd NH4-N	95%ile NH4-N
Consented Quality						
Basingstoke	3.78	3.42	**10.0**	0.66	0.79	**2.0**
Sherborne	3.69	2.28	**8.0**	2.57	2.84	**7.5**
Sherfield	14.94	7.96	**30.0**	3.59	2.07	**7.0**
Current Observed Quality						
Basingstoke	1.80	1.93	**5.2**	0.36	0.6	**1.2**
Sherborne	2.05	1.10	**4.1**	0.29	0.1	**0.5**
Sherfield	4.98	2.62	**9.9**	2.13	1.23	**4.2**

Appendix A (A2) shows the full suite of results for the 'what-if' SIMCAT simulation for each STW operating at current consents. Table 5.5 assesses the compliance of these results with the river quality targets in Table 5.1.

Table 5.5 River quality assessment for current consents

	REC				Salmonid Fishery			Operational Standard			
	BOD	NH4-N	DO	95% unzd NH4-N	mean DO	1% DO	95% NH4-N	95% BOD	1% DO	95% unzd NH4-N	95% NH4-N
d/s Basingstoke STW	PASS	FAIL	PASS	FAIL	FAIL	PASS	FAIL				
B3 (PLDR.0073)	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
d/s Lyde	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
B4 (PLDR.0033)	PASS	PASS	PASS	PASS	PASS	PASS	PASS	PASS	FAIL	PASS	FAIL
End of Upper Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
d/s Sherborne STW	PASS	FAIL	PASS	PASS							
B8 (PLDR.0051)	FAIL	FAIL	PASS	PASS							
d/s Bow Brook	PASS	PASS	PASS	PASS							
B10 (PLDR.0054)	PASS	PASS	PASS	PASS							
B12 (PLDR.0055)	FAIL	PASS	PASS	PASS							
d/s Sherfield STW	FAIL	PASS	PASS	PASS							
End of Bow Brook	FAIL	PASS	PASS	PASS							
Head of Lower Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
2.5km	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
5.0km	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
B5 (PLDR.0028)	PASS	PASS	PASS	PASS	PASS	PASS	PASS				
End of Lower Loddon	PASS	PASS	PASS	PASS	PASS	PASS	PASS				

There is a failure of the RE2 ammonia standard downstream of Basingstoke STW and of the operational standard at PLDR.0033. There are ammonia and BOD failures on Vyne Stream / Bow Brook. The Lower Loddon meets all standards.

As the consented flow from Sherfield STW is exceeded under current operation, a new consented effluent quality was required that took account of the additional flow. The SIMCAT model was used to determine the consent required at Sherfield to achieve the same immediate downstream impact as the current consent (i.e. 7.8 mg/l BOD and 0.68mg/l Ammonia, as 90%iles).

The revised Sherfield consents are 19.1mg/l for BOD and **4.4mg/l for Total Ammonia**, as 95 %iles for a consented flow equivalent to a mean flow of 2.0 Ml/d. Full simulation results for revised consents are presented in A3 of Appendix A.

5.3 Future scenarios

Three future scenarios were identified by TWUL to represent stages of population growth in the catchment. Each is represented in Table 5.6 which shows the mean effluent flow at each STW. For comparison, the actual and current (revised for Sherfield) consented flows are also included.

Table 5.6 Increased effluent flow scenarios

	Basingstoke	Sherborne	Sherfield	Sum of effluent flows (Ml/d)
Observed mean flow (Ml/d)	27.6	1.40	2.0	31.00
Current consented flow (Ml/d)	27.6	1.82	2.0	31.42
Flow in 2001 (Ml/d)	29.07	1.13	2.13	32.33
Flow in 2006 (Ml/d)	30.39	1.23	2.53	34.15
Flow in 2011 (Ml/d)	32.49	1.24	2.53	36.26

Under each future scenario, RE targets, EU fishery targets and fishery operational targets should be met. Under the policy of 'no deterioration' water quality must also not be worse than the predicted quality using current consents. However, the following exceptions apply because of the recognised seasonal eutrophication effects in the Vyne Stream/Bow Brook:

> ***'RE3 / no deterioration' standard only applies immediatelv downstream of Sherborne STW on Vyne Stream.***
>
> ***Only the ammonia 'RE3 / no deterioration' standard applies downstream of Sherfield on the Bow Brook.***
>
> ***No deterioration of BOD and ammonia is applied to the Loddon below the Bow Brook.***

In practice, the following constraints were applied to ensure no deterioration. SIMCAT predicted water quality to within 0.1mg/l of these targets was considered to be adequate.

i) 90% BOD d/s Sherborne should not be greater than 5.42 mg/l

ii) 90% BOD d/s Sherfield should not be greater than 7.70 mg/l

iii) 90% total Ammonia d/s Sherfield should not be greater than 0.68 mg/l

iv) 90%ile BOD @ headwater of Lower Loddon should not be greater than 2.91 mg/l

v) 90%ile total Ammonia @ headwater of Lower Loddon should not be greater than 0.20 mg/l

Increased flows were transferred from Basingstoke to Sherborne and Sherfield to meet these river quality criteria. The consents were tightened at each works to the following 'best effluent' limits', as mg/l for BOD and Ammonia respectively:

Basingstoke	8.0/1.8
Sherfield	8.0/2.0
Sherborne	8.0/2.0

The best effluent values represent the tightest feasible consents agreed between the Agency and Thames Water that ensure downstream compliance with relevant river quality objectives. For example, Basingstoke STW causes a failure downstream if it operates at the current consent (8.0/2.0). With current flow, the consent has to be tightened to 8.0/1.8 to meet ammonia standards downstream.

Flows were transferred first to Sherborne until a consent of less than the 'best effluent' was required; and, then further flows were transferred to Sherfield. Transferred flows were added to the 'planned growth' flow for each discharge for each scenario.

Simulation results showing optimised water quality for each scenario are included in Appendix A as A4 (2001), A5 (2006) and A6 (2011). Table 5.7 shows how flows must be distributed in future scenarios. Basingstoke and Sherborne have maximum average flows of 24.5 and 2.0 Ml/d respectively. Additional flows have to be transferred to Sherfield.

Table 5.7 Flow transfer results

	Basingstoke	**Sherborne**	**Sherfield**	**Sum of effluent flows (Ml/d)**
Observed mean flow (Ml/d)	27.6	1.40	2.0	31.00
Revised consented flow (Ml/d)	27.6	1.82	2.0	31.42
Flow in 2001 (Ml/d)	24.5	2.0	5.83	32.33
Flow in 2006 (Ml/d)	24.5	2.0	7.65	34.15
Flow in 2011 (Ml/d)	24.5	2.0	9.76	36.26

For all scenarios, Basingstoke and Sherborne consents were set at 'best effluent' quality. Table 5.8 shows how Sherfield required a progressively tighter consent for each scenario to ensure no deterioration over planned water quality as effluent flows increased.

Table 5.8 Sherfield consent for future scenarios

	2001	2006	2011
BOD 95%ile	12.0	11.0	10.0
Amm 95%ile	2.7	2.3	2.0

The SIMCAT model simulations show that no further effluent flows can be treated in the catchment after 2011 unless an Ammonia consent of less that 2 (mg/l as a 95%ile) is applied at Sherfield or the 'best effluent quality' consents for Basingstoke or Sherborne are tightened.

6. CONCLUSIONS

The outcome of the modelling study using a calibrated SIMCAT model to represent specified modelling scenarios may be summarised as follows:

1. Under current operation, RE2 standards are achieved in the Loddon; the Bow Brook/ Vyne Stream fails to meet RE3; and, Salmonid standards are met on the Loddon, except for DO.

2. Under current consents for flow and quality, RE2 and Salmonid standards will not be achieved immediately downstream of Basingstoke in the Loddon; Bow Brook will fail to achieve RE3; and, the Loddon downstream of Bow Brook will achieve RE2, salmonid and operational standards.

3. A revised consent for Sherfield STW (19.1/4.4), based on the current actual flow, has been calculated which will produce the same downstream impact as the current consent.

4. Three future scenarios have been represented for 2001, 2006 and 2011 effluent flow predictions. The modelling study has shown that planned river quality can be maintained if consents are tightened (to the 'best effluent quality' standard) and flows are transferred from Basingstoke to Sherborne and Sherfield. The catchment cannot sustain further effluent inputs beyond the year 2011 projections without further reductions in the consented quality of the discharges.

5. A Total Ammonia consent of less than 1.0 (as a 95 %ile) is required to meet river quality objectives on the Loddon if future flows are routed through Basingstoke (rather than transferred to Sherborne and Sherfield)

6. The SIMCAT model may be used to examine further scenarios.

Appendix A contains model results

Appendix B contains the SIMCAT data file.

Appendix C presents an examination of the Total Ammonia data of Basingstoke STW final effluent.

APPENDIX A MODEL RESULTS

A1 SIMCAT PREDICTED RIVER QUALITY FOR CURRENT SITUATION

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	1.35	2.39	2.96	5.18	0.21	0.44	0.69	1.50	8.66	7.58	7.26	6.73
Upper Loddon	Keepers Cottage B3	1.09	1.93	2.34	3.61	0.12	0.36	0.43	0.80	10.48	8.84	8.25	7.52
Upper Loddon	Blacklands Loop	1.05	1.86	2.33	3.35	0.10	0.24	0.30	0.51	10.03	8.76	8.36	7.76
Upper Loddon	Lyde B13/14	1.09	2.06	2.57	4.30	0.08	0.18	0.21	0.32	10.31	8.78	8.25	7.41
Upper Loddon	Long Bridge B4	1.09	2.15	2.70	4.68	0.07	0.15	0.18	0.28	10.60	8.72	8.18	7.10
Upper Loddon	End of reach Upper Loddon	1.17	2.18	2.78	4.84	0.06	0.14	0.17	0.25	10.61	8.72	8.14	6.95
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.58	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.21	4.40	6.13	11.75	0.13	0.22	0.27	0.42	9.64	8.55	8.30	7.72
Vyne Stream	Vyne Stream d/s Vyne B8	3.08	6.90	9.03	18.01	0.06	0.12	0.14	0.20	10.22	8.41	7.74	6.95
Vyne Stream	Natural flow estimate	3.52	8.08	10.55	19.24	0.07	0.13	0.15	0.22	9.99	7.50	6.68	5.39
Vyne Stream	Bow Brook B9	2.69	5.62	7.41	12.10	0.05	0.08	0.10	0.15	9.55	7.87	7.45	6.52
Vyne Stream	Locks Bridge B10	2.73	5.83	7.74	13.33	0.05	0.09	0.10	0.16	9.65	7.89	7.50	6.44
Vyne Stream	Bow Bridge B12	3.03	7.14	9.44	19.63	0.05	0.12	0.14	0.22	10.27	7.28	6.42	4.70
Vyne Stream	Sherfield STW B15	3.29	7.05	9.21	18.10	0.27	0.56	0.75	1.08	9.59	7.24	6.38	4.66
Vyne Stream	Natural flow estimate	3.28	7.03	9.22	18.14	0.26	0.55	0.73	1.05	9.62	7.24	6.37	4.60
Vyne Stream	End of reach Vyne Stream	3.27	7.01	9.18	18.18	0.25	0.53	0.70	1.02	9.64	7.23	6.32	4.55
Lower Loddon	Start of reach Lower Loddon	1.50	2.64	3.34	5.55	0.09	0.16	0.20	0.28	10.46	8.48	7.94	6.94
Lower Loddon	Kingsbridge B5	1.47	2.64	3.21	5.02	0.07	0.18	0.22	0.37	9.86	7.93	7.38	6.27
Lower Loddon	Sheep Bridge Gauge	1.47	2.62	3.17	4.97	0.07	0.18	0.22	0.36	9.88	7.99	7.47	6.40
Lower Loddon	End of reach Lower Loddon	1.48	2.62	3.17	4.96	0.07	0.18	0.22	0.36	9.89	8.01	7.49	6.42

A2 SIMCAT PREDICTED RIVER QUALITY FOR CURRENT CONSENTS

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	2.11	3.97	5.17	9.76	0.31	0.69	1.09	2.41	8.66	7.58	7.26	6.73
Upper Loddon	Keepers Cottage B3	1.66	3.20	4.06	6.71	0.18	0.55	0.69	1.28	10.43	8.76	8.22	7.48
Upper Loddon	Blacklands Loop	1.34	2.46	3.21	4.94	0.13	0.34	0.42	0.75	10.00	8.72	8.29	7.75
Upper Loddon	Lyde B13/14	1.26	2.47	3.11	5.04	0.10	0.23	0.27	0.46	10.27	8.75	8.22	7.32
Upper Loddon	Long Bridge B4	1.23	2.47	3.15	5.30	0.08	0.19	0.23	0.38	10.56	8.65	8.09	6.94
Upper Loddon	End of reach Upper Loddon	1.29	2.47	3.17	5.43	0.07	0.16	0.21	0.33	10.57	8.66	8.01	6.88
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.56	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.88	5.42	7.10	11.43	1.64	2.80	3.36	4.79	9.58	8.51	8.28	7.73
Vyne Stream	Vyne Stream d/s Vyne B8	3.45	7.09	9.31	17.39	0.70	1.32	1.66	2.36	10.10	8.36	7.79	6.95
Vyne Stream	Natural flow estimate	3.81	8.22	10.65	18.73	0.62	1.17	1.48	2.10	9.91	7.53	6.74	5.42
Vyne Stream	Bow Brook B9	2.83	5.73	7.43	12.06	0.26	0.56	0.78	1.27	9.53	7.67	7.45	6.57
Vyne Stream	Locks Bridge B10	2.85	5.92	7.75	13.26	0.24	0.50	0.72	1.16	9.62	7.90	7.52	6.45
Vyne Stream	Bow Bridge B12	3.08	7.13	9.40	19.41	0.14	0.30	0.44	0.72	10.23	7.28	6.44	4.73
Vyne Stream	Sherfield STW B15	3.79	7.81	9.81	19.10	0.32	0.68	0.87	1.34	9.74	7.25	6.38	4.65
Vyne Stream	Natural flow estimate	3.77	7.71	9.80	19.12	0.31	0.66	0.83	1.30	9.75	7.25	6.35	4.59
Vyne Stream	End of reach Vyne Stream	3.74	7.66	9.79	19.14	0.30	0.64	0.81	1.27	9.76	7.22	6.31	4.53
Lower Loddon	Start of reach Lower Loddon	1.66	2.91	3.80	5.64	0.10	0.19	0.24	0.36	10.44	8.45	7.87	6.86
Lower Loddon	Kingsbridge B5	1.53	2.73	3.34	5.05	0.07	0.19	0.23	0.39	9.83	7.87	7.36	6.19
Lower Loddon	Sheep Bridge Gauge	1.53	2.71	3.31	5.00	0.07	0.19	0.23	0.39	9.85	7.95	7.44	6.29
Lower Loddon	End of reach Lower Loddon	1.53	2.70	3.30	4.99	0.07	0.19	0.23	0.39	9.86	7.96	7.46	6.32

A3 SIMCAT PREDICTED RIVER QUALITY AT REVISED (for Sherfield) CONSENTS

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	2.11	3.97	5.17	9.78	0.31	0.69	1.09	2.41	8.66	7.58	7.26	6.73
Upper Loddon	Keepers Cottage B3	1.66	3.20	4.06	6.71	0.18	0.55	0.69	1.28	10.43	8.76	8.22	7.48
Upper Loddon	Blacklands Loop	1.34	2.48	3.21	4.94	0.13	0.34	0.42	0.75	10.00	8.72	8.29	7.75
Upper Loddon	Lyde B13/14	1.26	2.47	3.11	5.04	0.10	0.23	0.27	0.46	10.27	8.75	8.22	7.32
Upper Loddon	Long Bridge B4	1.23	2.47	3.15	5.30	0.08	0.19	0.23	0.38	10.56	8.65	8.09	6.94
Upper Loddon	End of reach Upper Loddon	1.29	2.47	3.17	5.43	0.07	0.16	0.21	0.33	10.57	8.66	8.01	6.88
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.56	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.88	5.42	7.10	11.43	1.64	2.80	3.36	4.79	9.58	8.51	8.28	7.73
Vyne Stream	Vyne Stream d/s Vyne B8	3.45	7.09	9.31	17.39	0.70	1.32	1.66	2.36	10.10	8.36	7.79	6.95
Vyne Stream	Natural flow estimate	3.81	8.22	10.65	18.73	0.62	1.17	1.48	2.10	9.91	7.53	8.74	5.42
Vyne Stream	Bow Brook B9	2.83	5.73	7.43	12.06	0.26	0.56	0.78	1.27	9.53	7.87	7.45	6.57
Vyne Stream	Locks Bridge B10	2.85	5.92	7.75	13.26	0.24	0.50	0.72	1.16	9.62	7.90	7.52	8.45
Vyne Stream	Bow Bridge B12	3.08	7.13	9.40	19.41	0.14	0.30	0.44	0.72	10.23	7.28	6.44	4.73
Vyne Stream	Sherfield STW B15	3.78	7.70	9.55	18.30	0.33	0.68	0.87	1.46	9.59	7.25	6.39	4.70
Vyne Stream	Natural flow estimate	3.75	7.64	9.54	18.33	0.32	0.66	0.84	1.42	9.61	7.26	6.37	4.64
Vyne Stream	End of reach Vyne Stream	3.73	7.62	9.53	18.35	0.31	0.64	0.81	1.38	9.63	7.24	6.34	4.58
Lower Loddon	Start of reach Lower Loddon	1.67	2.91	3.79	5.63	0.10	0.20	0.25	0.38	10.42	8.45	7.86	6.86
Lower Loddon	Kingsbridge B5	1.53	2.72	3.33	5.03	0.07	0.19	0.23	0.39	9.83	7.87	7.36	6.21
Lower Loddon	Sheep Bridge Gauge	1.53	2.70	3.30	4.98	0.07	0.19	0.23	0.38	9.85	7.95	7.45	8.30
Lower Loddon	End of reach Lower Loddon	1.53	2.70	3.30	4.97	0.07	0.19	0.23	0.38	9.86	7.97	7.47	6.33

A4 SIMCAT PREDICTED RIVER QUALITY IN 2001

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	1.74	3.18	4.02	7.56	0.27	0.60	0.93	2.04	8.74	7.65	7.37	6.83
Upper Loddon	Keepers Cottage B3	1.38	2.54	3.14	5.13	0.16	0.48	0.59	1.09	10.59	8.89	8.28	7.54
Upper Loddon	Blacklands Loop	1.19	2.15	2.76	4.18	0.12	0.30	0.37	0.65	10.04	8.78	8.36	7.80
Upper Loddon	Lyde B13/14	1.18	2.23	2.82	4.73	0.09	0.21	0.24	0.40	10.30	8.75	8.22	7.32
Upper Loddon	Long Bridge B4	1.16	2.32	2.93	5.05	0.08	0.17	0.21	0.34	10.59	8.67	8.13	6.90
Upper Loddon	End of reach Upper Loddon	1.23	2.33	2.99	5.21	0.07	0.15	0.19	0.30	10.59	8.68	8.04	6.84
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.56	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.92	5.42	7.04	11.21	0.49	0.81	1.00	1.33	9.56	8.50	8.26	7.69
Vyne Stream	Vyne Stream d/s Vyne B8	3.45	7.00	9.23	17.07	0.22	0.39	0.49	0.66	10.07	8.37	7.83	7.01
Vyne Stream	Natural flow estimate	3.80	8.10	10.45	18.39	0.20	0.36	0.45	0.61	9.90	7.56	6.78	5.45
Vyne Stream	Bow Brook B9	2.83	5.72	7.38	11.99	0.10	0.19	0.26	0.40	9.53	7.87	7.47	6.59
Vyne Stream	Locks Bridge B10	2.85	5.89	7.71	13.23	0.09	0.18	0.24	0.39	9.62	7.91	7.53	6.46
Vyne Stream	Bow Bridge B12	3.07	7.09	9.36	19.29	0.07	0.16	0.20	0.32	10.23	7.29	6.44	4.76
Vyne Stream	Sherfield STW B15	3.84	7.45	8.95	15.80	0.35	0.68	0.88	1.49	9.17	7.21	6.45	4.87
Vyne Stream	Natural flow estimate	3.81	7.39	8.93	15.83	0.34	0.66	0.85	1.45	9.21	7.22	6.45	4.83
Vyne Stream	End of reach Vyne Stream	3.78	7.34	8.91	15.87	0.33	0.64	0.81	1.41	9.24	7.25	6.43	4.79
Lower Loddon	Start of reach Lower Loddon	1.68	2.92	3.64	5.64	0.11	0.20	0.26	0.38	10.36	8.39	7.85	6.86
Lower Loddon	Kingsbridge B5	1.53	2.71	3.30	5.03	0.08	0.19	0.23	0.38	9.83	7.89	7.37	6.26
Lower Loddon	Sheep Bridge Gauge	1.53	2.68	3.26	4.98	0.07	0.19	0.23	0.38	9.86	7.96	7.45	6.35
Lower Loddon	End of reach Lower Loddon	1.53	2.68	3.25	4.97	0.07	0.19	0.23	0.38	9.86	7.98	7.47	6.36

A5 SIMCAT PREDICTED RIVER QUALITY IN 2006

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	1.74	3.18	4.02	7.56	0.27	0.60	0.93	2.04	8.74	7.65	7.37	6.83
Upper Loddon	Keepers Cottage B3	1.38	2.54	3.14	5.13	0.16	0.48	0.59	1.09	10.59	8.89	8.28	7.54
Upper Loddon	Blacklands Loop	1.19	2.15	2.76	4.18	0.12	0.30	0.37	0.65	10.04	8.78	8.36	7.80
Upper Loddon	Lyde B13/14	1.18	2.23	2.82	4.73	0.09	0.21	0.24	0.40	10.30	8.75	8.22	7.32
Upper Loddon	Long Bridge B4	1.16	2.32	2.93	5.05	0.08	0.17	0.21	0.34	10.59	8.67	8.13	6.90
Upper Loddon	End of reach Upper Loddon	1.23	2.33	2.99	5.21	0.07	0.15	0.19	0.30	10.59	8.68	8.04	6.84
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.56	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.92	5.43	7.04	11.21	0.49	0.81	1.00	1.33	9.56	8.50	8.26	7.69
Vyne Stream	Vyne Stream d/s Vyne B8	3.45	7.00	9.23	17.07	0.22	0.39	0.49	0.66	10.07	8.37	7.83	7.01
Vyne Stream	Natural flow estimate	3.80	8.10	10.45	18.39	0.20	0.36	0.45	0.61	9.90	7.56	6.78	5.45
Vyne Stream	Bow Brook B9	2.83	5.72	7.38	11.99	0.10	0.19	0.26	0.40	9.53	7.87	7.47	6.59
Vyne Stream	Locks Bridge B10	2.85	5.89	7.71	13.23	0.09	0.18	0.24	0.39	9.62	7.91	7.53	6.46
Vyne Stream	Bow Bridge B12	3.07	7.09	9.36	19.29	0.07	0.16	0.20	0.32	10.23	7.29	6.44	4.76
Vyne Stream	Sherfield STW B15	3.85	7.20	8.85	14.89	0.36	0.68	0.89	1.46	9.02	7.18	6.52	4.94
Vyne Stream	Natural flow estimate	3.82	7.18	8.83	14.92	0.35	0.66	0.85	1.42	9.07	7.21	6.47	4.90
Vyne Stream	End of reach Vyne Stream	3.78	7.12	8.82	14.96	0.33	0.64	0.83	1.39	9.11	7.22	6.46	4.87
Lower Loddon	Start of reach Lower Loddon	1.71	2.94	3.66	5.62	0.11	0.21	0.27	0.40	10.33	8.37	7.85	6.86
Lower Loddon	Kingsbridge B5	1.54	2.71	3.29	5.00	0.08	0.19	0.23	0.38	9.84	7.90	7.38	6.28
Lower Loddon	Sheep Bridge Gauge	1.54	2.68	3.25	4.95	0.07	0.19	0.22	0.37	9.86	7.98	7.47	8.37
Lower Loddon	End of reach Lower Loddon	1.54	2.68	3.25	4.94	0.07	0.19	0.22	0.37	9.86	7.99	7.49	6.38

A6 SIMCAT PREDICTED RIVER QUALITY IN 2011

Reach	Feature	BOD Mean	BOD P90	BOD P95	BOD P99	Amm Mean	Amm P90	Amm P95	Amm P99	DO Mean	DO P90	DO P95	DO P99
Upper Loddon	Head of Loddon B1	0.97	1.76	2.12	3.35	0.08	0.15	0.18	0.26	9.74	8.25	7.89	7.21
Upper Loddon	Basingstoke STW B2	1.74	3.18	4.02	7.56	0.27	0.60	0.93	2.04	8.74	7.65	7.37	6.83
Upper Loddon	Keepers Cottage B3	1.38	2.54	3.14	5.13	0.16	0.48	0.59	1.09	10.59	8.89	8.28	7.54
Upper Loddon	Blacklands Loop	1.19	2.15	2.76	4.18	0.12	0.30	0.37	0.65	10.04	8.78	8.36	7.80
Upper Loddon	Lyde B13/14	1.18	2.23	2.82	4.73	0.09	0.21	0.24	0.40	10.30	8.75	8.22	7.32
Upper Loddon	Long Bridge B4	1.16	2.32	2.93	5.05	0.08	0.17	0.21	0.34	10.59	8.67	8.13	6.90
Upper Loddon	End of reach Upper Loddon	1.23	2.33	2.99	5.21	0.07	0.15	0.19	0.30	10.59	8.68	8.04	6.84
Vyne Stream	Head of Vyne Stream B6	1.99	4.70	6.56	14.63	0.06	0.17	0.24	0.53	10.06	8.58	8.21	7.54
Vyne Stream	Sherborne STW B7	2.92	5.43	7.04	11.21	0.49	0.81	1.00	1.33	9.56	8.50	8.26	7.69
Vyne Stream	Vyne Stream d/s Vyne B8	3.45	7.00	9.23	17.07	0.22	0.39	0.49	0.66	10.07	8.37	7.83	7.01
Vyne Stream	Natural flow estimate	3.80	8.10	10.45	18.39	0.20	0.36	0.45	0.81	9.90	7.56	6.78	5.45
Vyne Stream	Bow Brook B9	2.83	5.72	7.38	11.99	0.10	0.19	0.26	0.40	9.53	7.87	7.47	6.59
Vyne Stream	Locks Bridge B10	2.85	5.89	7.71	13.23	0.09	0.18	0.24	0.39	9.62	7.91	7.53	6.48
Vyne Stream	Bow Bridge B12	3.07	7.09	9.36	19.29	0.07	0.16	0.20	0.32	10.23	7.29	6.44	4.76
Vyne Stream	Sherfield STW B15	3.81	7.00	8.58	14.41	0.36	0.68	0.88	1.42	8.88	7.16	6.47	5.01
Vyne Stream	Natural flow estimate	3.77	6.94	8.46	14.42	0.35	0.66	0.85	1.37	8.93	7.16	8.50	4.98
Vyne Stream	End of reach Vyne Stream	3.74	6.91	8.40	14.42	0.34	0.64	0.82	1.33	8.98	7.20	6.54	4.95
Lower Loddon	Start of reach Lower Loddon	1.73	2.94	3.68	5.59	0.12	0.22	0.27	0.41	10.29	8.36	7.84	6.86
Lower Loddon	Kingsbridge B5	1.54	2.70	3.28	4.97	0.08	0.19	0.23	0.38	9.84	7.91	7.39	6.31
Lower Loddon	Sheep Bridge Gauge	1.54	2.67	3.24	4.92	0.07	0.19	0.22	0.37	9.86	7.99	7.49	6.39
Lower Loddon	End of reach Lower Loddon	1.54	2.67	3.24	4.91	0.07	0.19	0.22	0.37	9.87	8.01	7.50	6.41

APPENDIX B SIMCAT MODEL DATAFILE

```
===================================================================
======= SIMCAT data file: B_feb19.Dat                             =
======= Created by E Gill on 19/02/99                             =
======= data analysed using PSI tools for the period 1995-1998    =
======= unless specified otherwise                                =
===================================================================
======= Lines beginning with '====' are notes explaining the      =
======= data. These notes are not used by SIMCAT and may be       =
======= removed from the data-file if not needed....              =
=======                                                           =
======= The following sets of data (Data-Sets) are required:      =
=======                  [a] General;                             =
=======                  [b] Determinands;                        =
=======                  [c] Reaches;                             =
=======                  [d] River Flow;                          =
=======                  [e] River Quality;                       =
=======                  [f] Effluent Flow & Quality;             =
=======                  [h] River Quality Targets;               =
=======                  [i] Intermittent Discharges;             =
=======                  [j] Features.                            =
=======                                                           =
======= For sets [d],[e] and [f] extra data will need to be       =
======= appended if the more unusual distributions are selected.  =
=======                                                           =
======= In the following notes the term, River Chemistry,         =
======= refers to the effect of the fixed set of Rate Constants   =
======= defined below in the Data-Sets for Determinands and       =
======= Reaches. These can be used with the equations written into =
======= SIMCAT to model changes in river quality.                 =
=======                                                           =
======= Additionally, or alternatively, changes in river          =
======= quality are handled by Auto-Calibration (AC).             =
===================================================================
===================================================================
======= A descriptive title follows...                            =
===================================================================
      Thames Basingstoke
===================================================================
========[a] General ===============================================
===================================================================
======= The next 3 variables can be zero or 1                     =
===================================================================
   0    set to 1 to exclude confidence limits from output;        =
   1    set to 1 to exclude tables of input data;                 =
   0    set to 1 to exclude output for non-effluent features;     =
===================================================================
======= In Mean Mode the calculated values of the mean river quality=
======= will be output to the screen and the River Targets entered =
======= as Set [h] are taken as averages....                      =
======= In 95-percentile Mode the calculated values of            =
======= 95-percentileswill be output to the screen and the River  =
======= Targets (Set [h]) will be taken as 95-percentiles....     =
======= In 90-percentile Mode the calculated values of            =
======= 90-percentileswill be output to the screen and the River  =
======= Targets (Set [h]) will be taken as 90-percentiles....     =
===================================================================
======= set to 1 for mean mode, zero for 95-percentile mode; or   =
   2    2 for 90-percentile mode; or 3 for 99-percentile mode     =
  1000   number of shots (minimum is 5; maximum is 2500);         =
  11.2  mean temperature of river water.                          =
 'Ml/d' units for river and effluent flow (4 characters in quotes) =
===================================================================
   1    set to 1 to insert Diffuse Sources;                       =
   1    set to 1 to include River Chemistry;                      =
   0    set to 1 for Auto-Interpolation.                          =
```

```
=====================================================================
========[b] Determinand ==============================================
=====================================================================
======= The code number for each determinand is defined by its      =
======= order in the list. There is one line of data for            =
======= each determinand. Each line holds the following:            =
=======  (a) defines the type of determinand and the method of      =
=======      handling River Chemistry and Auto-Calibration (AC);    =
=======      The types are:                                         =
=======        1: the determinand is Conservative; also, all        =
=======           the corrections calculated by AC will be          =
=======           applied as a linear function of river length;     =
=======        2: losses calculated by AC will be applied as an     =
=======           exponential function of river length; gains       =
=======           will be linear;                                   =
=======        3: Dissolved Oxygen; it is assumed that the          =
=======           second and third pollutants in the list are       =
=======           BOD and Ammonia respectively; the AC              =
=======           corrections are as for type 2;                    =
=======        4: (or any other number) the determinand will be     =
=======           excluded from the run.
=======  (b) the name of the determinand;                           =
=======  (c) the short name for the determinand;
=======  (d) the unit of measurement;
=======  (e) the global rate constant (reciprocal days);             =
=======  (f) the minimum quality achievable by exponential           =
=======      decay with above rate constants listed under (c);      =
=======  (g) the quality of the diffuse inflows added by AC          =
=======      when fitting river flows;                              =
=======  (h) the minimum quality allowed by extrapolation of         =
=======      the extra exponential decay introduced by AC;          =
=======  The following variables (h),(i) and (j) are used as        =
=======  constraints by Modes 7 & 8; all are 95-percentile          =
=======  concentrations; enter zero if not needed:                  =
=======  In Mean Mode they are means...                             =
=======  (i) the worst permissible effluent quality;                 =
=======  (j) the best feasible effluent quality; and,                =
=======  (k) a definition of good effluent quality.                  =
==========b==========c=======d=====e=====f====g====h====i====j====k===
1    'Chloride...'   'Cl    ' 'mg/l' 0     0    26.5  20   0    0    0
2    'B.O.D......'   'BOD   ' 'mg/l' 5     1    1.24  1    500  3    20
2    'Ammonia....'   'Amm   ' 'mg/l' 10    0    0.08  0    32   2    10
3    'Diss.Oxygen'   'DO    ' 'mg/l' 10    0    9.74  0    0    7    2
*************** indicator of end of determinand data ***************
=====================================================================
========[c] Reaches ==================================================
=====================================================================
======= Data on river Reaches follow ...                            =
=====================================================================
======= For each Reach the following are given:                     =
=======  (a) the code number;                                       =
=======  (b) the name;                                              =
=======  (c) length (km);                                           =
=======  (d,e,f) define the sequence in which the Reaches will      =
=======      be processed:                                          =
=======           0,x,0  ... the NEXT Reach will be a branch to     =
=======                      Reach number x;                        =
=======           x,0,0  ... the NEXT Reach will be a straight      =
=======                      continuation to Reach number x;        =
=======           z,y,x  ... the NEXT Reach, number x, will be      =
=======                      formed by mixing z and y.              =
=======  (g) the flow data-set for any diffuse inflow;               =
=======  (h) the quality data-set for these diffuse inflows;         =
=======  (i) term a for velocity/discharge relation;                =
=======  (j) term b for velocity/discharge relation;                =
=======  The following rate constants, if non-zero, replace the     =
=======  global values given in the determinand data (at (c)).      =
=======  To replace the global value with zero enter '-1.0';        =
=======  (k) the rate constant for the decay of the BOD;            =
```

```
=======  (l) the reaeration constant for Dissolved Oxygen;           =
=======  (m) the rate constant for the loss of Ammonia.              =
============b===========c===d====e====f===g=====h===i=====j===k====l====m=
1        'Upper Loddon  ' 7.4  0    2    0    8    12   1    1    0    0    0
2        'Vyne Stream   ' 8.9  1    2    3    8    12   1    1    0    0    0
3        'Lower Loddon  ' 10.0 0    0    0    8    12   1    1    0    0    0
**************** indicator of end of Reach data ******************
========[d] River Flow ==============================================
====================================================================
======= The River Flow Data-Sets follow:                             =
======= One line for each data-set: For each line:                   =
=======  (a) the code number of the data-set;                        =
=======  (b) the code number of type of distribution:                =
=======      for Feature types 7 and 9: zero,. 1 or 2;               =
=======         0 - constant, uniform flow;                          =
=======         1 - flow follows the Normal Distribution;            =
=======         2 - the Log-Normal Distribution;                     =
=======         3 - a Three-Parameter Log-Normal Distribution;       =
=======         4 - non-parametric distributions.                    =
=======  (c) the mean flow; except when used by:                     =
=======      Feature Type 7 (abstractions): the abstracted flow;     =
=======      Feature Type 9 (river regulation): zero;                =
=======      Distribution Type 3: mean of transformed data           =
=======  (d) the 95-percentile low flow: except when used by:        =
=======      Feature Type 7 (abstractions): the Hands-Off Flow;      =
=======      Feature Type 9 (river regulation): the Maintained       =
=======      Flow                                                    =
=======  (e) the shift parameter for distribution types 3:           =
=======      for Distribution Type 0, 1, 2: zero or blank;           =
=======      for Distribution Type 3:                                =
=======         negative; log(flow-shift) is Normal;                 =
=======         positive; log(flow+shift) is Normal;                 =
=======  (f) reserved for non-standard correlation coefficient       =
=======  (g) the name of the site (this is used only for             =
=======      identification. It is not needed by SIMCAT).            =
==========c====d=====e=====f=====================g====================
========1    2      37.1   13.0     0 -9.9          'Pyotts Bridge flow esr
========1    2      45.0  15.8      0 -9.9          'WRc estimate
1    3      37.30  17.7  6.7 -9.9        'Pyotts Bridge LHS (95-98)    '
2    2      23.95  6.38    0 -9.9        'Lyde                         '
3    2       3.68  1.27    0 -9.9        'Head of Vyne Stream          '
4    2      10.72  1.89    0 -9.9        'Vyne Stream est.             '
5    2      18.51  2.84    0 -9.9        'Bow Brook                    '
6    2      34.37  4.64    0 -9.9        'Bow Brook est.               '
7    3     183.00 85.30 76.6 -9.9        'SheepBridge Gauge (95-98)    '
8    2       0.49  0.25    0 -9.9        'diffuse flow for calibration'
9    3      55.60 30.70 23.0 -9.9        'Blacklands Loop    (95-98)   '
**************** indicator of end of river flow data *************
====================================================================
========[e] River Quality============================================
====================================================================
======= River Quality Data-Sets follow. For each Data-Set there      =
======= is a line of data for each determinand.                      =
======= For each line the following items are required:              =
=======  (a) the code number of the data-set;                        =
=======  (b) the code number for the determinand;                    =
=======  (c) the code number of type of distribution:                =
=======      for Feature types 7 and 9: zero, 1 or 2;                =
=======         0 - constant, uniform flow;                          =
=======         1 - flow follows the Normal Distribution;            =
=======         2 - the Log-Normal Distribution;                     =
=======         3 - a Three-Parameter Log-Normal Distribution;       =
=======         4 - non-parametric distributions.                    =
=======  (d) the mean concentration;                                 =
=======  (e) the standard deviation;                                 =
=======  (f) the shift parameter for distribution types 3:           =
=======      for Distribution Type 0, 1 or 2: zero or blank;         =
=======      for Distribution Type 3:                                =
=======         negative; log(flow-shift) is Normal;                 =
```

```
=======          positive; log(flow+shift) is Normal;                =
=======  (g) reserved for non-standard correlation coefficient       =
=======
=======  (h) number of samples used to compute the mean;             =
=======  (i) the name of the site (this is used for                  =
=======      identification. It is not needed by SIMCAT).            =
=========c=====d=====e=====f======g=====h=============i===========
1    1      2  26.51   2.46   0   -9.9      57        'Pyotts Bridge B1      '
1    2      2   0.97   0.62   0   -9.9      58
1    3      2   0.08   0.05   0   -9.9      58
1    4      2   9.74   1.22   0   -9.9      57
2    1      1  62.81  16.00   0   -9.9      59        'Keepers Cottage B3    '
2    2      2   1.09   0.66   0   -9.9      59
2    3      2   0.12   0.24   0   -9.9      61
2    4      2  10.48   1.35   0   -9.9      55
3    1      2  22.50   5.13   0   -9.9      56        'Deanland Farm B13/14  '
3    2      2   1.09   0.58   0   -9.9      54
3    3      2   0.10   0.06   0   -9.9      56
3    4      2  10.09   1.28   0   -9.9      55
4    1      1  42.57   7.50   0   -9.9      56        'Long Bridge B4        '
4    2      2   1.09   0.87   0   -9.9      56
4    3      2   0.07   0.06   0   -9.9      57
4    4      1  10.60   1.47   0   -9.9      56
====== 1989-1996 data has been used for dataset 5 (B6) ===================
5    1      2  30.47  26.07   0   -9.9      30        'HW Vyne Stream B6     '
5    2      2   1.98   2.66   0   -9.9      29
5    3      2   0.06   0.10   0   -9.9      30
5    4      2  10.06   1.21   0   -9.9      28
6    1      2  49.06  19.55   0   -9.9      45        'Vyne Stream d/s Vyne B8'
6    2      2   3.08   3.44   0   -9.9      45
6    3      2   0.06   0.04   0   -9.9      45
6    4      2  10.22   1.51   0   -9.9      43
====== 1989-1992 data has been used for dataset 8 (B9) ===================
8    1      2  40.25  10.07   0   -9.9       8        'HW Bow Brook B9       '
8    2      2    2.1   2.12   0   -9.9       8
8    3      2   0.03   0.01   0   -9.9       8
8    4      1   9.04   1.55   0   -9.9       7
====== 1989-1992 data has been used for dataset 9 (B10) ==================
9    1      2  56.75   9.19   0   -9.9       8        'Locks Bridge B10      '
9    2      2   3.28   2.52   0   -9.9       8
9    3      2   0.04   0.03   0   -9.9       8
9    4      1   8.82   1.44   0   -9.9       6
10   1      2  49.02  17.50   0   -9.9      46        'Bow Bridge B12        '
10   2      2   3.03   3.89   0   -9.9      44
10   3      2   0.05   0.05   0   -9.9      46
10   4      1  10.27   2.34   0   -9.9      45
11   1      2  45.07   7.46   0   -9.9      46        'Kingsbridge B5        '
11   2      2   1.47   0.92   0   -9.9      45
11   3      2   0.07   0.09   0   -9.9      46
11   4      1   9.86   1.51   0   -9.9      47
12   1      2  26.51   2.46   0   -9.9      57        'diffuse flow (B1)     '
12   2      2   0.97   0.62   0   -9.9      58
12   3      2   0.08   0.05   0   -9.9      58
12   4      2   9.74   1.22   0   -9.9      57
***************** indicator of end of river quality data **********
===================================================================
========[f] Effluent Flow & Quality ===============================
===================================================================
======= Effluent Flow and Quality Data-Sets follow. For each       =
======= Data-Set there is a line for the flow and a line for       =
======= each determinand in turn:                                  =
======= For each line the following are entered:                   =
=======  (a) the code number of the data-set;                      =
=======      (this will be referred to in the Feature Data)        =
=======  (b) the code number for the determinand;                  =
=======  (c) the code number of type of distribution:              =
=======      for Feature types 7 and 9: zero, 1 or 2;              =
=======         0 - constant, uniform flow;                        =
=======         1 - flow follows the Normal Distribution;          =
```

```
=======         2 - the Log-Normal Distribution;                      =
=======         3 - a Three-Parameter Log-Normal Distribution;        =
=======         4 - non-parametric distributions.                     =
======= (d) the mean value;                                           =
======= (e) the standard deviation;                                   =
======= (f) the shift parameter for distribution types 3:             =
======= for Distribution Type 0, 1 or 2: zero or blank;               =
======= for Distribution Type 3:                                      =
======= negative; log(flow-shift) is Normal;                          =
======= positive; log(flow+shift) is Normal;                          =
======= (g) reserved for non-standard correlation coefficient          =
=======
======= (h) number of samples used to compute the mean;               =
======= (i) the name of the discharge (this is used for               =
======= identification. It is not needed by SIMCAT).                  =
=========c=====d======e=====f=======g======h===============i============
================calibration data - current flow and quality==============
=======1    0    3      27.6   4.5   21.6 -9.9    541      'Basingstoke STW
'
=======1    1    1     114.9  21.03   0   -9.9    149
=======1    2    2      1.80   1.93   0   -9.9    143
=======1    3    2      0.36   0.60   0   -9.9    152
=======1    4    2      7.11   1.21   0   -9.9     80
=======2    0    3       1.4   0.6   0.6 -9.9    497      'Sherborne STW
'
=======2    1    1     208.5  89.34   0   -9.9     44
=======2    2    2      2.05   1.10   0   -9.9     42
=======2    3    2      0.29   0.10   0   -9.9     44
=======2    4    2      8.90   1.31   0   -9.9     18
=======3    0    3       2.0   0.4   0.9 -9.9    371      'Sherfield STW
'
=======3    1    2     108.3  18.44   0   -9.9     42
=======3    2    2      4.98   2.62   0   -9.9     42
=======3    3    1      2.13   1.23   0   -9.9     43
=======3    4    2      7.10   1.25   0   -9.9     18
================2001 situation        =================================
1    0    3      24.5  3.99   19.17  -9.9     541      'Basingstoke STW      '
1    1    1     114.9  21.03   0    -9.9     149
1    2    2      2.78   2.98   0    -9.9     143
1    3    2      0.53   0.88   0    -9.9     152
1    4    2      7.11   1.21   0    -9.9      80
2    0    3       2.0  0.86  0.86   -9.9     497      'Sherborne STW        '
2    1    1     208.5  89.34   0    -9.9      44
2    2    2      3.97   2.13   0    -9.9      42
2    3    2      1.22   0.42   0    -9.9      44
2    4    2      8.90   1.31   0    -9.9      18
========3    0    3      5.83   1.17   2.62   -9.9    371      'Sherfield STW
'
========3    1    2     108.3  18.44   0    -9.9     42
========3    2    2       6.0   3.19   0    -9.9     42
========3    3    2      1.26   0.76   0    -9.9     43
========3    4    2      7.10   1.25   0    -9.9     18
====================2006 situation ====================================
========3    0    3      7.65   1.53   3.44   -9.9    371      'Sherfield STW
'
========3    1    2     108.3  18.44   0    -9.9     42
========3    2    2       5.5   2.93   0    -9.9     42
========3    3    2      1.08   0.65   0    -9.9     43
========3    4    2      7.10   1.25   0    -9.9     18
====================2011 situation ====================================
3    0    3      9.76   1.95   4.39   -9.9     371      'Sherfield STW     '
3    1    2     108.3  18.44   0     -9.9      42
3    2    2      5.00   2.66   0      -9.9     42
3    3    2      0.94   0.57   0      -9.9     43
3    4    2      7.10   1.25   0     -9.9      18
************ indicator of end of effluent flow and quality data ****
=====================================================================
========[g] River Quality Targets ==================================
=====================================================================
```

```
======= The data sets for River Quality Targets follow. There is   =
======= one line for each set containing:                          =
=======   (a) the code number cited in the Feature data;           =
======= The targets follow. These are 95-percentiles except in     =
======= Mean Mode when they are taken as averages:                 =
=======   (b) the target for the first determinand;                =
=======   (c) as (b) for the second determinand;                   =
=======   (d) as (b) for the third determinand;                    =
=======   (e) as (b) for fourth determinand (Dissolved Oxygen);    =
=======       (SIMCAT cannot compute automatically (under Option   =
=======        7 or 8) the discharge quality needed to achieve     =
=======        Dissolved Oxygen targets).                          =
======= Zero indicates that no target is to be applied.            =
======a=====b====c====d====e========================================
      1    0.0  4.0  0.6  0.0
      2    0.0  6.0  1.3  0.0
======= D/S Sherfield - No det
      3    0.0  7.7  0.68  0.0
************* indicator of end of data on river quality targets ****
====================================================================
========[i] Features ================================================
====================================================================
======= The Data-Sets for Features follow. There is one line for   =
======= each feature. Each line holds:                             =
=======            (a) the name of the Feature;                    =
=======            (b) the code for the type of Feature; these are: =
=======                 1 - monitoring station;                    =
=======                 2 - stream or tributary;                   =
=======                 3 - sewage works or sewage discharge;      =
=======                 4 - river flow gauge;                      =
=======                 5 - industrial effluent discharge;         =
=======                 6 - plotting point;                        =
=======                 7 - abstraction (of flow);                 =
=======                 8 - weir;                                  =
=======                     (must be at head of Reach);            =
=======                 9 - river flow regulation point;           =
=======                     (switched on only in Modes 3-8)        =
=======                10 - upstream river boundary;               =
=======                11 - bifurcation                            =
=======                     (must be at head of Reach);            =
=======                13 - start point for diffuse pollution;     =
=======                14 - end point for diffuse pollution;       =
=======                     (river type)                           =
=======                15 - start point for diffuse pollution;     =
=======                16 - end point for diffuse pollution;       =
=======                     (effluent type)                        =
=======            (c) the code number of the Reach on which the   =
=======                Feature is located;                         =
=======            (d) distance from the head of the reach (km);   =
=======            (e) the code number of the river flow Data-Set; =
=======                (discharged from Feature Types 2 & 13)      =
=======                (recorded at Feature Type 4)                =
=======                (abstracted at Feature Type 7)              =
=======            (f) the code number for the river quality       =
=======                Data-Set or the effluent flow/quality       =
=======                Data-Set;(non-zero for Feature Types 2,3,5, =
=======                13 &15);                                    =
=======                (data-set for quality produced by Weir;     =
=======            (g) the code number of any river flow Data-Set  =
=======                to be fitted in Auto-Calibration;           =
=======                Prefixing a minus sign will suppress        =
=======                downstream extrapolation;                   =
====================================================================
=======                Defining the Feature to be at the Head of a =
=======                Reach will suppress upstream interpolation. =
=======                In this way the Feature acts as a Quality   =
=======                Adjustment Point and can model the effects  =
=======                of unusual discharges.                      =
====================================================================
```

```
=======           (h) the code number for any river quality      =
=======               Data-Set to be fitted by Auto-Calibration;  =
=======               Prefixing a minus sign will suppress        =
=======               downstream extrapolation;                   =
=======               For Feature Type 8: the code number for the =
=======               river quality Data-Set defining quality     =
=======               downstream of the Weir                      =
===================================================================
=======               Defining the Feature to be at the Head of a =
=======               Reach will suppress upstream interpolation. =
=======               In this way the Feature acts as a Flow      =
=======               Adjustment Point and can model the effects of=
=======               unusual abstractions and discharges.        =
===================================================================
=======           (i) the code number for any Data-set of river   =
=======               quality targets.                            =
===========a=================b===c====d====e====f====g====h====i===
'Head of Loddon B1          ' 10   1    0.0  1    1    0    0    0
'Basingstoke STW B2         ' 3    1    0.1  0    1    0    0    0
'Keepers Cottage B3         ' 1    1    1.0  0    2    0    2    0
'Blacklands Loop            ' 2    1    1.5  9    1    0    0    0
'plotting point1            ' 6    1    4.7  0    0    0    0    0
'Lyde B13/14                ' 2    1    4.7  2    3    0    0    0
'Long Bridge B4             ' 1    1    6.3  0    4    0    4    0
'Head of Vyne Stream B6     ' 10   2    0.0  3    5    0    0    0
'Sherborne STW B7           ' 3    2    0.3  0    2    0    0    0
'Vyne Stream d/s Vyne B8    ' 1    2    2.4  0    6    0    6    0
'Natural flow estimate      ' 4    2    3.0  4    0    0    0    0
'Bow Brook B9               ' 2    2    3.5  5    8    0    0    0
'Locks Bridge B10           ' 1    2    4.2  0    9    0    0    0
'Bow Bridge B12             ' 1    2    8.1  0    10   0    10   0
'Sherfield STW B15          ' 3    2    8.5  0    3    0    0    3
'Natural flow estimate      ' 4    2    8.7  6    0    0    0    0
'plotting point 2           ' 6    3    0.3  0    0    0    0    0
'plotting point 3           ' 6    3    2.5  0    0    0    0    0
'plotting point 4           ' 6    3    5.0  0    0    0    0    0
'Kingsbridge B5             ' 1    3    9.3  0    11   0    11   0
'SheepBridge Gauge          ' 4    3    9.9  7    0    7    0    0
*************** indicator of end of data *************************
```

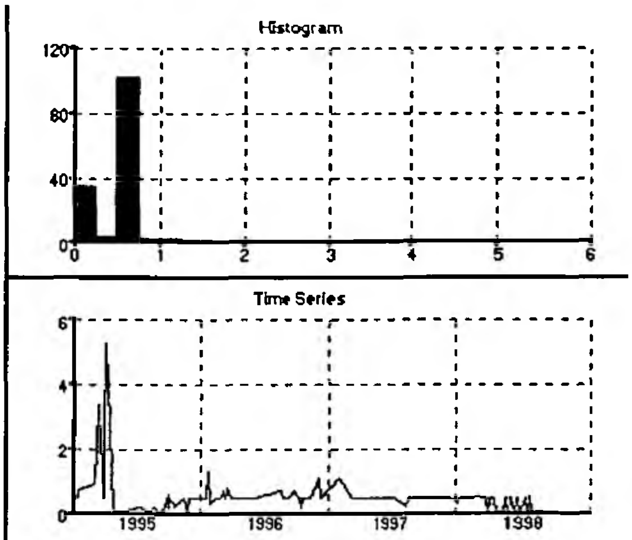
APPENDIX C AMMONIA CONCENTRATIONS IN BASINGSTOKE FINAL EFFLUENT

Three versions of total ammonia statistics for Basingstoke final effluent are presented below. Estimates of the 95 %ile are calculated using Method of Moments. It was agreed to proceed with the statistics in case No. 2 for the modelling study.

1. The whole Agency record for the period 1995 to 1998 with values at the limit of detection multplied by 1.0

BASINGSTOKE STW
Determinand Summary - Ammonia N

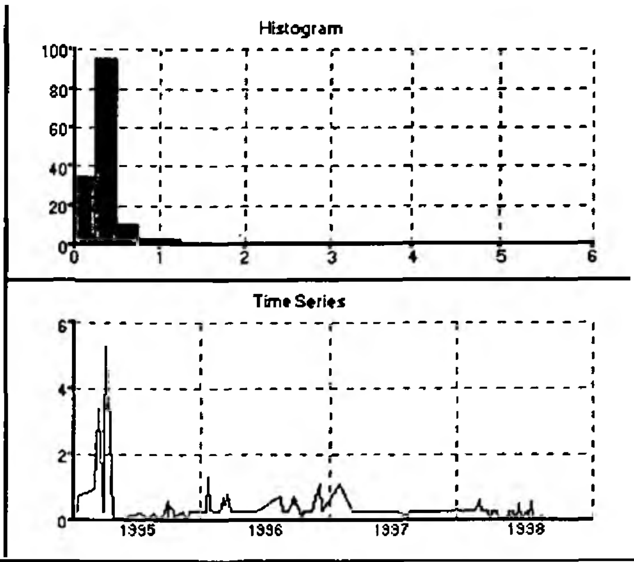
Number of Observations	152
Date Range	11-01-1995 to 22-10-1998
Minimum	0.0300
Mean	0.5140
Maximum	5.3000
Standard deviation	0.5847
SDD	0.4411
Log-Normal estimate (MoM) of:	
5 Percentile	0.0758
10 Percentile	0.1056
20 Percentile	0.1576
Median	0.3394
80 Percentile	0.7307
90 Percentile	1.0910
95 Percentile	1.5192



2. The whole Agency record for the period 1995 to 1998 with values at the limit of detection multplied by 0.5 (0.5 is the standard limit of detection multiplier)

BASINGSTOKE STW
Determinand Summary - Ammonia N

Number of Observations	152
Date Range	11-01-1995 to 22-10-1998
Minimum	0.0150
Mean	0.3595
Maximum	5.3000
Standard deviation	0.6032
SDD	0.4538
Log-Normal estimate (MoM) of:	
5 Percentile	0.0274
10 Percentile	0.0418
20 Percentile	0.0695
Median	0.1841
80 Percentile	0.4874
90 Percentile	0.8109
95 Percentile	1.2347



3. The whole Agency record for the period **1996** to 1998 with values at the limit of detection multplied by 0.5

BASINGSTOKE STW
Determinand Summary - Restricted (Ammonia N)

Number of Observations	120
Date Range	17-01-1996 to 22-10-1998
Minimum	0.0150
Mean	0.2620
Maximum	1.3000
Standard deviation	0.2072
SDD	0.1874
Log-Normal estimate (MoM) of:	
5 Percentile	0.0653
10 Percentile	0.0842
20 Percentile	0.1143
Median	0.2056
80 Percentile	0.3695
90 Percentile	0.5021
95 Percentile	0.6467