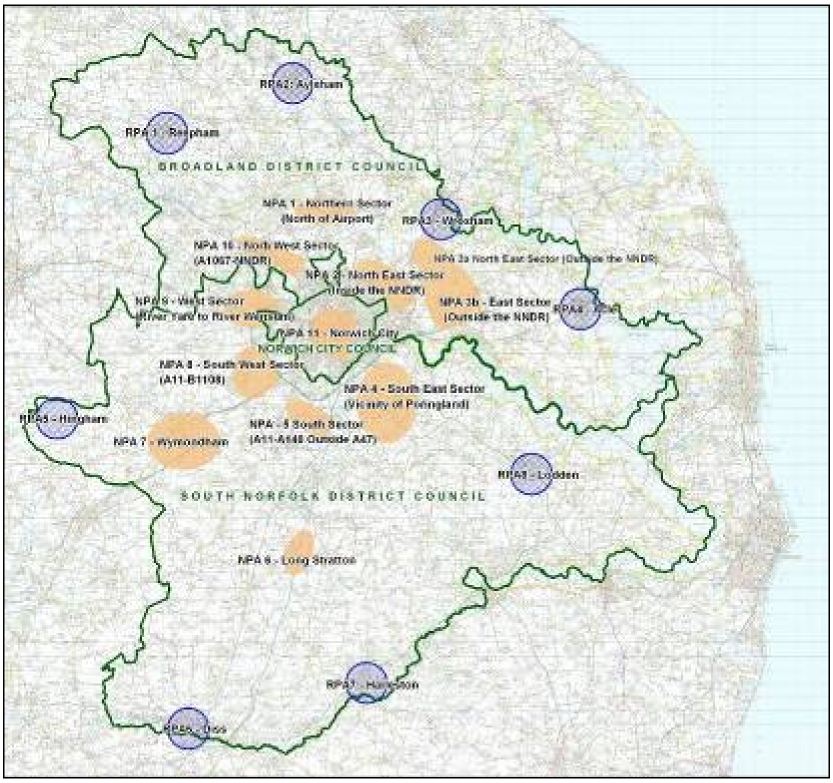
Greater Norwich Development Partnership
Stage 2b Water Cycle Study

Technical Report - Final

February 2010



Prepared for:

Broadland District Council
Norwich City Council
South Norfolk Council
Broads Authority - The Broads - a member of the National Park family
Norfolk County Council

Revision Schedule

Stage 2 Water Cycle Study
Technical Report - Final
February 2010

Rev	Date	Details	Prepared by	Reviewed by	Approved by
1.2	September 2009	D118607 - Stage 2b Draft Final Report	**Sarah Kelly** Water Scientist	**Carl Pelling** Principal Consultant	**Jon Robinson** Associate Director
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Glossary

Abbreviation	Description
AA	Appropriate Assessment (under the Habitats Regulations)
AMP	Asset Management Plan
AP	Abstraction Point
AS	Activated Sludge
AWS	Anglian Water Services
BOD	Biological Oxygen Demand
CAMS	Catchment Abstraction Management Strategy
CfSH	Code for Sustainable Homes
DCLG	Department for Communities and Local Government
DEFRA	Department for Environment, Food and Rural Affairs
DWF	Dry weather flow
GOGDS	Great Ouse Groundwater Development Scheme
GNDP	Greater Norwich Development Partnership
GNWCS	Greater Norwich Water Cycle Study
HD	Habitats Directive
HR	Habitats Regulations
HRA	Habitats Regulations Assessment
JCS	Joint Core Strategy
L/h/d	Litres/head/day
LDD	Local Development Document
LDF	Local Development Framework
LP	Leaching Potential
Ml/d	Megalitres per day (1000m3/day)
NE	Natural England
NEP	National Environment Programme
NNDR	Northern Norwich Distributor Road
NPA	Norwich Policy Area
Ofwat	The Office of Water Services
P	Phosphorous
PE	Population Equivalent
PDS	Possible Dwelling Scenario
PGA	Potential Growth Area
PR	Periodic (or Price) Review
PPS	Planning Policy Statement
RoC	Review of Consents (under the Habitats Directive)

Abbreviation	Description
RQP	River Quality Planning tool (water quality consent modelling tool)
RPA	Rural Policy Area
RSS	Regional Spatial Strategy
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SAP	Site Actrion Plan (in relation to the Habitats Directive RoC)
SPA	Special Protection Area
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SuDS	Sustainable (urban) Drainage Systems
UWWTD	Urban Wastewater Treatment Directive
WASC	Water and Sewerage Companies
WCS	Water Cycle Study(ies)
WFD	Water Framework Directive
WRMP	Water Resources Management Plan
WTW	Water Treatment Works
WwTW	Waste Water Treatment Works

1 Introduction

1.1.1 The undertaking of a Phase 2 detailed Water Cycle Study (WCS) involves a significant amount of technical data collection, analysis and interpretation. However, it is acknowledged that the WCS key purpose is to act as a planning evidence base and hence, the Greater Norwich Water Cycle Study (GNWCS) has been reported via two distinct documents:

- A Non Technical Planning Report - to act as the principal planning reference for the WCS which sets out the overall water cycle strategy, the key findings of the study in relation to the Local Development Frameworks (LDFs) and the various documents which it informs and sets out planning implications of the solutions proposed from the study; and
- A Technical report - setting out how the strategy was developed, detailing how the capacity and new infrastructure assessments were undertaken, methodologies used in the various assessments, further discussion around the policy and legislative drivers affecting the assessments and conclusions, and details of the data used and results provided. Its aim is to act as the technical reference for the evidence base to the partner authorities' LDFs, showing how the strategy has been developed in more detail.

1.1.2 This report represents the GNWSC Stage 2b – Technical Report.

2 Stage 2b Methodology

2.1 Assumptions

2.1.1 It was agreed at the inception of Stage 2b that several assumptions would be carried forward into the Stage 2b assessments on the basis that findings of several key inputs (such as Anglian Water Services' [AWS] Water Resources Management Plan [WRMP]and the Water Resources elements of the Review of Consents Process) were still not finalised during undertaking the assessments. In addition, the favoured growth areas have been identified but specific sites within the growth areas have not been identified. This has therefore necessitated a high level strategic assessment of the infrastructure required to service the large Potential Growth Areas (PGA). It has not been possible to determine site specific infrastructure requirements such as household connections, local pumping stations or site specific Sustainable Drainage Systems (SuDS).

2.1.2 These assumptions and the reasons for them are detailed below. It is recommended that the Stage 2b WCS remains a live strategy and its recommendations and findings are reviewed and reassessed as updates are made to key inputs and legislation such as the Water Framework Directive (WFD), and Habitats Directive Review of Consents (RoC) process.

Assumption I: PGAs

2.1.3 It is assumed that the PGAs which have been provided by the GNDP are representative of the location of proposed development. No account of ownership, boundaries or other has been made.

2.1.4 *Reason: No other data is available at present to determine exactly where development would occur within each PGA.*

Assumption II: There is no spare capacity in the wastewater network

2.1.5 AWS have advised that there is limited capacity within the wastewater network in and around Norwich; hence for the Norwich Policy Areas (NPA) in and around the city centre, it has been assumed that, as a general rule that new connections are required. A similar stance has been assumed for the NPAs of Long Stratton and Wymondham and hence new strategic mains have been assessed here. For the Rural Policy Areas (RPA), it has been assumed that the limited level of growth is most likely to be able to use the existing network; but with localised upgrades where required.

2.1.6 This stance is based on the AWS view that any spare capacity that may be available will be used to provide capacity for:

- changes in flow due to the impacts of climate change on rainfall patterns (increases in rainfall intensity); and
- additional flow from in-fill development within the existing developed areas.

2.1.7 Although the starting position is that there is limited existing capacity within the PGAs, there will be some existing capacity that can be used to allow early phasing of some development prior to new connecting network infrastructure being built and commissioned. At the time of the completing the assessments for the Stage 2b WCS, AWS were in the process of updating their computer model of the Norwich wastewater network model which was due for completion in

March 2010. Therefore, it has not been possible to us the model to determine the extent of available capacity in detail. As part of the capacity assessments, Scott Wilson undertook a high level capacity analysis which largely confirmed AWS position; but also confirmed that there is some capacity in key trunk sewers that could be used for early phasing.

2.1.8 Reason: Current AWS position (broadly confirmed by Scott Wilson independent analysis in Stages 1 and 2a of the GNWCS).

Assumption III: Optimise existing wastewater treatment process capacity

2.1.9 There are a number of Wastewater Treatment Works (WwTW) which have existing consented volumetric headroom to treat flow from new dwellings. It is therefore assumed that these existing capacities at the nearest WwTW to each PGA will be optimised, where possible and practical. This is for a number of reasons:

- it is considered most cost-efficient to optimise these in the first instance;
- The lead-in time for construction of new WwTW is approximately 10-15 years[1]. Therefore, optimising the existing capacity will ensure that early phasing of the development can take place.

2.1.10 Reason: This is considered to be best practice, optimises existing efficiency and complies with East of England Plan requirements.

Assumption IV: Heigham Water Treatment Works (WTW)

2.1.11 It is assumed that the infrastructure at Heigham WTW is sufficient for receiving additional water supply for distribution and hence will not require upgrading.

2.1.12 *Reason. This is based on the AWS position that there are no water supply infrastructure issues in the region.*

Assumption V: Development and Flood Risk

2.1.13 It is considered that in line with PPS25 and sustainable development principles, development will be preferentially located outside of flood zone 2 and 3.

2.1.14 Reason: This is considered best practice, and planning policy requirement (PPS25 Sequential Test) especially in the absence of confirmed location of development within PGAs.

New Assumptions for Stage 2b

Assumption VI: Costing

2.1.15 It was agreed at the inception of Stage 2b, that costing of strategic infrastructure to be provided solely by AWS would not be costed as part of this WCS for the following reasons:

- because of the strategic nature of the study, it is not possible to be prescriptive about the exact type of infrastructure and solution that AWS would eventually implement. This study has identified the most feasible and achievable options for meeting new demand for water services from growth at the time of completion in order to demonstrate that a solution to the provision of water supply and wastewater is feasible. AWS may consider that other

[1] Gary Parsons (AWS) *pers comm*

alternatives are progressed in preparation of future business plans, and hence costing the strategic infrastructure at this stage is likely to be premature. This position is supported by AWS; and

- developers cannot contribute directly to certain water company infrastructure such as WwTW and WTW as dictated by Ofwat regulations; hence there is no possibility for seeking contributions to this infrastructure.

Methodology

2.1.16 Using the capacity assessment from Stage 1 and the infrastructure option appraisal and costing from Stage 2a, this Stage 2b report outlines which specific strategic infrastructure options are required in order to deliver the proposed level of growth in each of the PGAs.

2.1.17 Whilst much of the capacity and option assessment work was undertaken in stages 1 and 2a, some additional detailed study has been required in Stage 2b to refine the infrastructure options. This work was not possible in previous stages owing to the uncertainty in housing locations and numbers. Additional work that has been undertaken to complete option refinement includes:

- optimisation of the preferred wastewater collection and treatment strategy for each PGA considering all of the PGAs jointly and based on available capacity at each of the WwTWs in the study area;
- water quality modelling using the Environment Agency's River Quality Planning Tool (RQP) to determine the quality consents which will apply to the increased treated wastewater discharges. This is required to ensure future compliance with WFD river quality standards and the thresholds set by the Habitats Directive;
- define the timing of upgrade works required at the wastewater treatment facilities in order to meet the proposed quality consents and to meet with the preferred collection and treatment strategy;
- optimisation of the water supply strategy based on final water resource proposals from AWS and the distribution strategy for transmitting the treated water to the PGAs;
- water neutrality assessment (i.e. achievement of no net increase in water demand from development) and the production of a water efficiency plan;
- assessment of most suitable SuDS techniques to comply with PPS25 (no increase in flood risk) at each PGA;
- assessment of the wastewater and water supply strategy against the Habitats Regulations requirements to ensure that the proposed strategies will not impact on HD sites;
- phasing assessments of the required infrastructure elements, including advice on developer contributions and developer guidance (developer checklist) to bring wastewater, water supply and SuDS under a single 'water cycle strategy'; and
- policy required to ensure that development meets with the overall 'water cycle strategy'.

2.1.18 The above assessment have been undertaken in an iterative manner, to ensure that at each step in the formulation of the strategy, compliance with the various legislative requirements (WFD, HD, PPS25) have been met. Where a strategy did not comply, it was altered to achieve the best possible solution. The process taken was agreed with the WCS project working group and is summarised in Appendix A:

3 Wastewater Strategy Development

3.1 Assumptions

3.1.1 Stage 2a assessed a number of options for collection and treatment of wastewater for each PGA. With the agreed housing figures per PGA, it was possible to optimise the strategy for best achieving this to reduce cost and minimise the requirement for new infrastructure (in keeping with Policy WAT2 of the RSS).

3.1.2 To achieve an optimal strategy the following assumptions have been made based on previous stages of the WCS and liaison with affected stakeholders:

- Whitlingham WwTW to the east of Norwich has the largest amount of treatment 'headroom'[2] and as such, much of the wastewater generated by the additional housing will need to be transferred to this WwTW;
- due to existing capacity issues and CSO discharges/sewer flooding incidents, collection of wastewater and connection to treatment facilities in the NPAs should assume new strategic mains and that no transfer to Whitlingham would be possible through Norwich city centre;
- for this reason, it has been agreed with AWS that large interceptor sewers running from the west of Norwich to the south (broadly along the route of the A47) and the north and providing a link to rising mains from the various growth areas around the city would be a preferable solution to the wastewater network capacity issue;
- prior to connection to Whitlingham WwTW, wastewater flow should be sent preferentially to the nearest WWTW to each PGA, utilising any spare treatment capacity first. The reasons for this are twofold:
  - to reduce operational costs and energy requirements for pumping of wastewater; and
  - reduce the likelihood of the requirement for new treatment facilities;
- it has been assumed from the Stage 2a WCS, that the wastewater networks within RPAs are generally able to transmit the additional wastewater flow to existing WwTW and therefore, there is no requirement for strategic scale sewer network upgrades in the RPAs.

3.2 Methodology

3.2.1 In order to determine how much of the additional wastewater generated at each PGA could be treated at the nearest works, it was necessary to determine the treatment capacity at each WwTW. Calculations undertaken in Stage 1 were updated using the latest flow information from AWS and housing and employment figures from GNDP for the WwTW most relevant to the location of growth within each PGA.

[2] Headroom refers to 'capacity' for further treatment

Calculation of Spare WwTW Treatment Capacity

3.2.2 There are fourteen Waste Water Treatment Works (WwTW) relevant to the PGAs taken forward into the favoured option assessment and these are shown in Table 3-1 along with the watercourse that receives the treated discharges.

Table 3-1: WwTWs Relevant to the PGAs

WwTW	Location	Receiving Watercourse
ACLE-DAMGATE LANE	TG40561000	RIVER BURE
AYLSHAM	TG20832675	RIVER BURE
BELAUGH	TG29441837	RIVER BURE
DISS	TM12057934	RIVER WAVENEY
HARLESTON	TM25008410	RIVER WAVENEY
LONG STRATTON	TM19339365	HEMPNALL BECK
PORINGLAND	TG28400090	RIVER CHET
RACKHEATH	TG26821420	DOBBS BECK, TRIB OF RIVER BURE
REEPHAM	TG10452257	BLACKWATER DRAIN, TRIB OF RIVER WENSUM
SISLAND	TM34319944	TRIB OF RIVER CHET
STOKE HOLY CROSS	TG22770292	RIVER TAS
SWARDESTON-COMMON	TG19600285	INTWOOD STREAM, TRIB OF RIVER YARE
WHITLINGHAM TROWSE	TG28290804	RIVER YARE
WYMONDHAM	TG09500299	RIVER TIFFEY

3.2.3 AWS have provided measured Dry Weather Flow (DWF) for all fourteen WwTWs. The measured flow at Acle-Damgate Lane, Rackheath, Reepham and Stoke Holy Cross is either at or above the amount AWS are allowed to discharge under their current consent and therefore, the Environment Agency have agreed that for these WwTW, they will increase the amount of discharge that can be consented. For the purposes of this assessment, the proposed new flow consents, which the Environment Agency is likely to approve for these WwTW, have been used as the current dry weather flow, and hence it is considered that these four WwTW do not have any headroom to accept further flows without a further change to the DWF consent,

3.2.4 The current and future headroom capacity at the WwTWs within Norwich and the surrounding area has been is calculated from the volumetric capacity (i.e. the difference between the maximum dry weather flow (DWF) that AWS are permitted to discharge under the discharge consent and the current DWF that is treated from the existing population). This is based on the assumption that AWS would seek the funding required to upgrade the processes in the works (if necessary) to treat the additional flow to the standard required under the existing licence. Where new flow consents have been proposed, it is assumed that there is no further capacity at the works to accommodate additional flow from proposed development and therefore AWS would need to seek a new DWF consent from the Environment Agency and/or upgrade the works to accommodate the additional flow at these works.

3.2.5 The capacity calculations were based on a number of assumptions and used industry standard calculations to determine the volume of additional flow. The assumptions are listed below:

- The resident (domestic) population (Pd) and non-resident (holiday) population (Ph) represent the current population being served by the WwTWs at June 2008;
- The per capita consumption for the domestic population (Gd – water used per head, per day) is taken as 144 l/h/d;
- The per capita consumption for the non-resident population (Gh – water used per head, per day) is taken as 55 l/h/d;
- The per capita consumption for commercial jobs (Gc) is taken as 28 l/h/d;
- The infiltration (I) rate[3] is calculated as 25% of the domestic and holiday population multiplied by the stated per capita consumptions (PG = (Domestic Population (Pd) x Domestic Consumption (Gd)) + (Holiday Population (Ph) x Holiday Consumption (Gh))) and that for future calculation of I, the additional infiltration is calculated as 25% of future PG;
- Dry Weather Flow (DWF) is calculated as PG + I + E where E is the volume of trade effluent discharged in the catchment (m^3/d);
- Flow to Full Treatment[4] (FtFT) is calculated as 3PG + I + 3E;
- The future per capita consumption for new development (Gf – water used per head, per day) is taken as 137 l/h/d.;
- No increase in non-resident or employment consumption has been assumed; and
- The occupancy rate is 2.1 per dwelling.

3.2.6 The calculations for each WwTW and the assumptions behind them are included as worksheets in Appendix B: Wastewater Treatment Capacity Calculations. The results are summarised in the following section.

WwTW Treatment Capacity Results

3.2.7 Table 3-2 gives the results of spare treatment capacity at each WwTW. Using assumptions on average Occupancy Rate the flow capacity has been converted into a dwelling capacity i.e. the number of new houses from which wastewater flow can be treated and discharged before consented capacity is reached.

[3] Infiltration in this sense is defined as the amount of water that enters the drainage system from other sources such as ingress of groundwater through defective pipes or joints in either public sewers or private sewers and drains.
[4] Flow to Full Treatment (FtFT) is the maximum rate of flow that can be treated at a WwTW.

Table 3-2: Existing WwTW Dwelling Capacity

Name	DWF Consent (m^3/d)	"Headroom" flow at which DWF consent required (m^3/d)[5]	Current Volumetric Capacity			
			2008 Measured DWF (m^3/d)	DWF Headroom (m^3/d)	Approximate Dwelling Headroom[6]	2009 DWF as percentage of flow "headroom"
ACLE-DAMGATE LANE	1,189	1,189	1,189	0	0	100%
AYLSHAM	1,440	1,440	1,150	290	805	80%
BELAUGH	2,273	2,273	1,401	872	2,425	62%
DISS	4,032	4,032	1,678	2,354	6,545	42%
HARLESTON	1,392	1,392	748	644	1,790	54%
LONG STRATTON	1,200	1,200	686	514	1,430	57%
PORINGLAND	930	930	660	270	750	71%
RACKHEATH	426	359	359	0	0	100%
REEPHAM	1,889	1,574	1,574	0	0	100%
SISLAND	1,600	1,600	1,028	572	1,590	64%
STOKE HOLY CROSS	560	467	467	0	0	100%
SWARDESTON-COMMON	1,100	1,100	715	385	1,070	65%
WHITLINGHAM TROWSE	66,250	66,250	55,639	10,611	29,505	84%
WYMONDHAM	4,400	4,400	2,746	1,654	4,600	62%
TOTAL CAPACITY					**50,510**	-

3.2.8 The results show that, although not all WwTW have capacity, there is sufficient 'dwelling' capacity in all of the WwTW combined (50,510 dwellings) to treat wastewater from the proposed 40,000 new dwellings. It was therefore necessary to optimise how this capacity was to be used by proposing strategic wastewater network connections that would result in least capital expenditure (CAPEX) in new strategic sewer infrastructure and least operational cost (OPEX) in terms distance for pumping (and hence least energy requirement and CO_2 emissions).

3.2.9 Using the assumptions as listed in Section 3.1.2, a spreadsheet optimisation assessment was undertaken to distribute the wastewater connections to the WwTW. As described, the strategy has been based upon the concept that additional flow should go to the closest WwTW to each PGA, and where this is not possible due to exceedance of the capacity headroom before an upgrade would be needed, connection to proposed new intercepting sewer main for treatment at Whitlingham WwTW has been considered. Only if both the above options where not suitable, was an upgrade to the existing works, or the construction of a new works considered.

[5] This figure has been provided by AWS as an estimate of when a new consent will be required
[6] For four WwTWs (Acle, Rackheath, Reepham and Stoke Holy Cross), new consents have been agreed which means that these works are shown as having no capacity as the actual DWF is larger than the measured figure given. There is therefore no capacity at these WwTWs.

The Wastewater Strategy

3.2.10 The optimisation exercise showed that, with the assumption of an intercepting wastewater main connecting NPAs to the West of Norwich to Whitlingham WwTW, it was possible to make use of existing capacity at the existing fourteen WwTW without the need to construct new treatment facilities. The results are shown in Table 3-3.

3.2.11 The assessment results shows that no growth can go to Rackheath WwTW due to capacity constraints and the large volume of employment growth planned for NPA1 (would require a significant upgrade at Rackheath) and therefore connection to Whitlingham WwTW would be required.

3.2.12 Three other WwTWs (Acle-Damgate Lane, Reepham and Stoke Holy Cross) have recently had new consents proposed for the works which are expected to be approved by the Environment Agency and operational by early 2010. These consents have a built in headroom allowance of between 15 – 20% for variability and are not considered to have any additional capacity for the treatment of further effluent from growth. Therefore, as Acle-Damgate Lane, Reepham and Stoke Holy Cross WwTWs are identified to receive additional wastewater from development in the area. New flow consents for these works will need to be sought from the Environment Agency, depending on how changing occupancy rates and consumption behaviour affects wastewater volumes in the area, and upgrades to the works may be required to treat the additional flow. With spare capacity utilised at Whitlingham, it was considered that an application for a new consent is the best solution for growth near these WwTWs and will save operation costs and energy required to transfer large distances to other WwTWs.

3.2.13 The assessment shows that the remaining WwTW are currently treating effluent within their current DWF consent. Taking into account the future development in Norwich and the surrounding area, the three WwTWs of Aylsham, Belaugh, and Poringland will be treating flows within 10% of their consent limit. This should be taken into consideration if further additional development above that identified is directed to these sites; in this instance the assessment will need to be reviewed.

3.2.14 Whitlingham WwTW will marginally (by less than 1%, 94 m^3/d) exceed its DWF consent under the proposed wastewater strategy, whilst Long Stratton WwTW will exceed its current DWF consent by 15% (179 m^3/d). A new flow consent will need to be sought from the Environment Agency for Long Stratton WwTW and upgrades to the works may be required to treat the additional flow. As the exceedence at Whitlingham WwTW is marginal, and potentially within the sensitivity of the assessments, further clarification was sought from AWS as to future volumetric and process capacity at the works following planned development up to 2026. AWS capacity assessments have shown that the works will have capacity to treat the required volume of flow and therefore a new DWF consent will not required to treat planned growth at this works. Further information on the AWS assessment is provided in section 3.2.17 onwards.

3.2.15 In summary, all additional growth can be accommodated within the GNDP area, without the need for construction of new WwTWs. The construction of the intercepting sewer main allows for utilisation of the current capacity headroom at Whitlingham WwTW.

3.2.16 The overall wastewater strategy and the proposed strategic wastewater connections are shown in Figure 2 (Appendix A). The site detail for the connections and the justification for the route and connection chosen is shown in the infrastructure assessments undertaken for each PGA (see Non Technical Planning Report).

Table 3-3: Existing and Future Treatment Capacity at the WwTW Following Treatment Connection Optimisation

PGA		Proposed Development		WwTW Selection			Dwelling Headroom (following employment growth)			
		Dwellings	Employment (No. Jobs)	WwTW serving NPA/RPA	% of PGA to WwTW	No. Dwellings to WwTW	Current (2009)	PGA in Isolation	Cumulative (All PGAs Growth)	2026 DWF as percentage of flow "headroom"
NPA1	North Sector	140	5,265	WHITLINGHAM	100%	140	29,506	27,778	-440	100%
NPA2	North East	9,100	3,290	WHITLINGHAM	100%	9,100	29,506	18,818	-440	100%
NPA3a	North East Sector	4,181	-	BELAUGH	52.5%	2,195	2,425	230	19	100%
				WHITLINGHAM	47.5%	1,986	29,506	25,932	-440	100%
NPA3b	East Sector	420	3,290	WHITLINGHAM	100%	420	29,506	27,498	-440	100%
NPA4	South East Sector	886	-	PORINGLAND	80%	709	751	42	42	98%
				STOKE HOLY CROSS	20%	177	0	-177	-177	134%
NPA5	South Sector	503	-	SWARDESTON-COMMON	100%	503	1,071	568	568	81%
NPA6	Long Stratton	1,927	-	LONG STRATTON	100%	1,927	1,429	-498	-498	115%
NPA7	Wymondham	2,750	4,605	WYMONDHAM	100%	2,750	4,602	1,491	1,343	89%
NPA8	South West	3,215	7,235	WHITLINGHAM	100%	3,215	29,506	24,703	-440	100%
NPA9	West Sector	3,106	1,315	WHITLINGHAM	100%	3,106	29,506	24,812	-440	100%
NPA10	North West	1,480	-	WHITLINGHAM	100%	1,480	29,506	26,438	-440	100%
RPA1	Reepham	241	-	REEPHAM	100%	241	0	-241	-241	126%
RPA2	Aylsham	600	-	AYLSHAM	100%	600	806	206	206	95%
RPA3	Wroxham	211	-	BELAUGH	100%	211	2,425	2,214	19	100%
RPA4	Acle	241	-	ACLE-DAMGATE LANE	100%	241	0	-241	-241	107%
RPA5	Hingham	148	-	WYMONDHAM	100%	148	4,602	4,093	1,343	89%
RPA6	Diss	537	-	DISS	100%	537	6,546	6,009	6,009	46%
RPA7	Harleston	779	-	HARLESTON	100%	779	1,791	1,012	1,012	74%
RPA8	Loddon	323	-	SISLAND	100%	323	1,591	1,268	1,268	72%
Norwich City	Norwich City	8,911	-	WHITLINGHAM	100%	8,911	29,506	19,007	-440	100%
Total		**39,699**	**25,000**			**39,699**				

AWS Capacity Assessment

3.2.17 Immediately prior to the final reporting of the GNDP Stage 2b WCS, Anglian Water undertook a separate wastewater capacity analysis for proposed growth within the Greater Norwich area as part of their business planning up to 2031. Their analysis goes beyond that undertaken for the GNDP WCS, factoring for a declining occupancy rate and water consumption rate throughout the plan period.

3.2.18 The AWS forecast up to 2026 is provided in Table 3-4. This assumes that approximately 38,154 dwellings will be built between 2009 and 2026, compared to the GNDP planned maximum allocation of 39,519 dwellings. The analysis shows that both Aylsham and Long Stratton WwTW will exceed their current DWF consents.

3.2.19 AWS have stated that a growth scheme is planned for Aylsham in AMP5 (by 2015) to address the capacity issues, whilst a scheme is expected to be required in AMP6 (by 2020) to address the growth at Long Stratton WwTW.

3.2.20 The AWS and the initial GNDP WCS wastewater strategies have been compared to identify whether they are broadly aligned (Table 3-5). The Key differences have been listed below and in each case a justification for which of the strategy figures have been taken forward as the capacity figures to use in the final wastewater strategy.

- both strategies concur that there is sufficient capacity (within existing consents) at the following WwTW to take the growth associated with PGAs to be connected; therefore, for these works the initial GNDP WCS assessment has been taken forward into the final wastewater strategy:
  - Belaugh (RPA 3 100% & NPA3a 53%);
  - Poringland (NPA4 80%);
  - Swardeston-Common (NPA5 100%);
  - Wymondham (NPA7 100%);
  - Harleston (RPA 7 100%); and
  - Sisland (RPA 8 100%).
- no information pertaining to Diss WwTW was provided by AWS (an additional 537 dwellings planned for RPA6 which the WCS is proposing is treated at Diss WwTW). The initial GNDP WCS assessment calculates capacity, therefore this has been taken forward into the final wastewater strategy;
- the AWS strategy states that more growth is going to Whitlingham than considered in the GNDP WCS, and even with this additional growth have assessed that there is sufficient capacity at the works to treat the proposed growth because of reducing occupancy rates and increased water efficiency. Therefore, for the purposes of this study, it has been assumed that there are no constraints in terms of diverting the proposed flows to Whitlingham WwTW from the proposed growth in GNDP based on the wastewater strategy described in Section 3.2.10 onwards;
- both strategies concur that there is insufficient capacity at Long Stratton to accommodate growth within the existing consent. As a worst case assessment (less capacity), the initial GNDP WCS assessment has been taken forward into the final assessment;

- in addition to Long Stratton, the initial GNDP WCS assessment states that there is insufficient capacity at the following works:
    - Stoke Holy Cross (20% NPA4);
    - Acle (100% RPA4); and
    - Reepham (100% RPA1);
- however the AWS states that there is sufficient capacity if reductions in water use and lower occupancy rates are considered at these WwTW. Despite this, the GNDP growth strategy requires more dwellings to be connected to the WwTW when compared to the AWS strategy (111, 167 and 163 more respectively) therefore it is considered that the initial GNDP WCS assessment is a closer reflection of the actual capacity constraints at the site and have been used in the final strategy on a precautionary basis[7]; and
- the AWS strategy suggests that there is insufficient capacity at Aylsham WwTW (100% RPA2); however, the GNDP growth strategy is requires 163 less dwellings to be connected to this WwTW and hence the initial GNDP WCS assessment is a closer reflection of the actual capacity constraints at the site and have been used in the final strategy on a precautionary basis.

3.2.21 In summary, the initial GNDP WCS assessment has been taken forward to the final strategy with the exception of Whitlingham WwTW, where the GNDP WCS assessment figures are used, but it is considered that because AWS has assessed more growth and calculated sufficient capacity, there is likely to be capacity within the existing consent to accommodate all flows which are proposed to be transferred there as part of the strategy.

[7] In the case of Reepham, there is a 300m3/d different between the the consented DWF limit at the flow at which AWS state that a new consent is required. In theory, there is a large amount of ‘headroom’ in the consent.

Table 3-4: WwTW Dwelling Capacity – AWS Assessment

Name	DWF Consents		Current DWF Estimates		Future DWF Estimates		
	2010 DWF Consent (m3/d)	"Headroom" flow at which DWF consent required (m^3/d)	2008 Measured DWF (m^3/d)	2009 Estimated DWF (m^3/d)	Approx No. new Dwellings to 2026	2026 Predicted DWF (m^3/d)	2026 DWF as percentage of flow "headroom"
ACLE-DAMGATE LANE	1,189	1,189	775	1,079	74	987	83%
AYLSHAM	1,440	1,440	1,150	1,338	763	1,665	116%
BELAUGH	2,273	2,273	1,401	1,670	163	1,465	64%
DISS	4,032	4,032	1,678	-	-	-	-
HARLESTON	1,392	1,392	748	838	916	1,150	83%
LONG STRATTON	1,200	1,200	686	797	2,106	1,466	122%
PORINGLAND	930	930	660	759	747	848	91%
RACKHEATH	426	359	56	264	34	296	82%
REEPHAM	1,889	1,574	882	1,574	78	1,478	94%
SISLAND	1,600	1,600	1,028	1,035	229	1,253	78%
STOKE HOLY CROSS	560	467	506	506	66	461	99%
SWARDESTON-COMMON	1,100	1,100	715	715	604	758	69%
WHITLINGHAM TROWSE	66,250	66,250	55,639	55,639	29,647	57,151	86%
WYMONDHAM	4,400	4,400	2,746	2,746	2,726	3,111	71%
TOTAL					**38,154**		

Table 3-5: Difference in AWS and GNDP WCS Wastewater Strategies

Name	AWS Approx No. new Dwellings to 2026	GNDP WCS Proposed No. Dwellings to 2026	Difference Between Strategies (GNDP compared to AWS)
ACLE-DAMGATE LANE	74	241	167
AYLSHAM	763	600	-163
BELAUGH	163	2,406	2,243
DISS	-	537	537
HARLESTON	916	779	-137
LONG STRATTON	2,106	1,927	-179
PORINGLAND	747	709	-38
RACKHEATH	34	0	-34
REEPHAM	78	241	163
SISLAND	229	323	94
STOKE HOLY CROSS	66	177	111
SWARDESTON-COMMON	604	503	-101
WHITLINGHAM TROWSE	29,647	28,258	-1,289
WYMONDHAM	2,726	2,898	172
TOTAL	**38,154**	**39,699**	**1,546**

3.3 Wastewater Strategy - Environmental Assessment

3.3.1 As well as optimising the wastewater strategy from a treatment perspective, it was essential to ensure that the strategy could achieve compliance with the WFD water quality standards for the receiving watercourses as well as assessing the potential impact of the strategy against the Habitats Regulations and protected sites.

Water Framework Directive Compliance

3.3.2 In order to determine what is required from the future discharges in terms of their treated quality, it was important to undertake an assessment of the existing quality of the receiving watercourses in relation to the classifications of watercourses under the WFD.

3.3.3 The WFD is the most significant piece of water legislation since the creation of the EU. Over the next two to three years, the existing statutory targets and legislation relating to water quality will be replaced with a new set of water quality standards under the WFD which was passed into UK law in 2003. The competent authority responsible for its implementation is the Environment Agency in England and Wales. The overall requirement of the directive is that all water bodies in the UK must achieve “good status” by 2015 unless there are grounds for deferring this until 2027.

3.3.4 The WFD also combines the water quality standards with standards for water resources, water availability, hydromorphology (i.e. habitat availability) and groundwater status with ecological requirements.

3.3.5 The delivery of the WFD will be achieved by a series of management plans within each EU member state. The Environment Agency has therefore separated England and Wales into a series of 'management basins' and each has its own plan called a River Basin Management Plan (RBMP). The GNDP study area and its water bodies are included within the Anglian RBMP.

3.3.6 Broadly, the RBMPs undertake the following for different water bodies (river, lake, aquifer, canal or coastal water) within the plan area:

- set out the standards (developed nationally) for each parameter that need to be met in each water body in order to achieve different levels of status (for water quality, this covers high, good, moderate, bad or poor status);
- classify the overall status of each water body, and provide classifications broken down into each status type (ecology, biology, chemical, water resource etc);
- for water bodies not meeting 'good overall status' determine what 'measures' are required in order to improve the overall status of each water body. This leads to the determination of a 'programme of measures' (POMs) which need to be implemented in order to allow good status to be reached for each water body by 2015 (or later if there are grounds for derogation); and
- determine which water bodies are 'heavily modified' (HMWB) or artificial (AWB) and hence only need to meet a status of 'good potential'. This specific status acknowledges that there are anthropogenic pressures on, or modifications to some water bodies that prevent good status being met and that it would be too cost prohibitive (or detrimental to water body users) to remove the barriers that prevent attainment of good status.

3.3.7 The final Anglian RBMP (released 22nd December 2009) has been incorporated into this Stage 2b WCS.

3.3.8 An important aspect that had to be considered in this assessment is the policy requirement of the WFD that there is a presumption against any development that would cause a deterioration within a classification status of a waterbody (i.e. a reduction in a river classification from high status to good status as a result of a discharge would not be acceptable, even though the overall target of good status as required under the WFD is achieved). Also, development must not prevent future attainment of 'good status', hence it is not acceptable to allow an impact to occur just because other impacts are causing the status of a water body to already be moderate or less. This is on the basis that the POMs may remove the existing barrier to attainment of good status and the development impact then may become the limiting factor.

3.3.9 Further detail on the WFD, the Anglian RBMP and the context of the rivers within the study area is provided in Appendix F: Water Framework Directive Detail. The following sections discuss specifically the attainment of the WFD water quality standards in relation to the additional discharges likely under the proposed wastewater strategy.

WFD Baseline

3.3.10 The water quality of the receiving watercourses has been assessed against the proposed WFD standards for rivers where data has been provided by the Environment Agency. For all other watercourses the assessment from the Anglian RBMP has been used to indicate the current water quality in the watercourses likely to be impacted by increase in WwTW discharges. Figure 3 (Appendix A) provides a visual representation of the current classification of the watercourses under the WFD.

3.3.11 Water quality monitoring information was provided by the Environment Agency and this has been examined to ensure there were no significant outliers, and the data period was restricted (in the majority of cases between 2004 - 2008) to provide a representative dataset of the current water quality situation and ensure reliability and robustness in the derived summary statistics.

Water Framework Directive Standards

3.3.12 The UKTAG proposed standards for lowland and high alkalinity typology water are provided in Table 3-6. All the assessed water bodies within the area are classified as 'lowland and high alkalinity' typology waters and therefore these standards will apply to these water bodies.

Table 3-6 Proposed WFD Standards for Lowland and High Alkalinity Typology Waters

Proposed WFD Targets (Upland and Low Alkalinity)				
Determinand	HES (mg/l)	GES (mg/l)	MES (mg/l)	PES (mg/l)
BOD (90%ile)	4	5	6.5	9
Ammonia (90%ile)	0.3	0.6	1.1	2.5
Dissolved Oxygen (DO) (10%ile)	70	60	54	45
Orthophosphate (Mean)	0.05	0.12	0.25	1

3.3.13 The River Bure, Blackwater Drain, River Tas, Intwood Stream and the River Yare (Tidal) are classed as 'Heavily Modified' (HMWB), with part of the River Bure (near Acle) classed as 'Artificial' (AWB). These water bodies have been modified to facilitate land drainage, navigation, urbanisation and reduce flood risks. These modifications have enabled urban development on land adjacent to rivers and continue to safeguard that development from flooding and subsidence. For example, many stretches of rivers in urban areas have been straightened and deepened for land drainage and flood protection and their banks and riparian zones strengthened to prevent lateral erosion.

3.3.14 The majority of ecological determinands fall within the high status category for most rivers in the study area, and it is phosphate, often classed as 'Poor', which results in the overall classification of 'Moderate'. Even with proposed POMs it is unlikely that the phosphate concentrations will be sufficiently lowered by 2015 to reach 'good ecological status'. The phosphate standards are particularly onerous and will require a range of planned and further measures and/or controls for point and diffuse sources[8]. However, it should be noted that further investigations may be required to assess whether the higher recorded concentrations of phosphates are actually having negative impacts on the natural environment.

3.3.15 The Anglian RBMP identifies that the watercourses affected by proposed increases in discharge from growth in Norwich are targeted to achieve 'good ecological status' or 'potential' by 2027.

3.3.16 Within the Broadland Rivers Catchment as a whole, 39km (8%) of river length assessed are currently achieving good ecological status or potential. The elements most commonly preventing good status in all water bodies by 2015 are phosphorous, invertebrates and dissolved oxygen.

[8] Diffuse pollution refers to polluting activity that has no specific point of discharge (e.g. runoff from agricultural fields), whereas point sources come from activities that have a known point of discharge which is often monitored and consented (e.g. wastewater treatment effluent discharge) or is known about but not strictly monitored (e.g. CSO discharges).

Measures proposed are expected to result in there being 44km of river length at good ecological status or potential by 2015, and all water bodies achieving good status or good potential by 2027. The actions proposed will reduce phosphorous (and result in class improvement i.e. from poor status to moderate status) in 194km of rivers in the catchment.

3.3.17 Further investment would be required in the total Broadland River catchment to manage input of Phosphate to the river from both diffuse sources (i.e. that running off from agricultural land) and point sources (i.e. that coming from treated discharges, both from WwTWs and industrial processes); in all likelihood, there will be a requirement for further Phosphate reduction for the WwTWs current consented discharge, over and above that currently required under the UWWTD and as proposed under the Habitats Directive.

3.3.18 The assessment shows that Ammonia and BOD is typically of good or high status in the majority of the rivers (Table 3-7). This will mean that the more onerous 'high ecological status' will need to maintained when additional wastewater is discharged into the receiving watercourse and is likely to require tightening of consents at WwTWs discharging to the headwaters or upper reaches of rivers.

3.3.19 Dissolved Oxygen concentrations within the River Waveney and River Chat catchments are assessed as being less than good status and future discharges into these watercourses will need to ensure that they do not deteriorate exiting water quality and help contribute to the improvement of the watercourse to 'good ecological status'.

3.3.20 The only current legislative driver that specifically states standards for point sources of Phosphate is the Urban Wastewater Treatment Directive (UWWTD) which requires limitations based on whether a WwTW discharges into a designated Sensitive Area (Eutrophic); however, this is not directly based on a target concentration for the river and only limits discharge from large WwTWs with population equivalent (PE) greater than 10,000 (2 mgl-1 limit – annual average) or 100,000 (1 mgl-1 – annual average).

3.3.21 Currently, five of the WwTW considered in this study have P discharge limitations:

- Whitlingham and Alysham WwTWs are consented for a discharge of 1mg/l P (mean);
- Diss and Rackheath WwTW both have a discharge limit of 2mg/l (mean); and
- P stripping has also been initiated at Wymondham under the Habitats Directive driver in AMP4 (2005 to 2010) to limit discharge of P to 1mg/l (mean).

3.3.22 The Review of Consents (RoC) process undertaking as part of the Habitats regulations requirements has identified WwTWs were there is a requirement to remove more Phosphorous than required by the UWWTD in order to maintain acceptable in-stream P concentrations for ecology (for more information on the Habitats Regulations, see section 3.3.24 onwards). The improvement schemes have been included within the Environment Agency's National Environment Programme (NEP) to identify schemes to be funded by water companies as part of PR09. P stripping schemes at Harleston, Long Stratton, Reepham and Sisland WwTW have been identified to limit discharge of P to 1 mg/l (mean); in the majority of cases, these are expected to be completed by 31 December 2012.

3.3.23 The results of the current waterbody classification are shown in Table 3-7 and shown visually in Figure 3.

Table 3-7: WFD Assessment of Environment Agency Monitoring Results

WwTW Name	Receiving Watercourse	RBMP Assessment				Monitoring Results Assessment					
		Designation	Current Overall Status	Current Ecological Status	Current Chemical Status	Water Quality Monitoring Point u/s	Water Quality Monitoring Point d/s	BOD	Ammonia	Dissolved Oxygen	Ortho-phosphate (P)
ACLE-DAMGATE LANE	RIVER BURE	AWB *Land Drainage*	Moderate	Moderate	N/A	-	-	High	High	Good	Good
AYLSHAM	RIVER BURE	HMWB *Navigation, Urbanisation*	Moderate	Moderate	Fail	BUR070	BUR080	High	High	High	High
BELAUGH	RIVER BURE	HMWB *Navigation, Urbanisation*	Moderate	Moderate	Fail	BUR80	BUR120	High	High	High	High
DISS	RIVER WAVENEY	-	Moderate	Moderate	N/A	WAV020	WAV040	High	High	Poor	Moderate
HARLESTON	RIVER WAVENEY	-	Moderate	Moderate	N/A	WAV100	WAV110	High	High	Moderate	Bad
LONG STRATTON	HEMPNALL BECK	-	Moderate	Moderate	N/A	-	TAS070	High	High	Good	Poor
PORINGLAND	RIVER CHET	-	Poor	Poor	Good	-	CHT004	High	Good	Moderate	Bad
RACKHEATH	DOBBS BECK, TRIB OF RIVER BURE	HMWB *Land Drainage*	Moderate	Moderate	N/A	-	-	High	Good	Good	Good
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	HMWB *Land Drainage*	Moderate	Moderate	N/A	-	-	High	High[9]	High	Good
SISLAND	TRIB OF RIVER CHET	-	Poor	Poor	Good	CHT004	CHT010	High	Good	Bad	Poor
STOKE HOLY CROSS	RIVER TAS	HMWB *Flood Protection, Land Drainage, Urbanisation*	Moderate	Moderate	N/A	TAS084	TAS110	High	High	High	Poor
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF YARE	HMWB *Flood Protection, Land Drainage, Urbanisation*	Moderate	Moderate	N/A	-	YAR150	High	High	High	Poor
WHITLINGHAM TROWSE	RIVER YARE	HMWB *Land Drainage*	Moderate	Moderate	N/A	YAR190	YAR200	High	High	High	Moderate
WYMONDHAM	RIVER TIFFEY	-	Moderate	Moderate	N/A	TIF050	TIF065	High	Good	High	Poor

WFD Classification Status/Potential					
High	Good	Moderate	Poor	Bad	N/A – Does Not Require Assessment

[9] Listed as High in RBMP update but only Good in Assessment of EA data

Habitats Directive Compliance

3.3.24 In addition to compliance with the Water Framework Directive, WCS should also be compliant with the requirements of the Conservation (Natural Habitats &c) Regulations 1994 (as amended), which interprets the EU Habitats Directive into English law.

3.3.25 The Regulations require land use plans to take steps (through a Habitat Regulations Assessment) to ensure that a policy framework exists to enable their implementation without adverse effects (either alone or in combination with other plans and projects) on internationally designated wildlife sites, specifically Special Protection Areas (SPA), Special Areas of Conservation (SAC) and, as a matter of UK Government policy, sites designated under the Convention on Wetlands of International Importance 1979 ('Ramsar sites').

3.3.26 Since WCS inform Core Strategies and other local authority DPDs it is essential that the WCS takes account of the thresholds above or below which damage to international wildlife sites will occur when devising water supply or wastewater treatment solutions.

3.3.27 In the case of the GNWCS, it was identified during Phases 1 and 2a that the River Wensum SAC and Broads SAC/Broadland SPA (specifically the Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI) are those sites for which the development covered by the WCS may lead to adverse water quality effects since these sites are hydrologically connected to the three watercourses that would be most likely to receive treated effluent – the River Wensum, the River Yare and the River Bure.

3.3.28 Water quality background and trends for the Wensum SAC, Broads SAC & Broadland SPA (Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI) along with details of the species or habitats for which the sites have been designatesd are included in Appendix C: Stage 3 RoC Detailed Findings. A brief summary of the sites is included below.

3.3.29 These sites have the potential to be affected by discharges from the wastewater strategy and hence need to be considered in detail. In addition, the River Yare ultimately drains into Breydon Water SPA and Ramsar site; as such there is the potential for adverse 'in combination' effects when Greater Norwich is considered cumulatively with other new development that discharges to watercourses draining to Breydon Water.

River Wensum SAC

3.3.30 The Wensum SAC was designated for:

- Floating Vegetation of *Ranunculus* of plain and submontainous rivers;
- Bullhead;
- Brook lamprey;
- White-clawed crayfish; and
- Desmoulin's whorl Snail

3.3.31 In terms of discharge consents, the following conclusions can be drawn from the Environment Agency's assessment which is pertinent to the Greater Norwich WCS:

- At least 18 of the existing consented discharges could not be ruled out as having no adverse impact (either alone or in combination) on the SAC. All of these consents will be reviewed as part of Stage 4;
- The key impacts are in siltation, discharge of toxic substances and phosphorus (P)
- The Wensum is not reaching the required Water Framework Directive (WFD) P target as set out by the UK's Technical Advisory Group (UKTAG) for the WFD for SAC rivers and that this is the case upstream of the SSSI as well as through the SAC component; and
- Any proposed discharges to the Wensum, both upstream and within the SAC as a result of new development is likely to prove difficult to consent without very high levels of treatment, because measures are required to ensure that the existing condition is improved to further protect the SAC.

The Broads SAC/Broadland SPA (Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI)

3.3.32 The Broads SAC was designated for:

- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
- Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
- Otter *Lutra lutra*
- Desmoulin`s whorl snail *Vertigo moulinsiana*
- Transition mires and quaking bogs
- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
- Alkaline fens
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (Alno-Padion, Alnion incanae, Salicion albae)
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)
- Fen orchid *Liparis loeselii*

3.3.33 The Broadland SPA was designated for:

- Breeding and wintering bittern Botaurus stellaris and marsh harrier Circus aeruginosus;
- Wintering Bewick's swan *Cygnus columbianus bewickii*, ruff *Philomachus pugnax*, whooper swan *Cygnus cygnus*, gadwall *Anas strepera*, pink-footed goose *Anser brachyrhynchus* and shoveler *Anas clypeata*; and
- Supporting more than 20,000 wintering waterfowl (irrespective of species) every year.

Yare Broads & Marshes SSSI

3.3.34 The broads within the Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI are hydrologically linked to the River Yare and Bure respectively such that poor water quality (e.g. elevated phosphate levels) in either river will lead to elevated phosphate levels within the relevant SSSI and thus an adverse effect on the integrity of the Broads SAC.

3.3.35 The Yare is a floodplain site, open to the river running through it and most areas and habitats are not protected from inundation by flood banks. Phosphorous is also believed to be the key nutrient limiting plant growth in Broadland.

3.3.36 Monitored P concentrations in the River Yare are 0.229 mg/l Orthophosphate and at fully licensed conditions are predicted to be 0.266 mg/l for Orthophosphate; these translate to 0.286 and 0.333mg/l total P. Monitoring results from the outflow from Rockland Broad show concentrations of 0.237 mg/l total P. All these results are well above the target for natural eutrophic lakes target of 0.1mg/l and 0.05mg/l.

3.3.37 However the site itself is a freshwater element here and hence a more applicable threshold to use would be the 0.1mg/l target for natural eutrophic lakes (Surlingham Broad and Rockland Broad) of 0.1mg/l for ditches and 0.05mg/l P for the lakes and broads themselves and 0.03 mg/l for the hard oligomesotrophic lakes.

3.3.38 Mean orthophosphate values in the River Yare (1998-2005) exceed the guideline value at five of the six sites. Consented discharges are implicated. The Environment Agency has confirmed that the Yare Broads & Marshes SSSI is 'at capacity' for the orthophosphate proportion arising from point sources under fully-consented conditions. For example, the proportional contribution of point sources to OP loads at the Review of Consents baseline has been calculated as 83%.

3.3.39 Mean orthophosphate values in the River Yare exceed the threshold values for natural eutrophic lakes and also the value used for estuaries in the UK to define "enriched". Approximately 55% derives from consented water company discharges.

Bure Broads & Marshes SSSI

3.3.40 The Bure Broads & Marshes SSSI is currently exceeding its nutrient targets: 42% of the nutrients impacting the SSSI site are from point sources, while 58% are from diffuse pollution. Currently fully consented discharges allow 0.029mg/l Ortho Phosphate (exceeding the Natura 2000 targets). Moreover, it is understood that all the major WwTWs in the Bure valley are already at the limits of Best Available Technology.

3.3.41 It has been identified that similar concerns apply for the Broads SAC/Broadland SPA & Ramsar site more generally. Considerable constraint is posed on environmental capacity arising from downstream elements of the Broads SAC/ Broadland SPA & Ramsar site, specifically Cantley Marshes SSSI and Hardley Flood SSSI, which are also 'at capacity' for the orthophosphate proportion arising from point sources under current fully-consented conditions.

Breydon Water SPA & Ramsar site

3.3.42 Breydon Water is designated as a Special Protection Area for its populations of breeding common tern *Sterna hirundo* and wintering Bewick's swan *Cygnus columbianus bewickii*, avocet *Recurvirostra avosetta* and golden plover *Pluvialis apricaria*. It is also designated for supporting more than 20,000 waterfowl each winter. The site was designated as a Ramsar site for the same reasons.

3.3.43 The following screening criteria are available from the Environment Agency document 'Applying the Habitats Regulations to Water Quality Permissions to Discharge: Review and New Applications 114_05':

- Within site - all discharges

- Within 3 km - all discharges
- Within 10km - all sewage or trade discharge greater than 5 m^3/day
- Within 50 km - all discharges greater than 1000 m^3/day.
- Beyond 50 km - there may be special cases to take into account but generally discharges beyond this distance should be discounted.

3.3.44 Since Whitlingham STW discharges into the River Yare, and has a total discharge considerably greater than 1000 m^3/day the discharge point is well within 50km of Breydon Water, impacts on this site must also be considered.

Habitats Regulation Assessment

3.3.45 The WCS will need to ensure that any solutions that are proposed which potentially affect the River Wensum, River Yare or River Bure as a result of discharges are such that they will enable the Broads SAC/Broadland SPA to comply with the need to keep to the following thresholds:

- A minimum of 0.1mg/l total Phosphorous or below for ditches/dykes; and
- A minimum of 0.05 mg/l total Phosphorous or below for lakes.

3.3.46 The bird interest of Breydon Water SPA does not have specific water quality standards set for Review of Consents purposes since they are not directly dependent on water quality. In general they do require good water quality but the habitats they utilise are not as reliant on nutrient sensitive habitats as the interest features of The Broads SAC/Broadland SPA. Standards to ensure compliance with the Habitats Directive with regard to The Broads SAC/Broadland SPA should also therefore be adequate to ensure compliance for Breydon Water SPA & Ramsar site.

3.3.47 The RoC process assessed each of the current discharge consents as if they were operating to their maximum consented volume and quality. From this process, it determined which of the current WwTW consents needed to be altered in order for compliance with the downstream P limits as described above to be met in the catchment. These consent changes were included in the Environment Agency's National Environment Programme (NEP) which informs water companies as to the key sites at which improvements to their assets are required in order to meet Environmental legislative drivers. AWS included the relevant NEP schemes in their business plan for AMP5 and will be implementing these schemes in the AMP5 investment cycle (2010 to 2015). These schemes are described in Table 3-8 under 'nutrients'.

3.3.48 The conclusion from this process was that as long as the revised consents are implemented and the flow conditions of other existing consents at other WwTW are not exceeded, then compliance with downstream targets for P could be met and the growth as described in the WCS would have no adverse impact.

3.3.49 Growth at each of the WwTW has the potential to increase consented flows and hence increase the load of P discharged to the Broadland catchment. The assessment work undertaken for the WCS to date has determined that consented flow increases are required at the WwTWs of Acle, Long Stratton, Reepham, and Stoke Holy Cross. The increases in flow above current consents will lead to an increase in overall P load from these works, over and above the limit which was assessed as part of the RoC.

3.3.50 Mitigation is therefore needed at these four specific sites to protect the downstream HD sites as indentified and the proposed solution to this is described in the following sections. Mitigation proposed is to propose measures that help to ensure that there is no overall increase in P load as a result of increases in treated wastewater flow by improving further the quality of the discharge through tighter consents.

Environmental Impact Assessment Results

3.3.51 The following section sets out the implications of meeting the requirements of both the WFD and the HD, and what changes may be required to the quality consents of the discharges as a result of growth, in order to achieve compliance. It includes a discussion as to whether the required mitigation is likely to be achievable within Best Available Technology Not Entailing Excessive Costs (BATNEEC).

AWS committed upgrades

3.3.52 Before considering changes required as a result of growth, it is important to consider changes imposed as a result of discharges from current WwTW operations. The stringent requirements of the WFD and the Habitats Regulations are such that the impact of discharges from the current consent (used at its maximum) is preventing the targets of both pieces of legislation from being met. As a result, several schemes (and investigations) are planned in AMP5 to rectify this or find solutions to the problem.

3.3.53 Anglian Water's Periodic Review 2009 and the Environment Agency's RBMP and National Environment Programme (NEP), has identified the measures provided in Table 3-8 to address current water quality related issues in the Broadland River Catchment that would impact upon the Greater Norwich WCS and proposed development. These improvements are as a result of the RoC process and the WFD assessment work undertaken to date at a catchment level.

Table 3-8: Water Industry Specific Measures to Address Water Quality Impacts from Point Sources up to 2015 (as identified in the Draft Anglian RBMP)

Pressure	Description of the Action			Means of Delivery	Driver for Actions
	What Will Happen	When By	Where		
Nutrients	Improvement to polluting discharge (continuous) at Sisland (Loddon) WwTW. Harleston WwTW, Reepham WwTW, and Long Stratton WwTW, as identified by the Review of Consents (not funded under PR04) and agreed by the conservation agencies and the Environment Agency, to remove more phosphorous than required by the UWWTD to protect downstream ecological sites including: • Hardley Flood SAC (Sisland WwTW) • Stanley and Alder Carrs, Geldeston Meadows, Spratts Water and Marshes SACs (Harleston WwTW) • River Wensum SAC (Reepham WwTW) • Yare Broads, Rockland Broad SAC (Long Stratton WwTW) Proposed P consent of 1 mg/l.	2012/ 2015 (Sisland)	Anglian RBD – Broadland Rivers. WwTW identified: • Sisland • Harleston • Reepham • Long Stratton	PR09	Habitats Directive – H1

Organic Pollutants, Nutrients	Improvement of polluting discharge (continuous) at Rackheath WwTW, Acle WwTW and Wymondham WwTW to ensure no deterioration in existing river quality as a result of increased volumes of discharge. • Rackheath WwTW – New proposed consents of 426 m3/d DWF, 11 mg/l BOD and 3mg/l Ammonia • Acle WwTW – New proposed consents of 1,189 m3/d DWF, 29 mg/l BOD and 13mg/l Ammonia	2015	Anglian RBD – Broadland Rivers WwTW identified: • Rackheath • Acle	PR09	WFD – FLOW1
Priority Pollutants & Hazardous substances	Investigations to quantify risk from chemicals in discharges through effluent screening (higher density) at Long Stratton WwTW as identified during Review of Consents process, to protect downstream Yare Broads and Rockland Broad SAC.	2011	Anglian RBD – Broadland Rivers WwTW identified: • Long Stratton	PR09	WFD – C1a
Nutrients	Improvement of polluting discharge (continuous) at Whitlingham WwTW	2008	Anglian RBD – Broadland Rivers WwTW identified: • Whitlingham	AMP4	UWWTD

Water Quality Capacity Assessment - Methodology

3.3.54 In order to ensure that the additional treated wastewater discharge as a result of proposed development in the GNDP study area has limited impact on the water quality of the receiving watercourses and to consider the impact against the targets of the WFD and HD, indicative quality discharge consent standards have been calculated for the WwTW based on the current proposed growth in the study area and in line with the wastewater strategy (see Section 3.2.9 onwards).

3.3.55 Simple mass balance Monte Carlo simulations have been undertaken using the Environment Agency's River Quality Planning (RQP) tool (v2.5). This provides an indication of the degree of change required in consent standards in order to achieve compliance with WFD standards and legislation assuming the full planned growth within the GNDP study area. The calculations were undertaken using upstream water quality and flow information, as provided by the Environment Agency, where available. The data used for the RQP modelling is provided in Appendix G: WwTW Quality Consent Calculations.

3.3.56 The required downstream water quality standards that need to be achieved under the WFD are provided in Table 3-9. For the HD, no increase in P load above existing maximum consents conditions must occur to ensure that there is no adverse impact.

3.3.57 For the majority of WwTWs upstream and downstream monitoring information was available (see Appendix G: WwTW Quality Consent Calculations). Where this monitoring information was unavailable or where the upstream water quality was shown to be less than 'good', it was agreed with the Environment Agency, that it should be assumed that the upstream quality achieves WFD Status 'Good' and the midpoint values from this class should be used in modelling the required consents. This assumes that all measures have been taken upstream to achieve 'good ecological status' or 'potential' so as not to unduly penalise the water company through potentially poor upstream quality. In reality, in some catchments there may be little opportunity to reduce other inputs in order to meet good status, in which case further modelling may need to be undertaken and the assumptions used within this assessment reviewed. As such, the consent standards derived from this process should be regarded as indicative only. The water quality results for the upstream and downstream monitoring sites, and where appropriate, the mid-class estimates for 'good' or 'high' ecological status used for the water quality assessment are provided in Appendix G: WwTW Quality Consent Calculations.

3.3.58 All scenarios include for revised consents introduced under the NEP for AMP5 to address increases in flow consents and/or compliance with Habitat's Directive.

Modelling Scenarios

3.3.59 Indicative consents have been modelled for five scenarios, which vary in the restrictions placed on the consents according to compliance with Environment Agency consenting policy as well as compliance with WFD and Habitat's Directive[10] (HD) targets (see Table 3-10).

3.3.60 A broad range of modelling scenarios have been undertaken for several reasons.

3.3.61 It is clear that with the significant level of growth proposed in the study area, there will be a significant increase in polluting loads (BOD, Ammonia and P) as a result of the additional generation of wastewater.

3.3.62 One of the objectives of the WCS is to show how growth can be accommodated without negatively impacting on compliance of watercourses with the WFD. However, the WFD baseline assessment described in the WCS demonstrates that the watercourses in Norfolk are already struggling to meet the stringent water quality targets as set by the WFD due to a variety of polluting sources, including from agricultural diffuse sources. Therefore, further additions of polluting load are likely to exacerbate this problem. Meeting WFD targets at every location within a watercourse (including immediately downstream) of a discharge point would require the majority of existing consents to be tightened even before the impact of growth is considered. It would therefore be unduly onerous both on AWS and the GNDP to suggest that as a result of growth, all WwTW discharge consents need to be altered in order to meet WFD compliance at every assessment point. In many cases, compliance with WFD targets may only be possible by considering a downstream point to allow for dilution and attenuation of pollutants from point discharges, and allowing for changes in quality upstream that are dependent on other catchment measures (such as changes in agriculture) taking place in future years.

3.3.63 Further, the Environment Agency has reviewed existing discharges as a result of the RBMP process under the WFD and has put forward priority discharges it considers need to be altered in order to move the worse affected watercourse towards compliance between 2015 and 2027. As described, these sites were included within AWS's recent business plan and several of these schemes are to go ahead in the next AMP5 period (2010 to 2015) – see Table 3-8. The remaining WwTW consents are not within the priority list and as such the capacity in these consents can be used to accommodate growth without requiring a change in quality conditions. Any deterioration in water quality as a result of using an existing consent to its current limit has been planned for by the Environment Agency and as such is termed 'planned deterioration'. For the purposes of this WCS, this scenarios is referred to as the 'planned consented scenario'.

[10] Compliance with the Habitat's Directive relates to Phosphorous only and must ensure that there is no net increase in the load of P where DWF is planned to increase beyond its current DWF consent. Increases in DWF where the DWF consent will not be exceeded can be ignored as the full consent limits will have already been assessed under the Review of Consents (RoC).

3.3.64 Further to this, compliance with WFD and HD targets in several cases is likely to require such stringent consents that the treatment process required to achieve them are, in general, not considered to be available at a cost which is not excessive or too energy intensive (BATNEEC). It is therefore important to show what can be achieved within the limits of BATNEEC.

3.3.65 Several scenarios have therefore been modelled between the planned consented scenario and the full compliance with the WFD targets (at every discharge point) both with and without BATNEEC compliance to show that, with flexibility, how new growth can be accommodated whilst minimising impact on the water quality of the existing environment.

3.3.66 Details of the modelling scenarios undertaken for the water quality capacity assessment are provided in Table 3-10. The results of the RQP modelling, i.e. the required consent standards for each of the WwTW for each of the modelling scenarios, are discussed in section 3.3.68 onwards.

3.3.67 This assessment is intended to provide an indication of the possible impacts the new standards might have on future wastewater discharges and water quality conditions in the GNDP study area to identify whether the discharge consents are feasible, but will be subject to future refinement based on further Environment Agency investigations and AWS's AMP programme.

Table 3-9: WwTWs and Water Quality Assessment Criteria – as provided by the Environment Agency

Name	Receiving Watercourse	WFD Target to be met Downstream to achieve Good Ecological Status and Good Ecological Potential (for AWB and HMWB)		
		BOD	Ammonia	P
ACLE-DAMGATE LANE	RIVER BURE	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
AYLSHAM	RIVER BURE	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	High – 0.05mg/l (Mean)
BELAUGH	RIVER BURE	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	High – 0.05mg/l (Mean)
DISS	RIVER WAVENEY	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
HARLESTON	RIVER WAVENEY	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
LONG STRATTON	HEMPNALL BECK	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
PORINGLAND	RIVER CHET	High – 4mg/l (90%ile)	Good – 0.6mg/l (90%ile)	Good – 0.12mg/l (Mean)
RACKHEATH	DOBBS BECK, TRIB OF RIVER BURE	High – 4mg/l (90%ile)	Good – 0.6mg/l (90%ile)	Good – 0.12mg/l (Mean)
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	High – 4mg/l (90%ile)	Good – 0.6mg/l (90%ile)	Good – 0.12mg/l (Mean)
SISLAND	TRIB OF RIVER CHET	High – 4mg/l (90%ile)	Good – 0.6mg/l (90%ile)	Good – 0.12mg/l (Mean)
STOKE HOLY CROSS	RIVER TAS	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
WHITLINGHAM TROWSE	RIVER YARE	High – 4mg/l (90%ile)	High – 0.3mg/l (90%ile)	Good – 0.12mg/l (Mean)
WYMONDHAM	RIVER TIFFEY	High – 4mg/l (90%ile)	Good – 0.6mg/l (90%ile)	Good – 0.12mg/l (Mean)

Table 3-10: Water Quality Capacity Assessment – Modelling Scenarios

Scenario	Variant	Description	Assessment Criteria					
				BOD & Ammonia		Phosphorous		
			WwTW to be assessed	WFD compliance	Limit consent to BATNEEC (5mg/l BOD & 1mg/l NH4)	WFD compliance	Limit consent to BATNEEC (1mg/l P)	HD compliance
A - Planned Consented scenario	A1: Consents limited to BATNEEC	Where volumetric consents will be exceeded, determine quality consent conditions required to achieve WFD and HD targets downstream, but limiting consents to BATNEEC. Assumes volumetric consents can be increased and no changes required where volumetric consent is not exceeded.	Only where DWF exceeds consent	✓	✓	✓	✓	×
	A2: % deterioration impact with BATNEEC	As A1, but describing what the downstream deterioration would be for determinands that are limited to BATNEEC.						
	A3: Consents beyond BATNEEC	Where volumetric consents will be exceeded, determine quality consent conditions required to achieve WFD and HD targets downstream, but **not limited** to BATNEEC Assumes volumetric consents can be increased and no changes required where volumetric consent is not exceeded.	Only where DWF exceeds consent	✓	×	✓	×	×
B - Compliance with WFD	B1: Dwelling Capacity with BATNEEC	Determine quality consent conditions assuming all watercourses need to meet WFD targets but limiting revised consents to BATNEEC	All	✓	✓	✓	✓	×
	B2: % deterioration impact with BATNEEC	As B1, but describing what the downstream deterioration would be for determinands that are limited to BATNEEC.						
	B3: Consents beyond BATNEEC	Determine quality consent conditions assuming all watercourses need to meet WFD targets but **not limiting** revised consents to BATNEEC	All	✓	×	✓	×	×

Scenario	Variant	Description	Assessment Criteria					
				BOD & Ammonia		Phosphorous		
			WwTW to be assessed	WFD compliance	Limit consent to BATNEEC (5mg/l BOD & 1mg/l NH4)	WFD compliance	Limit consent to BATNEEC (1mg/l P)	HD compliance
C - Meeting WFD with the Exception of P		Determine quality consent conditions assuming all watercourses need to meet WFD targets except for P, but limiting revised consents to BATNEEC	All	✓	✓	×	✓	×
D - WFD Deterioration - High to Good *Assumes that meeting 'good' status as opposed to 'high' as a minimum is acceptable under the policy requirements*	D1 - limited by BATNEEC	Determine quality consent conditions assuming all watercourses need to meet WFD targets but where upstream quality is 'High' allowing it to deteriorate to 'good' but also limiting revised consents to BATNEEC	All	✓	✓	✓	✓	×
	D2 - No BATNEEC limits	Determine quality consent conditions assuming all watercourses need to meet WFD targets but where upstream quality is 'High' allowing it to deteriorate to 'good' but **not limiting** revised consents to BATNEEC	All	✓	×	✓	×	×
E - Load Standstill (Compliance with HD)	E1: Consents limited to BATNEEC	Determine quality consent conditions assuming that there should be no increase in polluting load for all discharges but limiting to BATNEEC.	Only where DWF exceeds consent	✓	✓	✓	✓	✓
	E3: Consents beyond BATNEEC	Determine quality consent conditions assuming that there should be no increase in polluting load for all discharges thereby meeting HD requirements for P targets downstream.	Only where DWF exceeds consent	✓	×	✓	×	✓

Planned Deterioration

3.3.68 As described, under the planned consented scenario, only where growth results in a WwTW to exceed its current consented DWF limit is there a requirement to alter the quality conditions of the consent to attain downstream water quality compliance.

3.3.69 The wastewater strategy (see Section 3.2.10) showed that four WwTWs are likely to exceed their existing DWF consents as a result of growth planned within the GNDP study area up to 2026. For these works, it was necessary to undertake modelling to assess the consent requirements under the future planned DWF to ensure compliance with WFD and HD targets in the downstream watercourses. This is represented by the modelling runs undertaken for Scenarios A and E (see Table 3-10). For all other works, the planned growth is not expected to result in exceedence of the DWF consent, hence it has been assumed that any deterioration that occurs within the watercourses under the current consent conditions is planned for as part of the issue of that consent. This is inline with draft Environment Agency Policy that assumes that new quality consents will only be required when the WwTW exceeds its existing DWF consent (unless the WwTW consent was highlighted as a priority site in the NEP for AMP5).

3.3.70 The watercourses downstream of the WwTWs which exceed their DWF consent will need to ensure that they do not deteriorate from their current status, as identified in the draft Anglian RBMP, meaning that waterbodies currently classed as achieving 'high ecological status' will not be permitted to deteriorate from this status to 'good ecological status'[11], and those currently achieving less that 'good' status will need to improve to this status by 2015[12].

3.3.71 This assessment has considered compliance with WFD standards at the downstream point from the WwTW. The table has been colour coded to demonstrate the restrictions of the proposed new consents, based on whether they can be achieved with Best Available Technology Not Entailing Excessive Cost (BATNEEC).

Results

3.3.72 The results for each of the scenarios are displayed in Table 3-11 indicating the concentrations of determinands that the consent would need to be set at in order for the scenario objectives to be achieved. These consents are also shown visually in Figure 5a (Appendix A). Table 3-12 shows through a tick box exercise when a scenario is passed, and it fails, which determinands are limiting.

[11] Except where it can be demonstrated that the proposed measures to maintain this status would require disproportionate costs
[12] Except where it has been agreed that a 2015 is unachievable and instead a 2027 deadline has been set

Table 3-11: Water Capacity Consent Requirements for WwTW Planned to Exceed Current Flow Consent

		Acle			Long Stratton			Reepham			Stoke Holy Cross		
		BOD	NH4	P	BOD	NH4	P	BOD	NH4	P	BOD	NH4	P
Current Consent		29	13	-	20	16	1	30	10	1	50	-	-
Scenario A: Planned Consented scenario	A1	10.5	1.2	1	7	1	1	5	1	1	50	10	2.5
	A3	10.5	1.2	0.2	7	0.5	0.1	4.8	0.7	0.1	50	10	2.5
Scenario B: Compliance with WFD	B1	10.5	1.2	1	7	1	1	5	1	1	50	10	2.5
	B3	10.5	1.2	0.2	7	0.5	0.1	4.8	0.7	0.1	50	10	2.5
Scenario C: Compliance with WFD (excl. P)	C1	10.5	1.2	-	7	1	-	5	1	-	50	10	-
Scenario D: WFD Deterioration	D1	16.5	2.5	1	8.5	1.1	1	6	1	1	50	28	2.5
	D2	16.5	2.5	0.2	8.5	1.1	0.1	6	0.7	0.1	50	28	2.5
Scenario E: Load Standstill (compliance with HD)	E1	27	12	(2)	9.5	8	1	28	9.5	1	44	(17)	1.8
	E2	27	12	(2)	9.5	8	0.5	28	9.5	0.9	44	(17)	1.8
Best Case Recommended Consents		**10**	**1**	**1**	**7**	**1**	**1**	**5**	**1**	**1**	**50**	**10**	**2**

Key	No consent tightening required	Consent tightening within BATNEEC	Consent limited to BATNEEC	Consent beyond BATNEEC required

Table 3-12: Water Capacity Planning Considerations for WwTW Planned to Exceed Current Flow Consent

		Acle	Long Stratton	Reepham	Stoke Holy Cross
Planned No. Dwellings		241	1,927	241	177
Planned Employment (Jobs)		-	-	-	-
Scenario A: Planned Consented Scenario	A1	× (P)	× (NH4 & P)	× (BOD, NH4 & P)	✓
	A3	✓	✓	✓	✓
Scenario B: Compliance with WFD	B1	× (P)	× (NH4 & P)	× (BOD, NH4 & P)	✓
	B3	✓	✓	✓	✓
Scenario C: Compliance with WFD (excl. P)	C1	✓	× (NH4)	× (BOD& NH4)	✓
Scenario D: WFD Deterioration	D1	✓	× (P)	× (NH4 & P)	✓
	D2	✓	✓	✓	✓
Scenario E: Load Standstill (compliance with HD)	E1	✓	× (P)	× (P)	✓
	E2	✓	✓	✓	✓

Key	Full growth can go ahead and achieve compliance with WFD & HD	Growth limited by P Only	Full growth (with BATNEEC) cannot go ahead and comply with WFD & HD

3.3.73 In summary, the following points are noted for the planned consented scenario assuming that where flow consent increases are required, these will be consented:

- when considering the growth planned, only Acle, Reepham, Long Stratton and Stoke Holy Cross WwTWs need to have their quality consents tightened. All other WwTW would be operating within their current (or AMP5 proposed) flow consent and don't need to be altered as a result of the proposed growth. It is assumed that DWF consents can be increased at these works, but investigations would be required to ensure that this could take place without impacting on downstream habitats[13];
- Stoke Holy Cross WwTW can achieve compliance under all scenarios within the limits of BATNEEC (considered to be 5mg/l for BOD, 1mg/l for Ammoniacal-N and 1 mg/l for P). *It is recommended that a consent of 50mg/l BOD, 8 mg/l of Amm-N and 2 mg/l P would be sufficient to meet requirements of EA consenting policy, the WFD and HD.*
- Acle WwTW could achieve compliance with WFD only if limits on P are ignored (scenario C1); however, the Amm-N consents would be close to BATNEEC limits for Amm-N (1.2 Mg/l). If the status of the Bure downstream is allowed to deteriorate from High to Good (Scenario D1) the consent limits would be less stringent at 16.5mg/l for BOD and 2.5 mg/l of Amm-N. In order to comply with WFD P targets, the consent for P would need to be beyond that achievable with BATNEEC (Scenario A2) at 0.2mg/l. Achieving HD compliance would be possible by achieving a 2mg/l limit on P discharge thus ensuring no increase in overall P load discharged. *It is recommended that consent of 10mg/l BOD, 1 mg/l of Amm-N and 1 mg/l P would be sufficient to meet requirements of EA consenting policy, the WFD and HD (with the exception of WFD P requirements).*
- Achieving the required WFD at Reepham WwTW is unlikely to be possible for any determinands. The modelling indicates that consent limits of BOD, Amm-N and P would all be beyond that achievable within BATNEEC. Even allowing for a deterioration in downstream quality of the Blackwater Drain (Scenario D1) from High to Good would require Amm-N and P standards beyond BATNEEC (BOD would be achievable at 6mg/l). In order to comply with HD, a P consent of 0.9mg/l would be required; however consent of 1mg/l is likely to yield similar results as the modelling does not allow for assimilation of P through uptake via aquatic macrophytes, epiphytes and adsorption to sediment. Therefore it is considered that a consent of 1mg/l P would comply with HD requirements (but not WFD).
- Growth impacts at Long Stratton would result in similar discharge consent limitations as Reepham. The consent limits required to meet WFD targets for Amm-N and P would be beyond the limits of BATNEEC, although BOD would be achievable at 7mg/l. Allowing for a deterioration in the status of the Hempnall Beck from High to Good would require an Amm-N consent at 1.1mg/l, just within the limits of BATNEEC; however, it would still not be possible to achieve the WFD P target. Additionally, to comply with the HD a P consent of 0.5mg/l would be required and hence this is also considered not achievable within BATNEEC for the growth levels proposed.

3.3.74 Despite the non-compliance issues at Reepham, Acle and Long Stratton, there are several important points to note regarding the WwTW and the current discharges:

- Reepham's consents have been calculated based on the targets of the Blackwater Drain. The drain is a small drainage watercourse with a low flow such that during summer

[13] Stages 1 and 2a of the WCS assessed flood risk as a result of further discharge sof wastewater and deemed the impact to be insignificant.

conditions the flow is almost entirely made up of treated effluent discharge. In order to meet the instream water quality targets for the WFD during these periods, the discharge would need to be at the same concentrations as the instream targets (i.e. no dilution effects). This is not achievable with current technology (not entailing excessive costs). Consideration should therefore be given to considering targets in the downstream water course i.e. The River Wensum. Additionally, allowing a consent which sets the determinands at the limit of BATNEEC would result in an 82% improvement in downstream BOD concentrations, a 90% improvement in Amm-N concentrations and a less than 1% deterioration in P when compared to the current consent and current flow amount (see Table 3-13).

- In addition, there is a large degree of headroom built into Reepham's new flow consent. AWS figures provided immediately prior to submission of the Final Stage 2b report suggests that a new flow consent is required at Reepham when dry weather flow is 300m^3/d less than the consented limit. If the additional housing could be accommodated within this headroom, there would be no requirement to alter the quality conditions of the consent under the planned consented deterioration scenario.
- Similarly for Long Stratton, operating at BATNEEC would see significant improvements in in-stream, Amm-N concentrations; but a greater than 10% deterioration in P (See Table 3-13).

Table 3-13: Water Quality Deterioration for WwTW Planned to Exceed Current Flow Consent but Requiring Consent Tighter than BATNEEC (WFD Compliance)

WwTW	Det	Current Consent (mg/l)	Scenario B (Compliance with WFD)	
			B1	B2
			Consent (BATNEEC)	% Deterioration
Acle	P	-	1	4%
Long Stratton	NH4	16	1	90% (Imp)
	P	1	1	35%
Reepham	BOD	30	5	82% (Imp)
	NH4	10	1	90% (Imp)
	P	1	1	0%

Key	No Deterioration - Improvement	Deterioration <10%	Deterioration >10%

Meeting WFD and HD targets – All Locations

3.3.75 As previously described, meeting downstream compliance at all WwTW will require improvements at nearly all WwTW, and in many cases this would be required regardless of whether additional wastewater is being transferred to a WwTW or not. It is an important that the impact of growth is considered on WFD compliance, even for those WwTW where growth will not result in the WwTW exceeding its DWF consent as future compliance with WFD may be compromised. The Environment Agency will review all discharges again for the next AMP period (AMP6), during Price Review 2014 (PR14) and the discharge consents could be tightened again if it is deemed at this later date that WFD compliance is likely to be compromised.

3.3.76 This modelling has been undertaken for the nine WwTW not previously assessed under the planned consented scenario and results are discussed in the proceeding sections.

3.3.77 To achieve the WFD standards under future growth conditions the majority of the effluent discharge consents for sanitary determinands will need to be tightened as shown in Table 3-14 and displayed in Figure 5b (Appendix A). Based on industry standards it is considered that, although tight, most of these standards are achievable within BATNEEC and that BOD standards under the WFD can be met at each WwTW within BATNEEC. However, for Diss, Reepham WwTW[14], Swardeston and Whitlingham the Ammonia consent would need to be lower than the current BAT standard of 1mg/l. Despite this, insensitivities in the modelling would likely mean that a 1mg/l consent would meet downstream compliance.

3.3.78 It will only be possible to achieve the required WFD P standard downstream of the works within the current Best Available Technology (BAT) limit of P (1 mg/l Mean) at Belaugh (which needs to achieve 'high ecological status'). All other works will require a consent of less than 1 mg/l to achieve the proposed WFD instream standard of 0.12 mg/l (Mean) for 'good ecological status' and 0.05 mg/l (Mean) for 'high ecological status' (at Aylsham WwTW only). Under the RQP modelling process as described above, it was assumed that at worst case the upstream water quality in the receiving watercourses are at 'good ecological status' and as such there is little available 'headroom' to discharge additional effluent into the watercourse above the required watercourse quality standard of 0.12 mg/l, which is impossible with current technology.

3.3.79 In terms of Habitats Directive compliance, because none of the nine remaining WwTW will be exceeding their current (or proposed AMP5) DWF consent, and because the RoC deemed these consents to not be having a significant adverse impact on the watercourses at their maximum consented limits, treatment of wastewater as a result of growth is not expected to lead to any significant adverse impact on designated sites.

3.3.80 Table 3-16 shows where the works would comply with WFD requirements, and where it doesn't, what the limiting determinand is. Additionally, Table 3-16 shows what the percentage downstream deterioration would be if consents were limited to BATNEEC at where they are not considered achievable. There are only three WwTW where limiting consent requirements to that achievable under BATNEEC would result in a deterioration downstream of greater than the 10% as listed below:

- Harleston WwTW - 19% deterioration in P concentrations;
- Poringland WwTW – 19% deterioration in P concentrations; and
- Wymondham WwTW – 20% deterioration in P concentrations.

3.3.81 It should also be noted that this RQP assessment does not account for uptake of P once it is discharged into the natural system. It assumes that P load remains available in its soluble form as opposed to be taken up by aquatic life or adsorbing to sediment particles as is the case in reality.

3.3.82 The high level assessment presented in this study would need to be corroborated though a targeted catchment modelling study using existing SIMCAT modelling (or equivalent) to be agreed between AWS and the Environment Agency. A more detailed modelling study would identify where the additional growth is likely require tightening of the P consents as described in this section.

[14] It should be noted that there is no upstream or downstream monitoring information for the Reepham site meaning that the mid-class estimate of 0.43 mg/l (90%ile) for good ecological status was used for Ammoniacal-N. The works discharges into a small watercourse and as such there is less dilution available for the additional effluent discharge than offered at other works discharging into larger watercourses.

3.3.83 Whilst reductions in total P loads are possible, it will not be possible in all cases to ensure that the sections of watercourse immediately downstream of most WwTWs complies with the WFD standards for P within the limits of BATNEEC. This is a common position within the East of England and the UK generally with regards the WFD and is already occurring in several cases without further growth included. An agreement is required at a regional and national level as to whether the WFD should be applied in this way for areas where significant growth has been put forward in the Regional Spatial Strategies.

Table 3-14: Water Capacity Consent Requirements for WwTW Not Planned to Exceed Current Flow Consent (WFD Compliance)

		Aylsham			Belaugh			Diss			Harleston			Poringland		
		BOD	NH4	P	BOD	NH4	P	BOD	NH4	P	BOD	NH4	P	BOD	NH4	P
Current Consent		40	5	1	30	10	-	12	5	2	17	5	1	18	-	-
Scenario A: Planned consented	A1	40	5	-	30	10	-	12	5	2	17	5	1	18	-	-
	A3	40	5	-	40	10	-	12	5	2	17	5	1	18	-	-
Scenario B: Compliance with WFD	B1	40	5	1	30	10	1.1	12	1	1	9.5	1	1	7.5	1.1	1
	B3	40	5	0.2	30	10	1.1	12	0.8	0.5	9.5	1	0.4	7.5	1.1	0.2
Scenario C: Compliance with WFD (excl. P)	C1	40	5	-	30	10	-	12	1	-	9.5	1	-	7.5	1.1	-
Scenario D: WFD Deterioration	D1	40	5	4	30	10	6	12	2.3	1	17	3	1	10.5	1.1	1
	D2	40	5	4	30	10	6	12	2.3	0.5	17	3	0.4	10.5	1.1	0.2
Scenario E: Load Standstill (compliance with HD)	E1	40	5	-	30	10	-	12	5	2	17	5	1	18	-	-
	E2	40	5	-	30	10	-	12	5	2	17	5	1	18	-	-
Best case Recommended Consents		**40**	**5**	**1**	**30**	**10**	**1**	**12**	**1**	**1**	**9**	**1**	**1**	**7**	**1**	**1**

		Sisland			Swardeston-Common			Whitlingham			Wymondham		
		BOD	NH4	P	BOD	NH4	P	BOD	NH4	P	BOD	NH4	P
Current Consent		20	5	1	15	5	-	20	7	1	12	4	1
Scenario A: Planned consented	A1	20	5	1	15	5	-	20	7	1	12	4	1
	A3	20	5	1	15	5	-	20	7	1	12	4	1
Scenario B: Compliance with WFD	B1	15	2.5	1	7.5	1	1	10.5	1	1	9.5	1.8	1
	B3	15	2.5	0.3	7.5	0.7	0.2	10.5	0.7	0.3	9.5	1.8	0.2
Scenario C: Compliance with WFD (excl. P)	C1	15	2.5	-	7.5	1	-	10.5	1	-	9.5	1.8	-
Scenario D: WFD Deterioration	D1	20	2.5	1	11	1.7	1	17	2	1	12	1.8	1
	D2	20	2.5	0.3	11	1.7	0.2	17	2	0.3	12	1.8	0.2
Scenario E: Load Standstill (compliance with HD)	E1	20	5	1	15	5	-	20	7	1	12	4	1
	E2	20	5	1	15	5	-	20	7	1	12	4	1
Best Case Recommended Consents		**15**	**2.5**	**1**	**7**	**1**	**1**	**10**	**1**	**1**	**9**	**1.5**	**1**
Key		No consent tightening required			Consent tightening within BATNEEC			Consent limited to BATNEEC			Consent beyond BATNEEC required		

Table 3-15: Water Capacity Planning Considerations for WwTW Not Planned to Exceed Current Flow Consent (WFD Compliance)

		Aylsham	Belaugh	Diss	Harleston	Poringland	Sisland	Swardeston-Common	Whitlingham	Wymondham
Planned No. Dwellings		600	2,406	537	779	709	323	503	28,178	2,898
Planned Employment		-	-	-	-	-	-	-	20,395	4,605
Scenario A: Planned consented	A1	✓	✓	✓	✓	✓	✓	✓	✓	✓
	A3	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scenario B: Compliance with WFD	B1	× (P)	✓	× (NH4 & P)	× (P)	× (P)	× (P)	× (NH4 & P)	× (NH4 & P)	× (P)
	B3	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scenario C: Compliance with WFD (excl. P)	C1	✓	✓	× (NH4)	✓	✓	✓	× (NH4)	× (NH4)	✓
Scenario D: WFD Deterioration	D1	✓	✓	× (P)	× (P)	× (P)	× (P)	× (P)	× (P)	× (P)
	D2	✓	✓	✓	✓	✓	✓	✓	✓	✓
Scenario E: Load Standstill (compliance with HD)	E1	✓	✓	✓	✓	✓	✓	✓	✓	✓
	E2	✓	✓	✓	✓	✓	✓	✓	✓	✓

Key	Full growth can go ahead and achieve compliance with WFD & HD	Growth limited only by P	Full growth (with BATNEEC) cannot go ahead and comply with WFD & HD

Table 3-16: Water Quality Deterioration for WwTW Not Planned to Exceed Current Flow Consent but Requiring Consent Tighter than BATNEEC (WFD Compliance)

WwTW	Det	Current Consent (mg/l)	Scenario B (Compliance with WFD)	
			B1	B2
			Consent (BATNEEC)	% Deterioration
Aylsham	P	-	1	0%
Diss	NH4	5	1	70% (Imp)
	P	2	1	43% (Imp)
Harleston	P	1	1	19%
Poringland	P	-	1	19%
Sisland	P	1	1	5%
Swardeston-Common	NH4	5	1	75% (Imp)
	P	-	1	8%
Whitlingham	NH4	7	1	72% (Imp)
	P	1	1	9%
Wymondham	P	-	1	20%

Key	No Deterioration - Improvement	Deterioration <10%	Deterioration >10%

3.3.84 In terms of a best case compliance achievement within BATNEEC, a further scenario has been produced and is included in Figure 5c (Appendix C). This has been produced to show what is the best that can be achieved within the limits of BATNEEC

3.4 WwTW Consent Assessments

3.4.1 A high level risk assessment has been carried out on the current consents to identify the potential difficulties in tightening of consents as a result of development in the area i.e. those works which are operating at relaxed consents will have more difficulty and likely incur more costs in achieving tighter consents under future growth conditions. This information is presented in Table 3-17.

Table 3-17: WwTW Consent Change Analysis

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
	DWF (m^3/d)	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	
ACLE-DAMGATE LANE	**1,189**	**29**	**13**	**N/A**	**7%**	**1%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**1,189**	**29**	**13**	**N/A**	**1,276**	**10**	**1**	**1**	There is unlikely to be process capacity at the works to increase the nitrification required to achieve the tighter Ammonia consent which will be close to BATNEEC in order to meet WFD requirements. Significant further BOD reduction will also be required to achieve the tighter BOD consent. In addition, the works would require P removal to be installed for HD and beyond BATNEEC for WFD compliance (immediately downstream of works). Such upgrades would need to be phased in during AMP6 (2015 - 2020). It is considered unlikely that upgrades will be required to achieve the increase in volumetric capacity required due to the relatively low increase in wastewater flow to the WwTW As an additional complication, the WwTW is located within Flood Zone 3, and hence expansion of the works (if necessary) may be problematic as WwTW are not classified as 'water compatible' in PPS25.
	Acle WwTW has a new proposed DWF consent that is due to be operational in early 2010. The WwTW currently has a relatively relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the River Bure is at **high status** for BOD and Ammonia, is achieving a good status classification for Phosphorous. However, current overall ecological status for the river water body is only **moderate** and is targeted with achieving good ecological potential by 2027.			An NEP scheme is proposed to improve quality consent to ensure no deterioration in existing river quality as result of increased discharge volume. For the purposes of the WCS, these proposed consents have been assumed to represent the current consents, i.e. the WCS takes into account planned measures to address existing water quality issues.				To maintain downstream water quality and comply with the requirements of the WFD, the consent for BOD and Ammonia would need to be tightened. Immediate downstream compliance with the WFD standards for P is not possible within the confines of BATNEEC; to comply with the standard a consent of 0.2 mg/l (Mean) would be required. However, setting the consent at 1 mg/l would only result in a 4% deterioration of downstream water quality (assuming the WwTW was currently discharging at 1 mg/l). In order to ensure no increase in P load after growth and hence not impact on HD sites, only a consent of 2mg/l of P would be required. In addition, the WwTW would need to negotiate for an increase in DWF discharge to treat the planned growth.				
AYLSHAM	**1,440**	**40**	**5**	**1**	**19%**	**0.2%**	High - 4 mg/l	High - 0.3 mg/l	High – 0.05 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**1,440**	**40**	**5**	**1**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required; however, it is known that the works has current process issues (treatment restrictions) which result in difficulty treating to current consent requirements. Upgrades may be required early in AMP6 in order to enable growth to take place and for the consent standards to continue to be met.
	Aylsham WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge. However the ammonia consent is tighter and has less 'theoretical' capacity for process improvements.				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the River Bure is **high status** for all determinands, and uncharacteristically for rivers in the East of England, is achieving a high status classification for Phosphorous. However, current overall ecological status for the river water body is only **moderate** and is targeted with achieving good ecological potential by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing BOD, Ammonia and P quality consents would be required to maintain downstream water quality and comply with the requirements of the WFD under the planned consented scenario as there would be no requirement for a new DWF consent.				

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
BELAUGH	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	2,273	**30**	**10**	**N/A**	**62%**	**0.5%**	High - 4 mg/l	High - 0.3 mg/l	High – 0.05 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**2,273**	**30**	**10**	**N/A**	
	Belaugh WwTW currently has a relatively relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge				Increase in WwTW flow is considered to be high as a result of planned growth. However, increase in river flow is considered to be low.		The downstream quality of the River Bure is **high status** for all determinands, and uncharacteristically for rivers in the East of England, is achieving a high status classification for Phosphorous. However, current overall ecological status for the river water body is only **moderate** and is targeted with achieving good ecological potential by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				
DISS	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	4,032	**12**	**5**	**2**	**12%**	**1.3%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**4,032**	**12**	**5**	**1**	
	Diss WwTW currently has a relatively tight water quality consent condition and hence it has less 'theoretical' capacity for process improvements. The works has a Phosphorous consent issued under the UWWTD.				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the River Waveney is **high status** for ammonia and BOD, and **moderate status** for Phosphorous. Dissolved Oxygen is classified as poor status. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological status by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				
HARLESTON	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	1,392	**17**	**5**	**1**	**37%**	**1.8%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**1**	**1,392**	**17**	**5**	**1**	
	Harleston WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has some 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge. However the ammonia consent is tighter and has less 'theoretical' capacity for process improvements. The works has a Phosphorous consent issued under the Habitats Directive				Increase in WwTW flow is considered to be medium as a result of planned growth. However, increase in river flow is considered to be low.		The downstream quality of the River Waveney is **high status** for ammonia and BOD, and **bad status** for Phosphorous. Dissolved Oxygen is classified as moderate status. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological status by 2027.			An NEP scheme is proposed to improve the Phosphorous discharge consent to protect downstream ecological sites under the Habitats Directive. For the purposes of the WCS, this proposed consent has been assumed to represent the current consent, i.e. the WCS takes into account planned measures to address existing water quality issues.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
LONG STRATTON	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	There is unlikely to be process capacity at the works to increase the nitrification required to achieve the tighter Ammonia consent which will be at, or slightly beyond BATNEEC in order to meet WFD requirements. In addition significant improvements in BOD removal will also be required to meet the proposed BOD consent. Increase in proposed volumetric capacity is also significant and increases in site footprint are likely to be required. The works would require beyond BATNEEC technology for P removal to be installed for WFD and HD compliance (immediately downstream of works); It is considered that it would not be possible to design a WwTW to treat to this level within available technology (not entailing excessive costs and energy requirements).
	1,200	**20**	**16**	**1**	101%	33%	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**1**	1,379	7	1	1	
	Long Stratton WwTW currently has a relatively relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge.				Increase in WwTW flow is considered to be high as a result of planned growth, resulting in a doubling of flow being treated at the works. Subsequently, increase in river flow is considered to be medium due to the relatively small receiving watercourse.		The downstream quality of Hempnall Beck is **high status** for ammonia and BOD, and **poor status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological status by 2027.			Two NEP schemes are proposed; one to improve the Phosphorous discharge consent to protect downstream ecological sites (Habitats Directive(and a second to undertaken an investigation to quantify risk from chemicals in discharges through effluent screening to protect downstream ecological sites (WFD). For the purposes of the WCS, this proposed consent has been assumed to represent the current consent, i.e. the WCS takes into account planned measures to address existing water quality issues.				To maintain downstream water quality and comply with the requirements of the WFD, the consent for BOD would need to be tightened but within the limits of BATNEEC. Immediate downstream compliance with the WFD standards for Ammonia and P is not possible within the confines of BATNEEC. To comply with the WFD Ammonia standard a consent of 0.5 mg/l (95%ile) would be required. However, tightening the consent from 16 mg/l to 1 mg/l would result in improvement in existing downstream water quality (though it would fail to meet the WFD standard). If water quality were allowed to deteriorate from 'high' to 'good' status, then a less onerous consent of 1 mg/l (within BATNEEC) would be required. To comply with the WFD and HD P standard a consent of 0.1 mg/l (95%ile) would be required. However, setting the consent at 1 mg/l would cause a 35% deterioration in existing downstream water quality. In addition, the WwTW would need to negotiate for an increase in DWF discharge to treat the planned growth.				
PORINGLAND	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	930	**18**	**N/A**	**N/A**	**39%**	**9%**	High - 4 mg/l	Good - 0.6 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**930**	**18**	**N/A**	**N/A**	
	Poringland WwTW currently has a relatively relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge				Increase in WwTW flow is considered to be medium as a result of planned growth. However, increase in river flow is considered to be low.		The downstream quality of the River Chet is **high status** for BOD, **good status** for Ammonia and **bad status** for Phosphorous. Dissolved Oxygen is classified as moderate status. Current overall ecological status for the river water body is assessed as **poor** and is targeted with achieving good ecological status by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
REEPHAM	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	It is considered that it would not be possible to upgrade the WwTW to treat to this level within available technology (not entailing excessive costs and energy requirements).
	1,889	**30**	**10**	**1**	**6%**	**22%**	High - 4 mg/l	Good - 0.6 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**1**	**1661**	**5**	**1**	**1**	
	Reepham WwTW currently has a relatively relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge.				Increase in WwTW and River flow is considered to be low as a result of planned growth. Increase in river flow is considered to be medium due to the relatively small receiving watercourse.		The downstream quality of the Blackwater Drain is **high status** for BOD, **good status** for Ammonia and **good status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological potential by 2027.			An NEP scheme is proposed to improve the Phosphorous discharge consent to protect downstream ecological sites. For the purposes of the WCS, this proposed consent has been assumed to represent the current consent, i.e. the WCS takes into account planned measures to address existing water quality issues.				A new consent has been applied for by AWS. New predicted flow with growth is predicted to be lower than the consent, but AWS figures have indicated that a new DWF consent is required at approximately 1,500m3/d. Therefore new quality consents will be required to accommodate growth Immediate downstream compliance with the WFD standards for all quality consents is not possible within the confines of BATNEEC. To comply with the BOD standard a consent of 4.8 mg/l (Mean) would be required. However, tightening the consent from 30 mg/l to 5 mg/l would result in improvement in existing downstream water quality (though it would fail to meet the WFD standard). If water quality were allowed to deteriorate from 'high' to 'good' status, then a less onerous consent of 6 mg/l (within BATNEEC) would be required. To comply with the Ammonia standard a consent of 0.7 mg/l (Mean) would be required. However, tightening the consent from 10 mg/l to 1 mg/l would result in improvement in existing downstream water quality (though it would fail to meet the WFD standard). To comply with the P standard a consent of 0.1 mg/l (Mean) would be required. However, setting the consent at 1 mg/l would result in minimal deterioration (<1%) deterioration of downstream water quality				
SISLAND	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	1,600	**20**	**5**	**1**	**11%**	**0.9%**	High - 4 mg/l	Good - 0.6 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**1**	**1,600**	**20**	**5**	**1**	
	Sisland WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge. However the ammonia consent is tighter and has less 'theoretical' capacity for process improvements.				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the Tributary of the River Chet is **high status** for BOD, **good status** for ammonia, and **poor status** for Phosphorous. Dissolved Oxygen is classified as bad status. Current overall ecological status for the river water body is assessed as **poor** and is targeted with achieving good ecological status by 2027.			An NEP scheme is proposed to improve the Phosphorous discharge consent to protect downstream ecological sites under the Habitats Directive For the purposes of the WCS, this proposed consent has been assumed to represent the current consent, i.e. the WCS takes into account planned measures to address existing water quality issues.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
STOKE HOLY CROSS	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for BOD removal. Additional nitrification may be required to meet a proposed Ammoniacal consent (none currently) however it has been assumed that this can be achieved with current process capacity. P Stripping will be required, but not at BATNEEC (2.5mg/l) and hence this could be installed relatively quickly; however It is considered likely that upgrades will be required to achieve the increase in volumetric capacity required. For this reason, such upgrades are unlikely to be possible until AMP6 (2015).
	560	**50**	**N/A**	**N/A**	**14%**	**0.1%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**531**	**50**	**10**	**2.5**	
	Stoke Holy Cross WwTW currently has a relaxed water quality consent condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge.				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the River Tas is **high status** for BOD and Ammonia and **poor status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological potential by 2027.			No NEP schemes are proposed for the WwTW.				A new consent has been applied for by AWS. New predicted flow with growth is predicted to be lower than the consent, but AWS figures have indicated that a new DWF consent is required at approximately a flow lower than the new consent. Therefore new quality consents will be required to accommodate growth To maintain downstream water quality and comply with the requirements of the WFD, the consent for BOD would need to be tightened and a consent for Ammonia and P would need to be set; but these would all be within the limits of BATNEEC. In addition, the WwTW would need to negotiate for an increase in DWF discharge to treat the planned growth.				
SWARDESTON-COMMON	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	1,100	**15**	**5**	**N/A**	**25%**	**5%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**1,100**	**15**	**5**	**N/A**	
	Swardeston WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge. However the ammonia consent is tighter and has less 'theoretical' capacity for process improvements.				Increase in WwTW flow is considered to be medium as a result of planned growth. However, increase in river flow is considered to be low.		The downstream quality of the Inwood Stream is **high status** for BOD and ammonia., and **poor status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological potential by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF.				
WHITLINGHAM	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	66,250	**20**	**7**	**1**	**19%**	**2%**	High - 4 mg/l	High - 0.3 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**66,250**	**20**	**7**	**1**	
	Whitlingham WwTW currently has a relatively relaxed water quality consent condition for BOD and Ammonia and hence it has a 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge. The works has a BAT Phosphorous consent issued under the UWWTD and therefore tightening of the consent would be restricted.				Increase in WwTW and River flow is considered to be low as a result of planned growth.		The downstream quality of the River Yare is **high status** for BOD and ammonia, and **moderate status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological potential by 2027.			Improvements to the inlet works will be undertaken in AMP5 which will allow full use of the DWF. An NEP scheme is proposed to improve polluting discharge (continuous) at Whitlingham WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF				

WwTW	Current consent (2009) and Scope for Consent Tightening				Percentage Increase in flow		Downstream Water Quality Limits			Planned Improvements (AMP5 – up to 2015)				New Consent Required after housing and employment growth (by 2026)				Upgrade Assessment
WYMONDHAM	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**WwTW**	**River**	**BOD**	**NH4**	**P**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	**DWF (m^3/d)**	**BOD (mg/l)**	**NH4 (mg/l)**	**P (mg/l)**	Modelling has indentified that no upgrades in process capacity are required for any determinands and no volumetric upgrades are required
	4,400	**12**	**4**	**1**	**43%**	**5.5%**	High - 4 mg/l	Good - 0.6 mg/l	Good – 0.12 mg/l	**N/A**	**N/A**	**N/A**	**N/A**	**4,400**	**12**	**4**	**1**	
	Wymondham WwTW currently has a relatively tight water quality consent condition and hence it has less 'theoretical' capacity for process improvements.				Increase in WwTW flow is considered to be high as a result of planned growth. However, increase in river flow is considered to be low.		The downstream quality of the River Tiffey is **high status** for BOD, **good status** for ammonia, and **poor status** for Phosphorous. Current overall ecological status for the river water body is assessed as **moderate** and is targeted with achieving good ecological status by 2027.			No NEP schemes are proposed for the WwTW.				No change to the existing quality consents would be required as the additional growth will not result in an increase in consented DWF				

4 Water Supply Strategy

4.1 Introduction

4.1.1 In August 2009, the Secretary of State (SoS) for the Environment announced his decision on the nest steps English water companies' WRMPs. Along with seven other water companies, AWS's WRMP required further information in support of their proposals in order for the SoS to make a decision. The timing of the GNWCS required to support the Core Strategy means that the final WRMP was not available.

4.1.2 For the purposes of this final Stage 2 WCS report, an assessment has been made based on information provided by AWS in its draft WRMP (AWS, 2008) and in their Statement of Response to the consultation on the draft WRMP (AW, 2009). The Environment Agency's response to the draft WRMP (EA, 2008) has also been considered. It is recommended that when the final WRMP is made available, that the findings of this WCS are revisited.

4.2 Deriving a Water Supply Strategy

4.2.1 The creation of a water supply strategy is reliant on two aspects:

- the availability of raw water resources prior to treatment for potable use; and
- the availability of water supply infrastructure (such as network mains) to transfer treated water to PGAs.

4.2.2 Development of an optimised water supply strategy for the GNDP growth area is therefore a combination of both water resource availability and water supply infrastructure.

4.3 Water Resources

Purpose of Water Resources Assessment

4.3.1 Water resources are an important factor to be considered in developing a growth strategy for an area. The GNDP study area is fortunate in having large quantities of groundwater held within the Chalk aquifers which underlie large parts of the East Anglian region. These aquifers also provide important feeds to the baseflow of the region's rivers and numerous wetlands areas. It is therefore important to take a regional perspective when assessing the water resources of an area.

4.3.2 The East of England is one of the driest parts of the country and this combined with the high demand from its residents (both permanent and tourist populations) and from industry (including agriculture), means that the GNDP area lies within an area of 'serious water stress' (Environment Agency, 2008).

4.3.3 To address the issue of availability and scarcity of water resources, this section of the report looks at the extra demands which are likely to occur from the East of England Regional Spatial Strategy (EoE RSS) growth plans (EoE RSS 2008). The RSS figures have been used as opposed to the figures included in the Non-Technical Planning report to ensure consistency with the figures used by AWS in its water resource management planning.

4.3.4 A review of the available water resources which may be available to match these demands is considered, before looking at the phasing of water resource schemes to meet this extra growth in demand. The effect of climate change on the supply/demand balance is also considered in this section. Finally, the environmental effects of the proposed water resources schemes are considered.

The Supply/Demand Balance

Demand Scenarios

4.3.5 Using the housing growth figures provided by GNDP, a number of demand scenarios based on different water use rates have been modelled in order to determine the increase in water demand as a result of the proposed growth in the GNDP area. The water use assumptions used in the scenarios are shown in Table 4-1.

Table 4-1: Water Use Scenarios Modelled

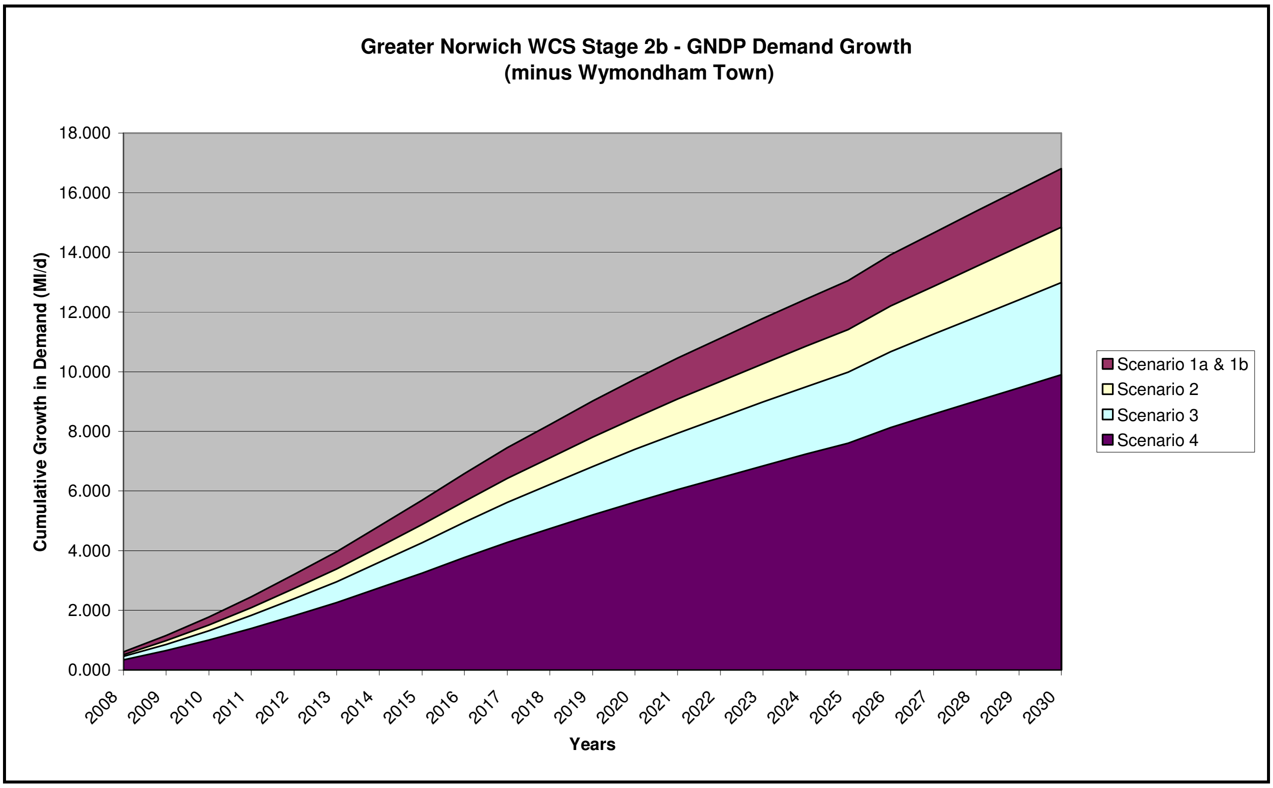
Scenario	Description	Water use rate (l/h/d)
1	'Do Nothing' i.e. the proposed future demand assuming water use (litres used per person per day [l/h/d]) remains as it is currently once all development is delivered *(142l/h/d is the current average usage per person per day based on metered and unmetered customers)*	142
2	AWS's target for future usage from new water efficient households[15]. It is also reflects the future demand if all new homes met water efficiency targets required to achieve levels 1 or 2 on the Code for Sustainable Homes (CfSH).	120
3	Future demand if all new homes met water efficiency targets required to achieve levels 3 or 4 on the CfSH.	105
4	Future demand if all new homes met water efficiency targets required to achieve levels 5 or 6 on the CfSH.	80

4.3.6 Further detail of how the demands have been calculated and the justification for them are included in Appendix H: Water Demand Calculations Detail.

4.3.7 Figure 4-1 shows the increase in demand expected for the four different water use scenarios. The difference in total demands between the various water use scenarios is from just under 17 Ml/d (Scenario 1) as a maximum to around 10 Ml/d (Scenario 4) as a minimum by 2030/31.

[15] Note – this was used in assessments before the Building regulations target of 125l/h/d was introduced

Figure 4-1: Demand Growth for four different water use scenarios



Available Water Resources

4.3.8 Estimates of the extra Deployable Output[16] (DO) available to meet the extra demands in the Greater Norwich area are based on AWS's draft WRMP (AW, 2008). The selection of sources is based on AWS's Statement of Response to the consultation on the draft WRMP (AW, 2009). The available resources are shown in Table 4-2.

Table 4-2: Available Water Resources in Greater Norwich

Resource Options [17]	Extra DO (Ml/d)
Spare Groundwater abstractions through existing abstraction licences (Thorpe St. Andrew B/h)	4
New Groundwater Resource Development (probably within Norwich)	4
Whitlingham Effluent Flow compensation scheme	12.3
Total	**20.3**

[16] Deployable output refers to the amount of water that is available from a resource for abstraction taking into account the variability that occurs over a season as a result of changes in hydrology and aquifer recharge with different rainfall patterns

4.3.9 The Whitlingham Effluent Flow compensation scheme proposed by the AWS's draft WRMP was to take Whitlingham final (treated) effluent and to discharge it downstream of the Costessey intakes. This would effectively work as a 'river augmentation scheme' whereby the river flow reducing effects of abstracting water at Costessey is 'compensated' by adding treated wastewater flow at a point just downstream. The scheme may also allow an increase in abstraction at Costessey so long as there is a commensurate increase in discharged treated effluent downstream. There also remains the possibility to discharge the treated effluent further upstream of Costessey in the Wensum, such that allowing a suitable retention time for dilution, could allow the water to be re-abstracted along with mixed river water at Costessey. This would then be classified as an 'indirect water re-use scheme'.

4.3.10 For this analysis it is has been assumed that there is no loss of DO from any existing sources within the Greater Norwich area as a consequence of the Environment Agency's RoC (see section 4.4.7), as under the RoC process it is possible that the Environment Agency could 'revoke' or effectively cease the operation of a licence if it is deemed to be impacting on the integrity of a Habitats Directive site or annexed species; however, AWS would be given the time and finding to find a replacement to any loss of licensed abstraction volumne

4.3.11 Further details on the environmental constraints associated with each of the above resource options are included in section 4.4.7.

4.4 Phasing of Water Resources Developments

Without the effects of Climate Change

4.4.1 Table 4-3 summarises the phasing of schemes required under Scenario 1 (high demands) and Scenario 4 (low demands).

Table 4-3: Phasing of WR developments under Scenarios 1 and 4 [excluding for the effects of climate change]

Sources	Scenario 1	Scenario 4
Spare GW licences	Incrementally from now	Incrementally from now
New GW Resource Development	AMP5 (in 2014)	AMP6 (2017)
Effluent compensation scheme	AMP6 (2018)	AMP8 (2026)

4.4.2 Under both scenarios, the additional growth forecast for Greater Norwich will require extra groundwater to be abstracted from sources with spare licensed capacity e.g. Thorpe St Andrew Borehole. The different rates of increase in demand effects the timing of resource developments. In the case of Scenario 1, a new groundwater resource development would be required at the end of AMP5 (in 2014). In the case of Scenario 4, this development would not be required until the middle of AMP6 (in 2017). The difference in the timing of the effluent compensation scheme planned for Norwich from the end of AMP6 (in 2018) under Scenario 1 to early AMP8 (in 2026) under Scenario 4.

With the effects of Climate Change

4.4.3 The effect of climate change (CC) on water resources is based on information provided by AWS, as part of Stage 2a and is based on information included in their draft WRMP. Their assessment for the draft WRMP was that it would lead to a loss of DO of <2 Ml/d by 2021 on their surface water intakes on the River Wensum intakes at Costessey. This loss is associated with changes (i.e. reductions) in river flow expected as a result of lower summer rainfall totals. The effects on Norwich's groundwater sources (at Costessey) were considered to be negligible as recharge to aquifers during potentially wetter winter months will likely counter balance the lower summer recharge expected with lower summer rainfall. The effect on groundwater is therefore not considered further.

4.4.4 In the case of surface water, this is shown in Table 4-4.

Table 4-4: Effects of Climate Change on surface water resources in Greater Norwich

Period	Loss of DO	% change in Deployable Output*
2010-2021	Reduction of up to 2 Ml/d over 11 years i.e. loss of 0.18 Ml/year	- 5%
2010-2030	Extrap. for 20 years of 3.6Ml/d	- 9%

* Based on a total Deployable Output for WRZ8 of 84.7 Ml/d.

4.4.5 The net effect of these changes will mean a loss of Deployable Output, primarily from the existing surface water resources within the GNDP study area. This will have the effect of bringing forward the date when new schemes will be required and potentially requiring the promotion of additional schemes at the end of the planning period (in AMP8). A summary of the 'key' dates when schemes are required changes without CC and with CC are presented in Table 4-5.

Table 4-5: Phasing of WR developments with and without CC under Scenarios 1 and 4

	Sources	Without CC	With CC
Scenario 1	New GW Resource Development	2014	2013
	Effluent Compensation scheme	2018	2017
	Additional Resource Development*	-	2030
Scenario 4	New GW Resource Development	2017	2015
	Effluent Compensation scheme	2026	2021

* Scheme most likely to be developed is the Trent Transfer Scheme

4.4.6 In general, the effect of CC is to advance the date when schemes will be required by approximately one year. The largest change is in the timing of the Effluent Compensation scheme under Scenario 4 from 2026 without CC to 2021 with CC i.e. from AMP8 to AMP7. The other feature is the need for an additional resource development at the end of AMP8 (in 2030) under Scenario 1. The most likely scheme to be promoted at this time would be Trent Transfer Scheme, a pumped storage reservoir with associated long distance transfers into the GNDP study area.

Review of Consents – Implications

4.4.7 Specifically for the water resources and the GNWCS, the key consents being considered as part of the Habitats Directive RoC are the abstractions direct from the Wensum at Costessey abstraction point, as well as from boreholes in close proximity to the Wensum located at Costessey. Both abstraction licences (when used to their maximum) can potentially impact on the Wensum SSSI and SAC by reducing available flow and water levels for the species within the 7km downstream stretch of the SAC that are reliant (directly or indirectly) on specific flow conditions.

4.4.8 At the time of undertaking the GNWCS Stage 2b report, the Environment Agency was in the process of consulting on its Stage 4 findings which reports on the Site Action Plan (SAP) for the Wensum SAC for consents which cannot be ruled out as not impacting on designated sites. This stage determines the level of alteration required to a licence and considers options for remediating the impact. Because the consultation process with licence and consent owners was ongoing, the full Stage 4 SAP was not made available in time for completion of the Stage 2b GNWCS report.

4.4.9 However, the following information from the RoC was made available:

- Stage 3 Appropriate Assessment reports (with some licence specific information removed);
- discussions with Natural England over the likely conclusions regarding the Costessey licences; and
- an Executive Summary for the consultation on the River Wensum SSSI and SAC Stage 4 SAP (without full figures and outputs).

4.4.10 The conclusions drawn from the interim information provided is that the abstractions at Costessey, (both surface water and groundwater), are likely to be impacting on the integrity of the 7km stretch of the River Wensum SAC located downstream of the abstraction point. Advice from the Environment Agency and Natural England is that there is likely to be a proposal to modify the maximum permitted abstraction volume from the licences in order to allow the River Wensum to reach its environmental outcomes. This is termed as a sustainability change and may lead to a reduction in the amount that can be abstracted and would therefore become known as a sustainability reduction. Further information on how the requirement for a sustainability change was determined and a discussion around the efficacy of this process is included in this Technical Report. It should be noted that the Review of Consents process for the Costessey abstraction is ongoing and the sustainability change has not yet been determined.

4.4.11 The Environment Agency have indicated that the Stage 4 SAP for the Wensum SAC will not be complete until March 2010 and hence will not be available to fully inform this Stage 2b GNWCS which is required to inform the Examination of the Joint Core Strategy prior to this date. Until March 2010, there is some considerable uncertainty as to the level of sustainability change that will be implemented for the Costessey licence and discussions between AWS (as the licence holder), the Environment Agency and Natural England are ongoing. Owing to the sensitivities around the process and the implications on AWS's WRMP, exact details of these discussions have not been made available for the GNWCS.

4.4.12 AWS's draft WRMP (2008) had not made any significant allowance for a sustainability change in the Costessey licence. Although it acknowledged that there is "a significant risk that the Environment Agency will seek sustainability reductions" the plan went on to say that "we have been advised to include only a nominal sustainability reduction for the intake west of Norwich" (i.e. at Costessey).

4.4.13 Under the RoC process, there will be a lengthy period over which solutions to the licence alterations will be discussed between Natural England, the Environment Agency and AWS. At present, the proposed effluent compensation scheme could be considered to be both a new resource but also a solution to the sustainability change. The WCS has shown that the increase in treated flow proposed for Whitlingham would result in dry weather discharge of over 66Ml/d allowing plenty of transfer capacity to both compensate for the sustainability change and provide additional resource. However, this would require a high degree of additional study to determine its suitability as an option and there remains considerable uncertainty as to the eventual solution that will be implemented.

4.4.14 As a worst case, it could be considered that the current baseline with respect to available water resources needs to be reduced by a significant amount to allow for the sustainability change. This could represent a much larger deficit of water supply than can be replaced by the proposed new water resource schemes as included in AWS's Statement of Response. However, any losses as a result of the Review of Consents process have to be compensated for by the Environment Agency where the removal or alteration of a licence impacts upon the existing operations of the licence owner and as such a solution to the loss of abstraction will need to be provided. The Environment Agency would grant AWS sufficient time and funding to implement a solution to replace any required reduction in supply, and the Environment Agency have confirmed that there would be no loss to overall supplies whilst the solution is being implemented. The uncertainty is around what this solution will be and when it can be implemented but the Environment Agency support the position that the RoC sustainability change should not affect AWS's to meet growth in the study area.

4.4.15 Once the final sustainability change is known and the Wensum SAP is available, the WCS should be revisited to alter the baseline of available water supply and reconsider what the water resource scheme developments will need to be. The delay to the issuing of AWS's final WRMP will in part be related to this issue, and as such the WCS should also be updated with the final plan at the same time.

4.5 Environmental Effects from Water Resource Developments

Ecological Consequences of Different Resource Options

4.5.1 In terms of environmental constraints associated with each of the resource options referred to in section 3.2.2, these are as follows:

- the spare capacity of the existing groundwater licences has been assessed by the Environment Agency's Review of Consents and with the exception of the Costessey Groundwater Licence; no issues have been identified by the Environment Agency regarding adverse effects on European sites. It is therefore concluded that it would be acceptable in terms of ecological consequences to rely on the extra Deployable Output from local groundwater sources to meet demands in the future;

- a new groundwater resource development, most probably within Norwich area, will be required under all growth scenarios. Since AWS have yet to publish their final WRMP, it is not known precisely from which aquifer and within which Environment Agency's Water Resources Management Unit (as defined by the local CAMS document) the abstraction is likely to take place from. If it is assumed however that the source to be developed would abstract from the deep Chalk aquifer beneath Norwich and that the groundwater source can be shown not to be connected to any European sites, then ecological consequence of such development are likely to be small[18]; and
- the Effluent Compensation scheme proposed within the draft WRMP, involves supplementing flows in the Lower River Wensum by re-distributing treated final effluent that currently discharges to the River Yare from Whitlingham WwTW and instead discharging it further up the catchment at a point just downstream of the Wensum intakes at Costessey. By doing this, Anglian Water would hope to both enhance river flows in the Lower River Wensum (see section 4.3, the Environment Agency's Review of Consents) and also to be able to abstract more from their intakes at Costessey without detrimentally reducing flows in the River downstream specifically in relation the Yare Broads and Marshes and Cantley Marshes SSSIs, part of the Broads SAC/ Broadlands SPA. In principle, this scheme should provide some extra Deployable Output, however until further details of the proposed scheme are provided by Anglian Water in its final WRMP (now delayed to beyond the completion date of this WCS by Defra requirement for further clarification), then there remains some uncertainty over the wider ecological consequences of this scheme. As the Water Cycle Study is intended as a living document, it is recommended that these interim conclusions are revisited once the final WRMP is made available.

4.5.2 A summary of the ecological consequences of the different resource options is included in Table 4-6.

Table 4-6: Resource Options and Ecological Consequences

Resource Options	Ecological Consequence
Spare GW licences (Thorpe St. Andrew B/h)	No major issues identified
New GW Resource Development (probably within Norwich)	To confirm aquifer and WRMU from which abstraction to take place; however impact is likely to be small
Effluent Compensation scheme (see note below)	Further details about this scheme are required before a final view can be given; however, a solution is likely to be achievable

Groundwater Protection and Discharges to Ground

4.5.3 The East of England RSS Policy No. ENV9 relates to water supply, management and drainage. Included as part of the policy, it says that local authorities will;

[18] Once the preferred solution is known, then impacts on other ecological sites as well as those designated under the HD will need to be considered and assessed before a licence would be granted. The potential licence would also need to be considered within the context of the overall CAMS position

"*In preparing local development documents, take into account (amongst other documents), the Environment Agency's groundwater vulnerability and groundwater source protection zone maps. The protection of water resources and provision for water abstraction should take into account environmental constraints*".

4.5.4 As mentioned in 4.3.2, the East Anglian region is fortunate in having large quantities of groundwater held within the Chalk rocks underlying the various local authority areas. However this does mean that local authorities have a responsibility to ensure that these resources are not impacted by development which may take place within their areas and this is covered in the following sections.

Groundwater Vulnerability

4.5.5 The threat to water supplies from soakaway systems has long been recognised by Norwich City Council (pers. comm. Colin Wright – Regional Director, Scott Wilson). Their policy of not permitting soakaways to be constructed on or near areas of 'River Terrace Deposits (Sands and Gravels) overlying the Chalk (a Major Aquifer[19])' but instead only permitting these soakaways to be constructed on areas of 'Glacial Boulder Clays' would appear to be a sensible policy.

4.5.6 The principles behind this policy is related to differences in physical properties between the 'Sands and Gravels' and the 'Boulder Clay' deposits, which will effect the rate of downward migration of pollutants from the surface to the underlying aquifers. This information is encapsulated into the Environment Agency's groundwater vulnerability maps, which divides the area up into Major, Minor or Non-aquifers, and in turn for both Major and Minor aquifers into areas of High, Intermediate and Low Leaching Potential (LP). The highest Groundwater Vulnerabilities (Major Aquifer – High LP Class 1 or 2) are along the lines of main river valleys e.g. River Yare downstream of Norwich. Whilst the lowest Groundwater Vulnerabilities, although still Major Aquifer (Low LP Class 1 or 2) are away from the river valleys (the interfluves between river valleys), where the Boulder Clay lies on top of the Chalk aquifer.

4.5.7 Both the Outline and Stage 2a reports have included details of the GW Vulnerability classification for the various proposed development areas around Greater Norwich. A summary is presented in Table 4-7, and is discussed under the PGA specific assessments (see Non-Technical Planning document).

Table 4-7: Groundwater Vulnerability Classifications for development areas in Greater Norwich

Constraint	GW Vulnerability Classification	Development area	
		NPA	RPA
Red	High Leaching Potential (LP)	3b,4 & Norwich	1
Amber	Intermediate LP	1,2, 3a, 8,9,10	2,3,4,6 & 7
Green	Low LP	5,6,7 & 11	5 & 8

Note: Major aquifers cover most of the area and so Leaching Potential (LP) – High, Intermediate or Low are used to differentiate between the areas

[19] A Major Aquifer is Highly Permeable strata usually with a known or probable presence of significant fracturing

Groundwater Source Protection Zones (SPZ)

4.5.8 The Environment Agency's SPZ maps show the Inner (Red), Outer (Green) and Total Catchments (Blue) zones for all the major public water supply sources within the Greater Norwich area. In total, nine sources exist within the Greater Norwich area boundary. The main concentrations of sources within the Greater Norwich area are along the lines of the main river valleys, the River Wensum (at Costessey), the River Yare (at Colney and Barford) and the River Tas (at Caister St Edmunds and Bixley).

4.5.9 The close proximity of these sources, their size (related to abstraction volumes) and the recharge mechanisms through the drift deposits will all combine to mean that the virtually all parts of the City of Norwich lie within a catchment area for one of the city's public water supply sources. In the outlying parts of the Greater Norwich study area, the coverage of SPZs is less extensive, although the towns of Wymondham and Diss both have individual SPZs situated locally.

4.5.10 The purpose of these maps has been to provide the Environment Agency with a planning tool by which to determine the type of development which may be permitted in the future. The heavy reliance on groundwater for the City's water supply and the need to provide these resources may mean that certain restrictions are needed, for example on the siting of petrol stations within the Greater Norwich area. In the case of residential developments, since these have much less polluting potential, then the restrictions on this type of development are also likely to be proportionately much less.

Summary

4.5.11 In order to safeguard the region's water resources, the preferred areas for development within the Greater Norwich area would be those areas lying away from the valley bottoms e.g. North of Norwich, and also the interfluve areas (those lying between the river valleys), comprising Boulder Clay overlying Chalk e.g. West and Southwest of Norwich. Specifically the preferred areas for development would include those to the North of Norwich e.g. NPAs 1, 2, 3a & 10, and those to the West and Southwest of Norwich e.g. NPA 7 (Wymondham) and RPAs 5, 7 & 8. This is discussed in more detail under the PGA specific assessments (See section Non-Technical Planning Document)

4.5.12 The proximity to a SPZ will be one of the factors which the Environment Agency takes into account in deciding what type of development should be permitted in a given area. In general housing developments, because of their low polluting potential, will not be subject to the same level of restrictions as say industrial development.

4.6 Water Supply strategy

4.6.1 Based on the draft WRMP outputs, it has been possible to determine a strategy for the provision of raw water sources to supply the level of development proposed in the study area,

4.6.2 In the short-term the use of spare groundwater licences (Thorpe St Andrew borehole) will allow early phasing of development to meet extra demand and will have no significant impacts on HD sites.

4.6.3 In the medium term, a further groundwater scheme will be developed. Until the final WRMP is made available, it is not possible to determine from which aquifer these abstraction are likely to occur; however, the screening assessment for HD sites has determined that this is unlikely to impact on HD sites.

4.6.4 In the longer term (and depending on the actual demands that are witnessed as a result of water efficiency measures) further water supply will be met from a strategic scheme. The draft WRMP highlights the Effluent Compensation scheme for the Wensum as a scheme which could provide an increase in Deployable Output as well as alleviating the potential reduction likely under the sustainability change at the Costessey licence as a result of the HD RoC process. The screening process for the HRA has suggested that water quality issues would have to be considered for the potential impact on the Wensum SAC upstream of Norwich; but until such a time as the final WRMP is made available, it will not be possible to determine which of these impact are likely to be significant. It is likely that a sufficient treatment level will be achievable to ensure no detriment to the SAC site and there would be flexibility as to where the discharge point would be located to mitigate any impact on the SAC.

4.6.5 In terms of available water supply infrastructure, all of the NGAs are well connected to existing mains. Until the final WRMP is made available, it is not possible to determine how the water will be transferred to the various potential growth areas. However, for this assessment, the assumption used in the Stage 2a WCS has been used to that all water would be distributed from Heigham WTW to the west of Norwich city centre. An assessment has therefore been made for each of the NGAs in section the Non-Technical Summary Report.

4.7 Water Efficiency Strategy

4.7.1 Given the availability of raw resources in the East of England, it is key that the WCS process considers options for how demand from new development can be managed via effective policy to ensure that future demand for new water supply is minimised.

4.7.2 There is also potential that a WCS can influence policy on water use from existing customers to further secure future water supplies. A water efficiency strategy has therefore been developed for the GNWCS to feed into policy recommendations for the LDF.

Current Water Use

4.7.3 In general, AWS customers' water use figures for both metered and un-metered customers are slightly above industry average for UK Water and Sewerage Companies' (WASC) customers. The average AWS supply area figure of 150 l/h/d is also slightly above the industry average of 145 l/h/d.

4.7.4 Levels of meter penetration[20] within the Anglian Region presently stands at around 60% (AWS's Statement of Response to the draft WRMP, 2009). The levels of metering are much higher than most other UK Water Companies (with the exception of South West Water) typically around 25% (Ofwat, 2007-08).

4.7.5 The current level of leakage as reported by AW is around 18%, as a proportion of the water put into supply (based on 2007/08). This compares with an industry average for UK WASC of 27%.

[20] Meter penetration refers to the take up of metering, or simply the percentage of households that currently have a water rmeter

Future Water Efficiency Plan (WEP)

4.7.6 The first step in a water efficiency plan to support the LDF is to consider the water efficiency measures being adopted by AWS in its WRMP. It should be assumed that these measures will be undertaken, and this will aid in identifying further measures that are required through the WCS and which cam be adopted as policy in the LDF.

Anglian Water's WEP

4.7.7 In undertaking their water resource management, Ofwat require that water companies undertake a twin-track approach to providing sufficient water supply to its customers, both existing and in the future.

4.7.8 Twin-track management refers to the two step process that Water Companies must take in the management process; with the first step being a reduction in water usage (demand) whilst step two is identifying new water resources (supply) to develop where there is predicted to be a shortfall in supply to meet demand.

4.7.9 The first step is achieved by proactive demand management which is undertaken in two main ways: demand reduction (reducing customer usage); and by reducing leakage from its supply pipe network.

4.7.10 A summary of AWS's planned water demand management measures included in their draft WRMP (AW, 2008) were as follows:

- water metering – AWS is actively encouraging customers to opt for a water meter. A *targeted enhanced metering programme* to improve metering levels in certain 'key' areas up to 75% by 2015 and 90% by 2035 has been proposed (see Statement of Response (AW, 2009);
- water efficiency – good practice guidance is followed where possible (Ofwat, 2006); and
- leakage – AWS is proposing to continue to operate at below the Economic Level of Leakage[21] (ELL), this is despite the expected increase of around 20% on the current leakage levels which is expected to occur as a result of extension to the distribution network over the next 25 years.

4.7.11 AWS's Statement of Response (AW, 2009) has incorporated revised targets for the level of metering of 80% by 2015, including proposals to install 3,440 meters in Wymondham. However until the final WRMP has been published, which is subject to approval by DEFRA, there are likely to be no further details on their WE plans.

4.7.12 Even allowing for AWS's planned reduction in usage up to the end of the RSS period, there will still be a significant amount of new demand (10Ml/d is the lowest additional demand with lowest water use by the end of the plan period – see Figure 4-1) as a result of new development. It is therefore important to look at further ways in which policy can further reduce overall demand for water over the LDF planning period.

[21] Economic Level of Leakage - The level of *leakage* for which the cost of achieving and then maintaining that level is exactly offset by savings in capital and operating costs.

Water Neutrality

4.7.13 Water neutrality is a concept whereby the total amount of water demand within a planning area is the same (or less) even allowing for additional demand from new development required in the RSS. In order for the water neutrality concept to work, the additional demand created by new development needs to be offset by reducing the demand from existing population and employment. If this can be achieved, the overall balance for water demand is 'neutral'.

4.7.14 The likelihood of achieving water neutrality can be enhanced by maximising water efficiency within new developments (housing and employment) by introducing a water neutrality concept at a development wide level. It is an aim for any development, (new housing or new employment), to use no more water than is absolutely necessary and re-use as much water as is practical. It is theoretically possible, that by using development wide rain water harvesting, grey water recycling and water reuse, to reduce demand for new potable demand to zero. However, in reality some 'clean' water will always be required for drinking water supplies.

Methodology

4.7.15 To determine if the GNDP planning area can be water neutral, calculations were undertaken to determine if the increase in demand for water from the new development can be met through improving water efficiency in existing homes.

4.7.16 As part of the analysis, a series of assumptions have been made:

- existing water use is in the study area is 142l/h/day – this is an average between houses that are already metered (and so considered more water conscious) and those not metered (Ofwat 2007-2008);
- for new development an occupancy rate of 2.1 is used; and
- the growth is defined using the number of dwellings and the calculations are in litres per head per day.

Water neutrality scenarios

4.7.17 A series of future scenarios water use have been developed to test the feasibility of water neutrality. A range of scenarios has been produced in the acknowledgement that whilst there may be aspirations to make new homes as water efficient as possible (and to reduce existing demand), it is much more difficult in practice to deliver water efficiency savings. This is especially the case in existing homes, where the retrofitting of water efficiency devices is expensive and resource intensive. In addition, funding streams for such retrofitting plans are not identified.

4.7.18 For each scenario, different assumptions have been applied to the expected water usage reductions for new homes coupled with different assumptions on the amount of water saving achievable in existing homes through retrofitting of water efficient devices and installation of water meters. The current levels of meter penetration within the Anglian Region presently stands at around 60% (AWS's Statement of Response to the draft WRMP, 2009) which means that water saving measures in terms of installation of water meters can only be realised in around 40% of the existing housing stock.

4.7.19 The demand management solutions for existing homes have been calculated using the findings from various reports produced by the Environment Agency, Defra, Waterwise and Ofwat.

4.7.20 Table 4-8 outlines the amount of water that can be saved in existing households through retrofitting of various water saving devices and methods.

Table 4-8: Water Saving Methods.

Water Saving Method	Potential saving	Comments/uncertainty.
Ultra Low Flush replacement Scheme	50-55l/hhold/d	4.5l toilet assumed to be used. Need incentive to replace old toilets with low flush toilets.
Variable flush retrofit device	21-29l/hhold/d	Need incentive to buy equipment and install the equipment. Potential problems with operation particularly if installed incorrectly.
Low flow shower head scheme	12-14l/hhold/day	Cannot be used with electric, power or low pressure gravity fed systems.
Metering Scheme	5-10% reduction. = 33.5/hhold/d saved	This can be implemented through compulsory metering or through metering on change of occupancy.
Low use fittings:	49.9l/hhold/day (conservative estimate)	This includes fitting Low use taps; Low flow Showerhead and a variable flush device.

4.7.21 The water savings in Table 4-8 for litres per household were converted into litres per head per day using the occupancy rate of 2.1. These were then collated to provide four demand management options to use in existing homes as presented in Table 4-9.

Table 4-9: demand management options for existing homes

Option	Potential Saving	Measures Included
Option 1	35.8l/h/d	Meter, Low flush toilet and a low flow shower.
Option 2	30.4 l/h/day	Meter and the low use fittings.
Option 3	28.7 l/h/day	No Meter, Low Flow Toilet and Low Flow shower.
Option 4	23.3 l/h/day	No Meter and low use fittings

4.7.22 The demand in new homes was calculated using the existing level of demand (142l/h/d) and then using the code for sustainable homes levels (level 1&2 120l/h/d, Level 3&4 105l/h/d level 5&6 80l/h/d).

4.7.23 An assessment matrix was then developed, whereby the different water use figures for new homes were combined with the different levels of water reductions for existing homes in order to ascertain whether enough water could be saved to achieve neutrality in total demand by 2026. As around 60% of the existing housing stock is already metered (AWS, 2009), Options 1 and 2 are only achievable in 40% of the existing houses and therefore a combination of the demand management scenarios were used to assess the potential water saving measures of installing meters in the remaining 40% of the existing housing stock and fitting water saving measures in all existing homes. The analysis was undertaken for each of the towns and villages with proposed growth and for the GNDP study area as a whole. Detailed breakdown of the calculations are provided in Appendix I: Water Neutrality Calculations.

Water Neutrality Results

4.7.24 Table 4-10 displays the results of the analysis for the entire GNDP area with new housing scenarios in the columns and existing house reductions in the rows. The results have been colour coded to show the level of neutrality achieved as follows:

- **Green**: water neutrality is feasible and overall savings could be achieved i.e. by making new homes more water efficient, the demand from new housing could be less than the amount saved by making existing homes more water efficient;
- **Amber**: water neutrality is possible, although there may not be large scale overall savings i.e. total future demand (from new and existing housing) is only 5% lower than the current demand from existing properties.
- **Red**: water neutrality is unlikely to be possible i.e. total future demand is greater than current demand from existing properties

4.7.25 The analysis showed that as long as the GNDP planning area is considered as a whole, water neutrality could theoretically be achieved if all existing homes were fitted with low flush toilets and a low flow shower (Option 3a) and/or all currently unmetered properties were fitted with a meter and low use fittings were installed in all existing homes (Table 4-10). All new houses would be required to be built to CfSH levels 5 & 6 (80 l/h/d) to achieve the water neutral state.

4.7.26 The result show that assuming that 40% of the existing households in Norwich are currently unmetered and could therefore benefit from the largest potential water saving (Option 1 - 35.8 l/h/d) and the remaining 60% of the population could benefit from Option 3 (28.7 l/h/d), the fitting of low flow toilets and showers, the total potential water saving from existing development would be 8.7 Ml/d (3.9 Ml/d from unmetered properties and 4.7 from metered). The lowest water demand scenario (Scenario 4) for new residential development, which requires all new houses to be built to CfSH Level 5 & 6 (80 l/h/d), would demand an extra 6.7 Ml/d water (excluding a 10% headroom allowance up to 2026) and would in theory allow development within Norwich to be water neutral. However, it should be stressed that this is assuming that all new development is built to the CfSH Levels 5 & 6, and that all non-metered existing housing is metered and all houses are fitted with low flush toilets and low flow showers. In reality is unlikely that this level of efficiency will be achieved by 2026.

4.7.27 A more realistic scenario is the introduction of low use fittings in existing homes (Option 4a) and a CfSH level 3 or 4 (105 l/h/d). This shows that whilst neutrality would not be achievable, savings would be such that total demand in 2026 would only be 2.45 megalitres per day more, and if water meters were fitted in the remaining 40% of existing properties in Norwich, this would be reduced to 1.68 megalitres per day more (Option 2 and 4b).

4.7.28 This analysis assumes that water efficient devices could be installed in all existing homes and that the devices would not be replaced over time with less efficient devices such as power showers. Appendix I: Water Neutrality Calculations, also shows that neutrality cannot be achieve in several of the villages or smaller towns when considered individually.

Table 4-10: Results of the water neutrality assessment in the GNDP Study Area. Savings are given in megalitres per day (Ml/d).

Greater Norwich	Existing Housing Affected	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use[22]
Option 1	40%	-2.81	-4.92	-6.18	-8.04
Option 2	40%	-3.40	-5.51	-6.78	-8.63
Option 3a	100%	1.13	-0.97	-2.24	-4.09
Option 3b	60%	-2.02	-4.12	-5.39	-7.24
Option 4a	100%	-0.35	-2.45	-3.72	-5.57
Option 4b	60%	-2.91	-5.01	-6.28	-8.13
Option 1 & 3b	100%	1.91	-0.19	-1.46	-3.31
Option 2 & 3b	100%	1.32	-0.79	-2.05	-3.90
Option 1 & 4b	100%	1.02	-1.08	-2.35	-4.20
Option 2 & 4b	100%	0.43	-1.68	-2.94	-4.79

Note: Where the water efficiency measures have only been applied to a proportion of the existing housing stock, the remaining housing is assumed to continue demanding water at the current average of 142 l/h/d

Water Efficiency in Existing Homes

4.7.29 There are possibilities within existing development to achieve significant savings and to improve efficiency and reduce the baseline water consumption. Existing homes can be retrofitted with a range of fixtures to increase efficiency in these homes, this can include:

- Metering;
- Water efficient fixtures and fittings – for example, flow restrictors or aerating fixtures;
- Low flush or dual flush toilets;
- Water efficient dishwashers and washing machines
- Installation of water butts for garden use; and
- Additionally, education of the existing population about water efficiency and in particular about water efficient fixtures, fittings and appliances can help to reduce water demand. This can be achieved through, for example, water audits or community education programmes.

4.7.30 Based on findings from the Environment Agency report Water Efficiency in the South East of England some of these measures have been considered as a guide to potential reductions in water demand through the use of water efficient measures (Table 4-8).

Water Efficiency in New Homes

4.7.31 New homes can be fitted with a range of fittings to reduce demand, in addition, new developments can have community wide measures to reduce the demand in water, this can range from rainwater harvesting to grey water recycling – the use of wash water from showers and sinks in toilets after on site treatment.

[22] Existing use assumed to be 142 l/h/d

4.7.32 The Code for Sustainable Homes (CSH) sets out the minimum water demand required to meet the different levels of water use in new homes. The CSH sets out the maximum water usage permitted for each code level. This provides a flexible outline for improving the overall sustainability of a house. Table 4-11 outlines the water efficiency that needs to be achieved to reach each of the sustainable levels.

Table 4-11 Code for Sustainable Homes – Water consumption targets for the different code levels and examples of how these targets can be attained in new build

Code for sustainable homes levels.	Amount of Water (litres per person per day)	Examples of how to achieve water efficiency level.
1	120	Install efficient equipment within the home – 18l max volume dishwasher and 60l max volume washing machine. Install 4/6l dual flush toilets. Install 6-9l/min showers. Educate users about how to be efficient water users. Installation of water meters.
2	120	
3	105	As above. In addition, install water butts and equipment to use rainwater in the garden. Install aerating fixtures into bathrooms and kitchens. Include surface water management in the surrounding development.
4	105	
5	80	As above, in addition: Grey water recycling, reduction of surface water from the development. Provide water audits for people to show them where they can reduce water usage.
6	80	

4.7.33 The examples of water efficiency measures include in Table 4-11 are an outline of the possible ways to improve water efficiency. There are many more possibilities that are site specific. Many of these are shown in the Ofwat water efficiency initiatives[23] for water and sewerage companies and it is recommended that these are assessed and considered for inclusion in new development as part of the Norwich WEP. Other steps which should be considered in new builds include: rainwater harvesting from roofs and paved areas (through the use of permeable surfaces); grey water recycling (with some mains support) which can provide enough water to run all toilets, a washing machine and outside taps.

4.7.34 New developments offer the opportunity to work towards a much higher level of water efficiency. The eco-towns water cycle worksheet[24] shows examples of where community schemes have been used as a way to improve efficiency for example, through the collection and supply of rainwater for use in toilets; these kinds of initiatives could be considered for Norwich on a strategic scale to further reduce water demand.

[23] Ofwat, 2006, Water Efficiency Initiatives – Good Practice Register Water Sewerage Companies (England and Wales) – 2006,http://www.ofwat.gov.uk/aptrix/ofwat/publish.nsf/AttachmentsByTitle/goodpracticeregister_2007.pdf/$FILE/goodpracticeregister_2007.pdf Accessed 28-03-08.

[24] TCPA, Environment Agency, Communities and Local Government, 2008, Sustainable Water Management: Eco-towns Water Cycle worksheet,

5 Surface Water Management

5.1 Introduction

5.1.1 This Section considers flood risk generated as a result of the developments, which is an important consideration with respect to the assessment of development areas and current national planning policy with regards to flood risk management.

5.1.2 In areas where development runoff is likely to be discharged to a river system, it is important that new development does not increase the risk of flooding downstream by increasing runoff rates to greater than that of the runoff generated by existing land use. In addition, it is important that new development does not increase the risk of overland flow to adjoining development areas by increasing the amount of impermeable area.

National Flood Risk Policy: PPS25

5.1.3 Planning Policy Statement 25: Development and Flood Risk (PPS25) requires that all new development should ensure that runoff rates and runoff volumes from new development are not increased above that of the existing land use. Some of the development of new homes may be on previously developed (brownfield) land; hence the requirement to reduce runoff rates, as a result of rainfall, will be less onerous for these developments, compared to those on Greenfield sites. For infill development on currently undeveloped land, there will be a requirement to ensure that runoff rates and volumes are no greater than the greenfield rates for the design event with return period of 1 in 100 years (with an allowance for climate change) and smaller rainfall events up to this level.

5.2 Flood Risk from Development: SUDS Utilisation Methodology

5.2.1 In order to reduce runoff rates from developed sites to that of existing (and where possible to achieve 'betterment'), PPS25 and its companion guidance recommend that Sustainable (urban) Drainage Systems (or techniques) are used, known collectively as SUDS. Development within the new development areas will need to include for the SUDS both at a site specific level but also a strategic scale level. In general, there are advantages to be gained to developing drainage strategies for site wide developments such that strategic scale options such as balancing ponds can be developed at lower overall cost, but also to:

- Strategically manage flood risk and surface water;
- Maximise green infrastructure linkage;
- Maximise ecological enhancement;
- Maximise water quality benefits from retention and filter type SUDS; and
- Contribute towards the point system for Code for Sustainable Homes grading.

5.2.2 Considering the options now is a key consideration for this strategic WCS. The following Sections outline some of the key outline or strategic considerations for SUDS for the development areas.

SUDS Options

5.2.3 A description of the type of SUDS that could be considered for the GNDP development areas dependent on the type of housing and density that is envisaged, is included in Appendix D: SuDS Types.

The SUDS Hierarchy

5.2.4 The Environment Agency and Defra currently suggest that the SUDS management train is adopted when considering SUDS techniques to be adopted for new development. This lists the order in which different SUDS techniques should be considered for a site in terms of their requirement to mitigate against surface water and flood risk.

5.2.5 The management train considers SUDS options which first 'prevent' the generation of runoff i.e. green roofs, rainwater harvesting; followed by techniques which control runoff at the source, such as infiltration to ground through permeable paving; then followed sequentially by site wide and regional wide techniques. When considering disposal of attenuated surface water, Part H of the Building Regulations requires that the first choice of surface water disposal should be to discharge to infiltration systems where practicable. In development sites over 1 hectare the Environment Agency will always seek that infiltration is the method of surface water disposal if feasible as the method mimics natural drainage methods.

5.2.6 A SUDS hierarchy should be followed looking at infiltration methods first, then attenuated discharge to a watercourse followed by an attenuated discharge to a sewer. The last options to consider are hard engineered solutions such as attenuation tanks. Infiltration for developments can occur via individual house soakaways through to infiltration lagoons. Attenuation, as a second option, should be provided so the runoff post-development is as a minimum no higher than the pre-development runoff rate, and as close to the site Greenfield runoff rate as possible.

5.2.7 Table 5.1 lists the order in which different SUDS techniques should be considered for a site in terms of their considered mitigation against surface water and flood risk. SUDS techniques at the top of the hierarchy are preferable for their infiltration and runoff prevention benefits. The management train provided below also states the additional potential ecological and water quality benefits that could be achieved by employing the proposed SUDS techniques.

Table 5.1 SUDS Management Train (Surface Water and Flood Risk Mitigation)

Management Train	Component	Description	Water Quantity	Water Quality	Amenity Biodiversity
Source, Prevention	Green roofs	Layer of vegetation or gravel on roof areas providing absorption and storage.	●	●	●
Source, Prevention	Rainwater harvesting	Capturing and reusing rainwater for domestic or irrigation uses.	●	○	○
Source, Prevention	Permeable pavements	Infiltration through the surface into underlying layer.	●	●	○
Source	Filter drains	Drain filled with permeable material with a perforated pipe along the base.	●	●	
Source	Infiltration trenches	Similar to filter drains but allows infiltration through sides and base.	●	●	
Source	Soakaways	Underground structure used for store and infiltration.	●	●	
Source	Bio-retention areas	Vegetated areas used for treating runoff prior to discharge into receiving water or infiltration	●	●	●
Source, Site	Swales	Grassed depressions, provides temporary storage, conveyance, treatment and possibly infiltration.	●	●	○
Site	Sand filters	Provides treatment by filtering runoff through a filter media consisting of sand.	●	●	
Site, Regional	Basins	Dry depressions outside of storm periods, provides temporary attenuation, treatment and possibly infiltration.	●	●	○
Site, Regional	Ponds	Designed to accommodate water at all times, provides attenuation, treatment and enhances site amenity value.	●	●	●
Site, Regional	Wetland	Similar to ponds, but are designed to provide continuous flow through vegetation.	●	●	●

Infiltration SUDS

5.2.8 Infiltration is a key factor in reducing runoff rates and volumes, as it reduces reliance on surface or engineered storage systems such as balancing ponds or storage tanks. Some infiltration SUDS have the additional benefit of being able to encourage habitat creation and water quality benefits (see Table 5.1). However, natural infiltration by creation of open grassland landscaping (where contamination is not an issue) should be encouraged, first for large developments to maximise natural runoff rate reduction, and second to encourage natural recharge of groundwater systems.

5.2.9 Green areas and open space should be maximised for large development areas where the soil and geology is sufficiently permeable to make it a feasible option. Infiltration can also be encouraged via managed SUDS techniques such as soakaways, swales or infiltration trenches. Given that much of the study area is underlain by permeable geology such as Chalk or Sands and Gravels, infiltration is a key consideration for new development in the GNDP study area. Despite this, the Chalk underlying much of the study area is considered a Major Aquifer used for public supply (including all the named towns) therefore due regard needs to be paid to protection of groundwater from pollution pathways that can be created by poorly managed or badly located infiltration SUDS, and as such, there are restrictions on the types of infiltration SUDS systems permitted within developments.

5.2.10 Determination of infiltration sensitive areas is considered by reviewing soil type and geology via groundwater vulnerability maps, and catchment areas which feed public water supply sources via source protection zone mapping.

Source Protection Zones

5.2.11 The Environment Agency defines groundwater Source Protection Zones around all major groundwater abstraction points. Source Protection Zones (SPZ) are defined to protect areas of groundwater that are used for potable supply, including public/private potable supply, (including mineral and bottled water) or for use in the production of commercial food and drinks.

5.2.12 SPZs are defined based on the time it takes for pollutants to reach an abstraction point from any point at the water table. It does not include the time taken for water to infiltrate from the surface down to the water table. This transmission time enables the Environment Agency to define 3 zones around a groundwater abstraction point.

- Zone 1 (Inner Protection Zone) – This is defined as ‘any pollution that can travel to the borehole within 50 days from any point within the zone is classified as being inside zone 1’
- Zone 2 (Outer Protection Zone) – This is defined as the area that ‘covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest’
- Zone 3 (Total Catchment) - The total catchment is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

5.2.13 Depending on the nature of the proposed development and the location of the development area with regards to the SPZs, restrictions may be placed on the types of SUDS appropriate to certain areas. Infiltration into SPZ1 is generally only permitted for clean roof runoff. Runoff from roads and car parks is not acceptable in SPZ1 and is only acceptable in SPZ2 if there are sufficient controls of sources of contamination (e.g. oil separators) and there is sufficient depth between the unsaturated soil into which the water is drained and the saturated water table in the geology below. The SPZ designations for the various PGAs are discussed in the Planning Document within the PGA infrastructure assessment section (section 6).

6 References

AWS (2008) draft Water Resources Management Plan – Text and Tables

Anglian Water Services (2006). Drought Plan. AWS, 2006.

Anglian Water Services. Waste Efficiency Plan.

ARUP & Oxford Economics (2008). Greater Norwich Employment Growth and Sites & Premises Study.

AWS (2007) Strategic Direction Statement 2010-2035

British Geological Survey (1989) Map Sheet No. 161 – Solid and Drift Geology. BGS– Geological Memoir of the County around Norwich.

Department of Communities and Local Government (2006). Planning Policy Statement 25; Development and Flood Risk

Department of Communities and Local Government (2007) Development and Flood Risk: A Practice Guide Companion to PPs25 'Living Draft' – A Consultation Paper

East of England Regional Assembly, (2004) East of England Regional Spatial Strategy (EERSS).

Environment Agency – Groundwater Vulnerability East Norfolk Sheet No. 26 and Source Protection Zone Maps (Environment Agency website)

Environment Agency (2001) Water Resources for the future. A summary of the strategy for Anglian Region. Environment Agency.

Environment Agency, (2006).The Broadland Rivers Catchment Abstraction Management Strategy.

Environment Agency (2009). Groundwater Protection: Policy and Practice. Part 4: Legislation and policies

Environment Agency (2007). River Basin Planning: Summary of Significant Water Management Issues – Anglian Water District.

Environment Agency (2009). Anglian River Basin Management Plan.

Halcrow Group Limited (2005) Corby Water Cycle Strategy – Phase 1 – Outline Strategy technical Report

Halcrow Group Limited (2007) North Northamptonshire Outline Water Cycle Strategy. Outline Water Cycle Strategy Technical Report

Leishman, R. 5th March 2007 GNWCS – Natural England Report of Issues. .

Norwich City Council (2007). JCS for Broadland, Norwich and South Norfolk – Strategic Growth Options

Norwich City Council (2007). Water Cycle Study Development Scenarios – “Additional” Development

Norwich City Council, (2003) Norwich’s Environment Strategy 2003-08.

Ofwat Security of supply, leakage and water efficiency 2007/08 report.

Appendix A: Figures

Figure 1: PGA Locations and Growth Figures

Figure 2: Wastewater Strategy

Figure 3: WFD current Ecological status classifications

Figure 4: Stage 2b WCS Methodology

Figure 5a: Quality Consent Details: Planned consented

Figure 5b: Quality Consent Details: WFD Compliance

Figure 5c: Quality Consent Details: Best Case Recommended

Figure 6: Environmental Designations

Appendix B: Wastewater Treatment Capacity Calculations

Calculations

Job Title	**Norwich Water Cycle Study - Detailed Study**					Date	Project Number
Element	WWTW Volumetric Capacity Assessment					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Purpose of Calculation
To undertake an assessment of the volumetric capacity of Wymondham, Swardeston, Poringland, Aylsham, Belaugh, Harleston, Sisland, Long Stratton, Reepham, Acle-Damgate, Stoke Holy Cross, Rackheath and Diss WWTW and calculate available headroom.

Method of Calculation
Spreadsheet

Source/Reference Documents Used
AWS WWTW Details (Norwich WCS Data.xls) provided 09-07-2008
GNDP Levels and Phasing (Development Levels and Phasing.doc) provided Feb-2010
OFWAT Security of Supply Rpt 2006-2007

Key Parameters Used
Dry Weather Flow (DWF)
Flow to Full Treatment (FtFT)
Measured Dry Weather Flow (mDWF) -
Current Population Served by WWTW (P)
Current Trade Flow Treated at WWTW (E)
Per Capita Water Demand (G)
Infiltration (I)
Property Occupancy Ratio (OR)

Calculated DWF = PG+I+E

where:	PG=Pd*Gd+Ph*Gh
	I=25%PG
	E=trade flows m3/d
where:	Pd=domestic poluation
	Ph=holiday poluation
	Gd=domestic per capita consumption (144 l/h/d)
	Gh=holiday per capita consumption (55 l/h/d)
	Gc=commercial per capita consumption (28 l/h/d)

Calculated FtFT = 3PG+I+3E

The Occupancy Rate (OR) is 2.1
The commercial employment per capita consumption (Gc) is 28 l/h/d
The future domestic per capita consumption (Gf) is 137 l/h/d

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Diss WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK			Date	Check		

Site Name: Diss WWTW
Site Location: TM 1205 7934
Receiving Watercourse: River Waveney

Base Data - Provided by AWS from June 2008 Return			
Total PE		12,569	PE
Domestic and Tanker Load PE	Pd	12,203	PE
Holiday PE	Ph	300	PE
Trade Flow	E	16	m3/d
Dry Weather Flow Consent	DWF	4,032	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	1,678	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	1,774	m3/d
Infitration	I = 0.25*PG	443	m3/d
Trade Flow	E	16	m3/d
Calculated DWF	PG+I+E	2,234	m3/d
Calculated FtFT	3PG+I+3E	5,814	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	2,354	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		13,746	PE
Dwelling Capacity	Population Capacity/OR	6,546	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	537	dwellings
Additional Population	Phf = Hf*OR	1,128	PE
Additional Flow from Housing	PGhf = Phf*Gf	154	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	39	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	193	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,871	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	6,316	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	2,161	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		12,619	PE
Dwelling Capacity	Population Capacity/OR	6,009	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study					Date	Project Number
Element	**Rackheath WWTW Volumetric Capacity Assessment**					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Site Name: Rackheath WWTW
Site Location: TG 2682 1420
Receiving Watercourse: Dobbs Beck, trib of River Bure

Base Data - Provided by AWS from June 2008 Return			
Total PE		1,663	PE
Domestic and Tanker Load PE	Pd	1,611	PE
Holiday PE	Ph	49	PE
Trade Flow	E	3	m3/d
Dry Weather Flow Consent	DWF	359	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	56	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	235	m3/d
Infitration	I = 0.25*PG	59	m3/d
Trade Flow	E	3	m3/d
Calculated DWF	PG+I+E	296	m3/d
Calculated FtFT	3PG+I+3E	771	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	0	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		0	PE
Dwelling Capacity	Population Capacity/OR	0	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	0	dwellings
Additional Population	Phf = Hf*OR	0	PE
Additional Flow from Housing	PGhf = Phf*Gf	0	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	0	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	0	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	359	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	771	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	0	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		**0**	PE
Dwelling Capacity	Population Capacity/OR	**0**	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Stoke Holy Cross WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK	Cpe		Date	Check		

Site Name: Stoke Holy Cross WWTW
Site Location: TG 2277 0292
Receiving Watercourse: River Tas

Base Data - Provided by AWS from June 2008 Return			
Total PE		1,637	PE
Domestic and Tanker Load PE	Pd	1,637	PE
Holiday PE	Ph	0	PE
Trade Flow	E	0	m3/d
Dry Weather Flow Consent	DWF	467	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	506	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	236	m3/d
Infitration	I = 0.25*PG	59	m3/d
Trade Flow	E	0	m3/d
Calculated DWF	PG+I+E	295	m3/d
Calculated FtFT	3PG+I+3E	766	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	0	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		0	PE
Dwelling Capacity	Population Capacity/OR	0	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	177	dwellings
Additional Population	Phf = Hf*OR	372	PE
Additional Flow from Housing	PGhf = Phf*Gf	51	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	13	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	64	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	531	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	932	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	-64	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		-374	PE
Dwelling Capacity	Population Capacity/OR	-178	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study					Date	Project Number
Element	**Acle-Damgate WWTW Volumetric Capacity Assessment**					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK	Cpe		Date	Check			

Site Name: Acle-Damgate WWTW
Site Location: TG4056 1000
Receiving Watercourse: River Bure

Base Data - Provided by AWS from June 2008 Return			
Total PE		3,650	PE
Domestic and Tanker Load PE	Pd	3,524	PE
Holiday PE	Ph	85	PE
Trade Flow	E	17	m3/d
Dry Weather Flow Consent	DWF	1,189	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	775	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	512	m3/d
Infitration	I = 0.25*PG	128	m3/d
Trade Flow	E	17	m3/d
Calculated DWF	PG+I+E	657	m3/d
Calculated FtFT	3PG+I+3E	1,716	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	0	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		**0**	PE
Dwelling Capacity	Population Capacity/OR	**0**	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	241	dwellings
Additional Population	Phf = Hf*OR	506	PE
Additional Flow from Housing	PGhf = Phf*Gf	69	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	17	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	87	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,276	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	1,941	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	**-87**	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		**-508**	PE
Dwelling Capacity	Population Capacity/OR	**-242**	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Reepham WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK	Cpe		Date	Check		

Site Name: Reepham WWTW
Site Location: TG 1045 2257
Receiving Watercourse: Blackwater Drain, trib of River Wensum

Base Data - Provided by AWS from June 2008 Return			
Total PE		3,826	PE
Domestic and Tanker Load PE	Pd	3,693	PE
Holiday PE	Ph	99	PE
Trade Flow	E	1	m3/d
Dry Weather Flow Consent	DWF	1,574	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	882	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	537	m3/d
Infitration	I = 0.25*PG	134	m3/d
Trade Flow	E	1	m3/d
Calculated DWF	PG+I+E	672	m3/d
Calculated FtFT	3PG+I+3E	1,748	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	0	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		0	PE
Dwelling Capacity	Population Capacity/OR	0	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	241	dwellings
Additional Population	Phf = Hf*OR	506	PE
Additional Flow from Housing	PGhf = Phf*Gf	69	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	17	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	87	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,661	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	1,973	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	-87	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		-508	PE
Dwelling Capacity	Population Capacity/OR	-242	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study	Date	Project Number
Element	**Long Stratton WWTW Volumetric Capacity Assessment**	17/11/2009	D118607

Originator	Checked	Revision	Suffix	Orig
SK			Date	Check

Site Name: Long Stratton WWTW
Site Location: TM 1933 9365
Receiving Watercourse: River Tas

Base Data - Provided by AWS from June 2008 Return			
Total PE		5,018	PE
Domestic and Tanker Load PE	Pd	4,986	PE
Holiday PE	Ph	0	PE
Trade Flow	E	0	m3/d
Dry Weather Flow Consent	DWF	1,200	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	686	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	718	m3/d
Infitration	I = 0.25*PG	179	m3/d
Trade Flow	E	0	m3/d
Calculated DWF	PG+I+E	898	m3/d
Calculated FtFT	3PG+I+3E	2,334	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	514	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		3,001	PE
Dwelling Capacity	Population Capacity/OR	1,429	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	1,927	dwellings
Additional Population	Phf = Hf*OR	4,047	PE
Additional Flow from Housing	PGhf = Phf*Gf	554	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	139	m3/d

Future Employment			
Number of Commercial Jobs	Ecf		Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	693	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,379	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	4,136	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	-179	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		-1,045	PE
Dwelling Capacity	Population Capacity/OR	-498	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study					Date	Project Number
Element	**Sisland WWTW Volumetric Capacity Assessment**					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Site Name: Sisland WWTW
Site Location: TM 3431 9944
Receiving Watercourse: Trib of River Chet

Base Data - Provided by AWS from June 2008 Return			
Total PE		6,294	PE
Domestic and Tanker Load PE	Pd	6,213	PE
Holiday PE	Ph	79	PE
Trade Flow	E	6	m3/d
Dry Weather Flow Consent	DWF	1,600	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	1,028	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	899	m3/d
Infitration	I = 0.25*PG	225	m3/d
Trade Flow	E	6	m3/d
Calculated DWF	PG+I+E	1,129	m3/d
Calculated FtFT	3PG+I+3E	2,939	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	572	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		3,340	PE
Dwelling Capacity	Population Capacity/OR	1,591	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	323	dwellings
Additional Population	Phf = Hf*OR	678	PE
Additional Flow from Housing	PGhf = Phf*Gf	93	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	23	m3/d

Future Employment			
Number of Commercial Jobs	Ecf		Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	116	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,144	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	3,241	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	456	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		2,663	PE
Dwelling Capacity	Population Capacity/OR	1,268	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Harleston WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK			Date	Check		

Site Name: Harleston WWTW
Site Location: TM 2500 8410
Receiving Watercourse: River Waveney

Base Data - Provided by AWS from June 2008 Return			
Total PE		5,283	PE
Domestic and Tanker Load PE	Pd	4,601	PE
Holiday PE	Ph	670	PE
Trade Flow	E	7	m3/d
Dry Weather Flow Consent	DWF	1,392	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	748	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	699	m3/d
Infitration	I = 0.25*PG	175	m3/d
Trade Flow	E	7	m3/d
Calculated DWF	PG+I+E	881	m3/d
Calculated FtFT	3PG+I+3E	2,293	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	644	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		3,761	PE
Dwelling Capacity	Population Capacity/OR	1,791	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	779	dwellings
Additional Population	Phf = Hf*OR	1,636	PE
Additional Flow from Housing	PGhf = Phf*Gf	224	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	56	m3/d

Future Employment			
Number of Commercial Jobs	Ecf		Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	280	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,028	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	3,021	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	364	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		2,126	PE
Dwelling Capacity	Population Capacity/OR	1,012	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study	Date	Project Number
Element	**Belaugh WWTW Volumetric Capacity Assessment**	17/11/2009	D118607

Originator	Checked	Revision	Suffix	Orig
SK			Date	Check

Site Name: Belaugh WWTW
Site Location: TG 2944 1837
Receiving Watercourse: River Bure

Base Data - Provided by AWS from June 2008 Return			
Total PE		8,557	PE
Domestic and Tanker Load PE	Pd	7,660	PE
Holiday PE	Ph	460	PE
Trade Flow	E	22	m3/d
Dry Weather Flow Consent	DWF	2,273	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	1,401	m3/d

Parameters		
Consumption		
Gd Domestic	0.144	m3/d
Gh Holiday	0.055	m3/d
Gc Commercial	0.028	m3/d
Gi Industry	0.028	m3/d
Gf Future Domestic	0.137	m3/d
Dwelling Occupancy		
OR Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	1,128	m3/d
Infitration	I = 0.25*PG	282	m3/d
Trade Flow	E	22	m3/d
Calculated DWF	PG+I+E	1,433	m3/d
Calculated FtFT	3PG+I+3E	3,734	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	872	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		5,092	PE
Dwelling Capacity	Population Capacity/OR	2,425	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	2,406	dwellings
Additional Population	Phf = Hf*OR	5,053	PE
Additional Flow from Housing	PGhf = Phf*Gf	692	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	173	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	865	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	2,266	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	5,984	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	7	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		41	PE
Dwelling Capacity	Population Capacity/OR	19	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study					Date	Project Number
Element	**Aylsham WWTW Volumetric Capacity Assessment**					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Site Name: Aylsham WWTW
Site Location: TG 2083 2675
Receiving Watercourse: River Bure

Base Data - Provided by AWS from June 2008 Return			
Total PE		8,507	PE
Domestic and Tanker Load PE	Pd	8,281	PE
Holiday PE	Ph	210	PE
Trade Flow	E	6	m3/d
Dry Weather Flow Consent	DWF	1,440	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	1,150	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	1,204	m3/d
Infitration	I = 0.25*PG	301	m3/d
Trade Flow	E	6	m3/d
Calculated DWF	PG+I+E	1,511	m3/d
Calculated FtFT	3PG+I+3E	3,930	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	290	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		1,693	PE
Dwelling Capacity	Population Capacity/OR	806	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	600	dwellings
Additional Population	Phf = Hf*OR	1,260	PE
Additional Flow from Housing	PGhf = Phf*Gf	173	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	43	m3/d

Future Employment			
Number of Commercial Jobs	Ecf		Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	216	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	1,366	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	4,491	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	74	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		432	PE
Dwelling Capacity	Population Capacity/OR	206	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Poringland WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK			Date	Check		

Site Name: Poringland WWTW
Site Location: TG 2840 0090
Receiving Watercourse: River Chet

Base Data - Provided by AWS from June 2008 Return			
Total PE		4,179	PE
Domestic and Tanker Load PE	Pd	4,179	PE
Holiday PE	Ph	0	PE
Trade Flow	E	0	m3/d
Dry Weather Flow Consent	DWF	930	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	660	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	602	m3/d
Infitration	I = 0.25*PG	150	m3/d
Trade Flow	E	0	m3/d
Calculated DWF	PG+I+E	752	m3/d
Calculated FtFT	3PG+I+3E	1,956	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	270	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		1,577	PE
Dwelling Capacity	Population Capacity/OR	751	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	709	dwellings
Additional Population	Phf = Hf*OR	1,489	PE
Additional Flow from Housing	PGhf = Phf*Gf	204	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	51	m3/d

Future Employment			
Number of Commercial Jobs	Ecf		Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	255	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	915	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	2,619	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	15	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		88	PE
Dwelling Capacity	Population Capacity/OR	42	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study				Date	Project Number
Element	**Swardeston WWTW Volumetric Capacity Assessment**				17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig		
SK			Date	Check		

Site Name: Swardeston WWTW
Site Location: TG 1960 0285
Receiving Watercourse: Intwood Stream, trib of River Yare

Base Data - Provided by AWS from June 2008 Return			
Total PE		3,840	PE
Domestic and Tanker Load PE	Pd	3,840	PE
Holiday PE	Ph	0	PE
Trade Flow	E	0	m3/d
Dry Weather Flow Consent	DWF	1,100	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	715	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	553	m3/d
Infitration	I = 0.25*PG	138	m3/d
Trade Flow	E	0	m3/d
Calculated DWF	PG+I+E	691	m3/d
Calculated FtFT	3PG+I+3E	1,797	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	385	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		2,248	PE
Dwelling Capacity	Population Capacity/OR	1,071	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	503	dwellings
Additional Population	Phf = Hf*OR	1,056	PE
Additional Flow from Housing	PGhf = Phf*Gf	145	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	36	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	0	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	0	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	181	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	896	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	2,267	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	204	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		1,191	PE
Dwelling Capacity	Population Capacity/OR	567	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study	Date	Project Number
Element	**Wymondham WWTW Volumetric Capacity Assessment**	17/11/2009	D118607

Originator	Checked	Revision	Suffix	Orig
SK			Date	Check

Site Name: Wymondham WWTW
Site Location: TG 0950 0299
Receiving Watercourse: River Tiffey

Base Data - Provided by AWS from June 2008 Return			
Total PE		16,518	PE
Domestic and Tanker Load PE	Pd	15,533	PE
Holiday PE	Ph	0	PE
Trade Flow	E	54	m3/d
Dry Weather Flow Consent	DWF	4,400	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	2,746	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	2,237	m3/d
Infitration	I = 0.25*PG	559	m3/d
Trade Flow	E	54	m3/d
Calculated DWF	PG+I+E	2,850	m3/d
Calculated FtFT	3PG+I+3E	7,431	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	1,655	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		9,664	PE
Dwelling Capacity	Population Capacity/OR	4,602	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	2,898	dwellings
Additional Population	Phf = Hf*OR	6,086	PE
Additional Flow from Housing	PGhf = Phf*Gf	834	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	208	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	4605	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	129	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	1,171	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	3,917	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	10,528	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	483	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		2,820	PE
Dwelling Capacity	Population Capacity/OR	1,343	dwellings

Calculations

Job Title	Norwich Water Cycle Study - Detailed Study					Date	Project Number
Element	**Whitlingham WWTW Volumetric Capacity Assessment**					17/11/2009	D118607
Originator	Checked	Revision	Suffix	Orig			
SK			Date	Check			

Site Name: Whitlingham WWTW
Site Location: TG 2829 0804
Receiving Watercourse: River Yare

Base Data - Provided by AWS from June 2008 Return			
Total PE		299,554	PE
Domestic and Tanker Load PE	Pd	229,698	PE
Holiday PE	Ph	3,667	PE
Trade Flow	E	3,322	m3/d
Dry Weather Flow Consent	DWF	66,250	m3/d
Flow to Full Treatment Consent	FtFT		m3/d
Measured Dry Weather Flow	mDWF	55,639	m3/d

Parameters			
Consumption			
Gd	Domestic	0.144	m3/d
Gh	Holiday	0.055	m3/d
Gc	Commercial	0.028	m3/d
Gi	Industry	0.028	m3/d
Gf	Future Domestic	0.137	m3/d
Dwelling Occupancy			
OR	Occupancy Rate	2.1	people

Current Calculated Flow (for Reference Only)			
Population Consumption	PG = (Pd*Gd)+(Ph+Gh)	33,278	m3/d
Infitration	I = 0.25*PG	8,320	m3/d
Trade Flow	E	3,322	m3/d
Calculated DWF	PG+I+E	44,920	m3/d
Calculated FtFT	3PG+I+3E	118,120	m3/d

Current Headroom Calculations			
DWF Capacity	DWF - mDWF	10,611	m3/d
FtFT Capacity	FTFT - Calculated FtFT		m3/d
Population Capacity		61,962	PE
Dwelling Capacity	Population Capacity/OR	29,506	dwellings

Future Housing Allocations			
Number of Dwellings	Hf	28,358	dwellings
Additional Population	Phf = Hf*OR	59,552	PE
Additional Flow from Housing	PGhf = Phf*Gf	8,159	m3/d
Additional Infiltration from Housing	Ihf = 0.25*PGHf	2,040	m3/d

Future Employment			
Number of Commercial Jobs	Ecf	20395	Jobs
Number of Industrial Jobs	Eif	0	Jobs
Additional Flow from Employment	Eef = (Ecf*Gc)+(Eif*Gi)	571	m3/d

Future Calculated Flow			
Additional DWF from Future Dev	aDWF = PGhf + Ihf +Eef	10,769	m3/d
Future Calculated DWF	fDWF = mDWF + aDWF	66,408	m3/d
Future Calculated FtFT	fFTfT=cFtFT+3PGhf*Ihf*3Eef	146,349	m3/d

Future Headroom Calculations			
DWF Capacity	DWF - fDWF	-158	m3/d
FtFT Capacity	FTFT - fFTft		m3/d
Population Capacity		-923	PE
Dwelling Capacity	Population Capacity/OR	-439	dwellings

Appendix C: Stage 3 RoC Detailed Findings

Water Quality Sensitivities - Wensum

6.1.1 further information as on water quality sensitivities have been obtained regarding the interest features of the SAC and have been listed below.

Bullhead[25]

6.1.2 Philippart (1979) found the lower tolerable pH limit to be 4.7. Although no studies have been conducted to determine the upper tolerable limit, this is known to reach about pH 7 in upland streams and 9 in lowland chalk streams in which bullheads occur. The upper tolerable limit is therefore likely to be >9.0. Brown trout, which typically occur sympatrically with bullhead, require a minimum dissolved oxygen concentration of 40% saturation, and it is likely that a similar level is required by bullheads. Provided oxygen saturation remains high, bullhead can tolerate high concentrations of nitrogen compounds.

Brook Lamprey[26]

6.1.3 As with other lamprey species, there are relatively few data available concerning the water quality requirements of the brook lamprey (Alabaster & Lloyd 1982). Occasional mortalities have been reported that have been ascribed to pollution, but few details are available.

Larvae

6.1.4 Potter et al. (1970, 1986) have shown that oxygen tension is a major factor in the maintenance of the burrowing habit of larvae. They can survive almost anoxic conditions in their burrows for only a few hours, after which they must come out or die. However, they can tolerate low oxygen tension, and may remain in their burrows for some time under these conditions (Hill & Potter 1970).

6.1.5 Laboratory studies on the effect of temperature on the development of embryos have shown that successful hatching of free-swimming ammocoetes is only possible within a relatively restricted range of water temperatures (Damas 1950). Hardisty & Potter (1971) note that 'the kind of fluctuations that sometimes occur in the spring (particularly in small streams) might adversely affect the production of hatched larvae'. Thomas (1962) has shown that, in *Lampetra lamottenii* (and *Petromyzon marinus*), ammocoetes are most active at water temperatures between 10ºC and 14ºC.The preferred temperature for *Lampetra planeri* was identified by Schroll (1959) as 12ºC.

6.1.6 The onset of transformation of larvae usually occurs in a short period (three to four weeks) and it may be that temperature is the operative factor (Potter 1970, Hardisty & Potter 1971).There are also indications that, in successive years, the time of onset of metamorphosis in *Lampetra planeri* in the field has varied according to the prevailing spring temperatures (Hardisty & Potter 1971).

Adults

6.1.7 The brook lamprey is regarded as being sensitive to pollution, but few data appear to be available. Some pollution in the lower reaches of quite a number of rivers in Britain appears to be

[25] Ecology of the Bullhead Conserving Natura 2000 Rivers Ecology Series No. 4 Mark L Tomlinson and Martin R Perrow
[26] Ecology of the River, Brook and Sea Lamprey Conserving Natura 2000 Rivers Ecology Series No. 5 Peter S Maitland

tolerated. In the absence of specific tolerance data for this species it must be assumed that conditions in all parts of any river where brook lampreys occur, or pass through on migration, are at least UK Water Quality Class B (in England, Wales and Northern Ireland) or A2 (in Scotland).

White-clawed crayfish

6.1.8 Populations in the UK are associated with chalk, limestone or sandstone deposits in water bodies where calcium content is a minimum of 5 mg/l and pH ranges of between 6.5 and 9.0 (alkaline). Oxygen levels below 5 mg/l for more than a few days in summer months may cause stress.

Desmoulin's whorl snail

6.1.9 No specific additional data

Watercourses characterised by Ranunculion fluitantis and Callitricho-Batrachion

6.1.10 The River Wensum constitutes the CB1 'Lowland, low-gradient *Potamogeton/Sagittaria'* eutrophic river community. This vegetation type typically occurs on large, slow-flowing lowland rivers with a stable base flow and a substrate consisting mainly of silts or clays. *Potamogeton* spp. (particularly *Potamogeton pectinatus)* and *Myriophyllum spicatum* are particularly prominent within the plant community, while *Ranunculus* species are less noticeable than in many other CB types, with *Ranunculus penicillatus ssp. pseudofluitans* and *Ranunculus fluitans* being characteristic.

6.1.11 No specific additional water quality data is available

River Wensum SAC – Stage 3 summary

6.1.12 The River Wensum SAC is one of the best examples in the UK of a naturally enriched calcareous lowland river. The upper reaches of the river are fed by chalk springs and drainage from calcareous soils, and support chalk stream vegetation communities. These are identified in the text below.

6.1.13 In terms of discharge consents, the following conclusions can be drawn from the Environment Agency's assessment which is pertinent to the Greater Norwich WCS:

- At least 18 of the existing consented discharges could not be ruled out as having no adverse impact (either alone or in combination) on the SAC. All of these consents will be reviewed as part of Stage 4;
- The key impacts are in siltation, discharge of toxic substances and phosphorus (P)
- The Wensum is not reaching the required Water Framework Directive (WFD) P target as set out by the UK's Technical Advisory Group (UKTAG) for the WFD for SAC rivers and that this is the case upstream of the SSSI as well as through the SAC component; and
- Any proposed discharges to the Wensum, both upstream and within the SAC as a result of new development is likely to prove difficult to consent without very high levels of treatment, because measures are required to ensure that the existing condition is improved to further protect the SAC.

6.1.14 In terms of abstraction licences, the following conclusions can be drawn from the Environment Agency's assessment which is pertinent to the Greater Norwich WCS:

- It is considered that existing abstraction licences are adversely impacting on the integrity of the SAC by altering groundwater levels and hence river levels and flow (velocities); this in turn has the effect of reducing available habitat and reducing dilution capacity of in stream nutrients and pollution;
- 71 groundwater licences (including 1 mixed groundwater and surface water licence) could not be ruled out as not having an adverse impact (in combination) on the SAC. All of these licences (to be reviewed in Stage 4) are believed to result in a groundwater drawdown (level reduction) of 0.001m or more;
- Of these licences, one is considered to be impacting on the SAC on its own. Although it is not explicitly stated in the Stage 3 reports released, The Costessey AP licence (which is a mixed groundwater and surface water licence dependent on flow conditions in the Wensum) is the licence which is considered to be impacting on the SAC when considered on its own;
- Liaison with the Environment Agency and Natural England has confirmed that the AP licence is considered to be having an adverse impact in isolation from (as well as in combination with) other abstraction licences;
- 30 surface water abstractions can also not be shown to be having no adverse impact on the SAC.
- It can be concluded that further direct surface water abstraction from the Wensum is unlikely to be permitted until solutions have been put in place (Stage 4) to address the current abstraction impacts on the SAC and that this would extend to the development of groundwater sources which draw on aquifer water which is hydraulically connected to baseflow in the Wensum.

SAC Designated Species and Habitats

- Floating Vegetation of *Ranunculus* of plain and submontainous rivers;
- Bullhead;
- Brook lamprey;
- White-clawed crayfish; and
- Desmoulin's whorl Snail

Yare Broads and Marshes SAC/SPA – Stage 3 RoC summary

6.1.15 The Yare Broads and Marshes are a nationally important wetland site consisting of extensive areas of unreclaimed fen, carr woodland, open water and grazing marsh on shallow fen peats. The species-rich fens, dykes and unimproved meadows hold an outstanding assemblage of plants including many rare species. SAC/SPA designated features are outlined below. In terms of discharge consents, the following conclusions can be drawn which are pertinent to the GNWCS:

- Toxic substances, salinity, temperature and pH are not considered to be adversely impacting on the designated sites. P is considered to be the key issue with respect to nutrient enrichment in the River Yare and hence adverse impact on the downstream designated sites. Orthophosphate (or soluble reactive phosphorus) is considered to be a key concern;

- The discharge from Whitlingham WwTW (into the tidal Yare) cannot be ruled out as not having an adverse impact on the designated European sites due to the substantial load contributed by this WwTW. All other water company WwTWs discharging to the tidal Yare have been ruled out as having an adverse impact (alone or in combination);
- Discharges from Wymondham and Long Stratton WwTWs (upstream of the tidal limit) cannot be ruled out as not having an adverse impact on the downstream designated sites; however, P modelling has shown that even if these discharges (as well as 2 smaller water company discharges) were removed completely, the orthophosphate concentrations would still be greater than the current proposed WFD standards for SAC rivers;
- Reepham WwTW discharging into the Wensum cannot be ruled out as not having no adverse impact on the downstream Yare Broads and Marshes site;
- Process discharge from Heigham WTW is not considered to be adversely impacting on the designated sites;
- In total, 12 discharges could not be ruled out as having no impact on the SAC/SPA and will be considered in Stage 4 of the RoC;
- Further discharges from those WwTWs whose consents have been highlighted as potentially impacting on the SAC will need to consider very high levels of treatment for P (and potentially other parameters) in order to prevent worsening of an already identified problem;
- Although the RoC has potentially highlighted some existing discharges as impacting on the SAC/SPA, increasing treated flow at other works which discharge upstream of the sites but eventually flow into the Yare Broads and Marshes, would also have to consider very high levels of treatment.
- Abstractions were not found to be impacted adversely on the SAC.

6.1.16 As the overall RoC process moves forward into Stage 4 (determination and production of management plans), more information should be made available on specific licences and consents which will need to be altered or have solutions implemented in order to address the impact of the consent/licence. It is recommended that this will be addressed in during Stage 2b of the GNWCS such that the impact of any existing consent or licence change is factored in the requirements of the future water environment baseline for detailed site selection and assessment.

SAC Designated Species and Habitats

- Transition mires and Quaking bogs
- Hard Oligo- mesotrophic waters
- Alluvial Forests
- Calcareous Fens
- Natural Eutrophic Waters
- Molinia Meadows
- Bittern
- Marsh Harrier
- Hen Harrier

- Gadwall
- Shoveler
- Ruff
- Assemblage
- Desmoulin's Whorl Snail
- Otter

Water Quality issues (discharge) and the RoC

River Wensum SAC

6.1.17 The River Wensum was designated as an SAC for its:

- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
- White-clawed (or Atlantic stream) crayfish Austropotamobius pallipes
- Desmoulin`s whorl snail Vertigo moulinsiana
- Brook lamprey Lampetra planeri ; and
- Bullhead Cottus gobio

Background trends

6.1.18 The Environment Agency concluded in their Review of Consents (RoC) process that nutrient enrichment of the River Wensum was a concern, especially as phosphorous concentrations were shown to be elevated above acceptable standards. The Environment Agency has further suggested that discharge consents have been shown to contribute nearly 75% of all phosphorous loads to the river system. The Agency identified twenty sources of phosphorous that were contributing nearly 95% phosphorous loading to the River Wensum catchment, of which many were Wastewater Treatment Works. Of the twenty consents, fourteen WwTW accounted for nearly 62% of point source loads and are shown in Table 0-1.

6.1.19 Whilst improvements to the consents listed in Table 0-1 to counter the current adverse effects will be made as a result of the Environment Agency RoC process, there is nonetheless potential for future development in Greater Norwich to exceed these standards and require further technological adaptations or re-routing of effluent from future development at Norwich to other WwTW's that do not discharge to the River Wensum.

Table 0-1: Major consents affecting the River Wensum (*Source: Environment Agency)*

Agency Ref	Description of permission, plan or project
AEELF12301	South Raynham HSW
AEENF1189	Sculthorpe WwTW
AEENF119B	Weasenham St Peter

Agency Ref	Description of permission, plan or project
AEENF12055	Foulsham WwTW
AEENF12100	Stibbard Moor End WwTW
AEENF12129	Horningtoft WwTW
AEENF1305	Reepham WwTW
AEENF1327	East Rudham WwTW
AEENF15448	Fakenham WwTW
AEENF527	Dereham WwTW
AW4NF1046X	Swanton Morely Airfield WwTW
AW4NF199X	North Elmham WwTW
AW4NF405X	Weasenham All Saints WwTW
AW4NF624X	Belaugh WwTW

Quality standards

6.1.20 The Environment Agency RoC process identified the designated SAC features as listed in Table 0-2 as having a requirement for good water quality and specific targets. .

Table 0-2: Water quality standards for the interest features of the River Wensum SAC

Indicator	Feature and Target
Biological class - Environment Agency's General Quality Assessment scheme	bullhead - >='b' brook lamprey - >='b' white-clawed crayfish >='b' Desmoulin's whorl snail >='b' In addition, no drop in class from existing situation
River Ecosystem Class	bullhead - >=RE2 brook lamprey - >=RE2 white-clawed crayfish>=RE3 Desmoulin's whorl snail >= RE2 In addition, no drop in class from existing situation
Suspended solids (annual average).	bullhead - <=25 mgl l^{-1} brook lamprey <=25 mgl l^{-1} white-clawed crayfish <=25mgl^{-1}
Soluble Reactive Phosphorus (annual mean) (equivalent to Total Reactive Phosphorus / Orthophosphorus)	An annual average phosphate concentration of 0.04mg/l from the upstream limits of the SSSI to Sculthorpe; 0.06mg/l from Sculthorpe to Taverham Bridge; and 0.1mg/l from Taverham Bridge

	to the downstream limit of the SAC.

6.1.21 In addition, to Table 0-2, further information as on water quality sensitivities have been obtained regarding the interest features of the SAC and have been listed in Appendix C: Stage 3 RoC Detailed Findings..

River Wensum Summary

6.1.22 In summary, the WCS will need to ensure that any solutions that are proposed for the River Wensum comply with the need to keep to the following thresholds:

Indicator	Feature and Target
Biological class - Environment Agency's General Quality Assessment scheme	>='b'
River Ecosystem Class	>=RE2
Suspended solids (annual average).	<=25mgl^{-1}
Soluble Reactive Phosphorus (annual mean)	An annual average phosphate concentration of 0.04mg/l from the upstream limits of the SSSI to Sculthorpe; 0.06mg/l from Sculthorpe to Taverham Bridge; and 0.1mg/l from Taverham Bridge to the downstream limit of the SSSI

6.1.23 It is important to note that, in order to comply with the requirements of the Habitats Directive, if the GNWCS can meet these thresholds when considered in isolation we must then consider whether the GNWCS would contribute materially to an overall failure of these thresholds when coupled with other relevant schemes (i.e. other upcoming schemes that are likely to discharge to the River Wensum).

The Broads SAC/Broadland SPA (Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI)

6.1.24 The broads within the Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI are hydrologically linked to the River Yare and Bure respectively such that poor water quality (e.g. elevated phosphate levels) in either river will lead to elevated phosphate levels within the relevant SSSI and thus an adverse effect on the integrity of the Broads SAC.

Background trends – Yare Broads & Marshes SSSI

6.1.25 The Yare is a floodplain site, open to the river running through it and most areas and habitats are not protected from inundation by flood banks. Phosphorus is also believed to be the key nutrient limiting plant growth in Broadland.

Number	Type Receiving	Volume m3	NGR
AEENF12073	WTW	3000*	TG2105009750

Number	Type Receiving	Volume m3	NGR
AEENF1158	STW	170**	TM4100098900
AEETF70	River Wensum	<5	TG2345009190
AEETS270	STW	224**	TG4294001650
AW4NF1031	River Wensum	<5	TG2247009720
AW4NF1064X	STW	1600**	TM3680099110
AW4NF1791	STW	20-100	TM2980097330
AW4NF504	STW	341**	TG2270003000
AW4NF910	STW	2790**	TG2840000900
AW4TS1032	River Wensum	<5	TG2269008920
AW4NF759	River Wensum	1400*	TG1648013230
AEENF12044	STW	1111*	TM2196097740
AEENF1305	STW	1000-10000	TG1040022700
AEENF1406	STW	1000-10000	TM1927093530
AEENF1456	STW	3300**	TF9210028900
AW4NF430X	Wymondham STW	11505**	TG0951002990
AW4TF1789	Whitlingham STW	66250**	TG2829008050
AEENF527	Dereham STW	9853**	TF9750013800

6.1.26 Monitored P concentrations in the river Yare are 0.229 mg/l Orthophosphate and at fully licensed conditions are predicted to be 0.266 mg/l for Orthophosphate, these translate to 0.286 and 0.333mg/l total P. Monitoring results from the outflow from Rockland Broad show concentrations of 0.237 mg/l total P. All these results are well above the target for natural eutrophic lakes target of 0.1mg/l and 0.05mg/l.

6.1.27 However the site itself is a freshwater element here and hence a more applicable threshold to use would be the 0.1mg/l target for natural eutrophic lakes (Surlingham Broad and Rockland Broad) of 0.1mg/l for ditches and 0.05mg/l P for the lakes and broads themselves and 0.03 mg/l for the hard oligomesotrophic lakes.

6.1.28 Mean orthophosphate values in the River Yare (1998-2005) exceed the guideline value at five of the six sites. Consented discharges are implicated. The Environment Agency has confirmed that the Yare Broads & Marshes SSSI is ‘at capacity’ for the orthophosphate proportion arising from point sources under fully-consented conditions. For example, the proportional contribution of point sources to OP loads at the Review of Consents baseline has been calculated as 83%.

6.1.29 The Environment Agency has also confirmed that all the major STWs in the area are already at the limits of Best Available Technology.

6.1.30 Mean orthophosphate values in the River Yare –as detailed in section B.1.5.6- exceed the threshold values for natural eutrophic lakes and also the value used for estuaries in the UK to define “enriched”. Approximately 55% derives from consented water company discharges.

Background trends – Bure Broads & Marshes SSSI

6.1.31 The Bure Broads & Marshes SSSI is currently exceeding its nutrient targets: 42% of the nutrients impacting the SSSI site are from point sources, while 58% are from diffuse pollution. Currently fully consented discharges allow 0.029mg/l Ortho Phosphate (exceeding the Natura 2000 targets). Moreover, it is understood that all the major STWs in the Bure valley are already at the limits of Best Available Technology.

Background trends – downstream elements of the SSSI

6.1.32 It has been identified that similar concerns apply for the Broads SAC/Broadland SPA & Ramsar site more generally. Considerable constraint is posed on environmental capacity arising from downstream elements of the Broads SAC/ Broadland SPA & Ramsar site, specifically Cantley Marshes SSSI and Hardley Flood SSSI, which are also 'at capacity' for the orthophosphate proportion arising from point sources under current fully-consented conditions.

6.1.33 The following screening criteria are available from the Environment Agency document 'Applying the Habitats Regulations to Water Quality Permissions to Discharge: Review and New Applications 114_05':

- Within site - all discharges
- Within 3 km - all discharges
- Within 10km - all sewage or trade discharge greater than 5 m3/day
- Within 50 km - all discharges greater than 1000 m3/day.
- Beyond 50 km - there may be special cases to take into account but generally discharges beyond this distance should be discounted.

6.1.34 On this basis, impacts on Breydon Water SPA can probably be screened out since it is likely to be located more than 10km from the point of discharge of any wastewater arising from Greater Norwich and no individual discharge is likely to be more than 1000 m3 per day; if this situation changes, the site will need to be reconsidered.

Water quality standards

6.1.35 The Broads SAC was designated for:

- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation
- Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
- Otter *Lutra lutra*
- Desmoulin`s whorl snail *Vertigo moulinsiana*
- Transition mires and quaking bogs
- Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*
- Alkaline fens
- Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)
- *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*)

- Fen orchid *Liparis loeselii*

6.1.36 The Broadland SPA was designated for:

- Breeding and wintering bittern *Botaurus stellaris* and marsh harrier *Circus aeruginosus*;
- Wintering Bewick's swan *Cygnus columbianus bewickii*, ruff *Philomachus pugnax*, whooper swan *Cygnus cygnus*, gadwall *Anas strepera*, pink-footed goose *Anser brachyrhynchus* and shoveler *Anas clypeata*; and
- Supporting more than 20,000 wintering waterfowl (irrespective of species) every year.

6.1.37 The lakes and the ditches in areas of fen and drained marshlands in The Broads SAC support relict vegetation of the original fenland flora, and collectively this site contains one of the richest assemblages of rare and local aquatic species in the UK. The broads and ditches would come under the definition of '*natural eutrophic lakes'*. The stonewort – pondweed – water-milfoil – water-lily *Characeae – Potamogeton – Myriophyllum – Nuphar* associations are well-represented, as are club-rush – common reed *Scirpo – Phragmitetum* associations. The dyke (ditch) systems support vegetation characterised by water-soldier *Stratiotes aloides*, whorled water-milfoil *Myriophyllum verticillatum* and broad-leaved pondweed *Potamogeton natans*.

6.1.38 According to the favourable condition tables drawn up by English Nature the designated SAC features as listed in have a requirement for good water quality and have specific targets:

Table 0-3: Designated sites with requirement for good water quality

Feature	Target
Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation	For southern systems 0.1mg/l total phosphorus or below
Hard oligomesotrophic waters with benthic vegetation of *Chara* formations	For *Chara* lake 0.03 mg/l total phosphorus or below.
Otter (*Lutra lutra*)	'Good', with no pollution incidents
Desmoulin's whorl snail (*Vertigo moulinsiana*)	GQA biology class >='b' River Ecosystem classification >='RE3'

6.1.39 The bird interest of the SPA does not have specific water quality standards since they are not directly dependent on water quality. In general however they do require good water quality habitat and as such any exceedence of the standards identified above within the SSSI can also be expected to have an adverse effect on the integrity of the SPA by reducing the quality of the site as breeding and wintering habitat. Natural England indicated to the EA during their RoC process for this site that if the site is delivering the targets for the eutrophic lakes or oligo-mesotrophic waters features it will be delivering the water quality targets for all the features.

6.1.40 In addition to targets in the Favourable Condition Tables, targets for SAC and SPA lakes have been given in WQTAG111c 'Guidance on the assessment of Phosphorus in SAC/SPA Lakes under the Review of Consents'. The target for SAC lakes in the Broads is 0.05mg/l P. The target of 0.1 mg/l however remains where the natural eutrophic feature consists of ditches/dykes.

Abstraction issues and the RoC

Introduction

6.1.41 In addition to compliance with general environment legislation such as the Water Framework Directive, Water Cycle Studies (WCS) should also be compliant with the requirements of the Conservation (Natural Habitats &c) Regulations 1994 (as amended), which interprets the EU Habitats Directive into English law.

6.1.42 The Regulations require land use plans to take steps (through a process dubbed Habitat Regulations Assessment) to ensure that a policy framework exists to enable their implementation without adverse effects (either alone or in combination with other plans and projects) on internationally designated wildlife sites, specifically Special Protection Areas (SPA), Special Areas of Conservation (SAC) and, as a matter of UK Government policy, sites designated under the Convention on Wetlands of International Importance 1979 ('Ramsar sites').

6.1.43 Since Water Cycle Studies inform Core Strategies and other local authority Development Plan Documents it is essential that the WCS takes account of the thresholds above or below which damage to international wildlife sites will occur when devising abstraction or effluent discharge solutions.

6.1.44 In the case of the Greater Norwich WCS, it was identified during Phases 1 and 2a that the River Wensum SAC and Broads SAC/Broadland SPA (specifically the Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI) are those sites for which the development covered by the WCS may lead to adverse water flow and depth effects since these sites are hydrologically connected to the watercourses that would ordinarily be most likely to be used as sources of abstraction – specifically, the River Wensum.

6.1.45 At this stage the water resource supply for the Greater Norwich development has not been definitively established and as such supply options may involve European sites other than the Wensum. However, it is understood that the supply options are likely to involve the following:

- Spare groundwater licences (Thorpe St. Andrew borehole);
- New groundwater resource development (probably within Norwich); and
- An effluent compensation scheme intended to supplement flows in the lower Wensum by re-distributing effluent that currently discharges to the Yare at Whitlingham STW, thereby allowing increased abstraction from the Wensum at Costessey without detrimentally reducing flows in that River.

River Wensum SAC

6.1.46 The River Wensum was designated as an SAC for its:

- Water courses of plain to montane levels with the Ranunculion fluitantis and Callitricho-Batrachion vegetation
- White-clawed (or Atlantic stream) crayfish Austropotamobius pallipes
- Desmoulin`s whorl snail Vertigo moulinsiana

- Brook lamprey Lampetra planeri ; and
- Bullhead Cottus gobio

6.1.47 According to the Broadland Rivers CAMS, the River Wensum is already over-licenced. This means that current actual abstraction is such that no water is available at low flows. If existing licences were used to their full allocation they could cause unacceptable environmental damage at low flows. Additional abstraction at low flow would therefore not be permitted. However, water may be available at high flows, with appropriate restrictions.

6.1.48 At this stage, specific standards against which the various existing consents have been assessed for the Environment Agency's Review of Consents process are not available as the RoC is still in progress, although it is known that the Wensum is currently suffering from low flow issues. The following depth and flow standards for the international interest features of the Wensum SAC have been obtained from the literature.

Watercourses characterised by Ranunculion fluitantis and Callitricho-Batrachion

6.1.49 The River Wensum constitutes the CB1 'Lowland, low-gradient Potamogeton/Sagittaria' eutrophic river community. This vegetation type typically occurs on large, slow-flowing (e.g. less than 10 cm s^{-1}) lowland rivers with a stable base flow and a substrate consisting mainly of silts or clays[27]. *Potamogeton* spp. (particularly *Potamogeton pectinatus)* and *Myriophyllum spicatum* are particularly prominent within the plant community, while *Ranunculus* species are less noticeable than in many other CB types, with *Ranunculus penicillatus ssp. pseudofluitans* and *Ranunculus fluitans* being characteristic.

White-clawed crayfish

6.1.50 The white-clawed crayfish typically inhabits watercourses with depth ranging between 0.75-1.25 m. The species has also been known to occur in very shallow streams (0.05 m depth) and in deeper, slow-flowing rivers (2.5 m depth) but this is not typical. Ideal flows are slow (less than 10 cm s^{-1}); flows up to 20 cm s^{-1} are also suitable. Strong flows (more than 20 cm s^{-1}) are generally not suitable but white-clawed crayfish can survive in rivers with a strong flow provided that suitable refuges such as weirs and boulders are present[28].

Bullhead[29]

6.1.51 Water depth is not critical, providing it is >5 cm and flow is adequate. Bullheads are often found in water of moderate velocity (i.e. greater than 10 cm s^{-1}).

6.1.52 Gubbels (1997)[30] found most bullheads at flow velocities of 22 cm s^{-1}. No specimens were found in places with flow rates of less than 10 cm s^{-1} or more than 38 cm s^{-1}. In contrast, Roussel and Bardonnet (1996)[31] recorded individuals in flow >40 cm s^{-1}, whereas Strevens (unpubl. Data as

[27] Hatton-Ellis TW & Grieve N (2003). Ecology of Watercourses Characterised by *Ranunculion fluitantis* and *Callitricho-Batrachion* Vegetation. Conserving Natura 2000 Rivers Ecology Series No. 11. English Nature, Peterborough
[28] Holdich D (2003). Ecology of the White-clawed Crayfish. Conserving Natura 2000 Rivers Ecology Series No. 1. English Nature, Peterborough
[29] Tomlinson ML & Perrow MR (2003). Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough
[30] Gubbels REMB (1997). Preferred hiding places of the bullhead (*Cottus gobio* L., 1758) in the Zieversbeek brook. Natuurhistorisch Maandblad 86, 201–206.
[31] Roussel JM & Bardonnet A (1996). Differences in habitat use by day and night for brown trout (Salmo *trutta*) and sculpin (*Cottus gobio*) in a natural brook: multivariate and multi-scale analyses. Cybium 20, 45–53.

cited in Tomlinson & Perrow, 2003) suggested they preferred velocities >80 cm s^{-1} and avoided those <60 cm s^{-1}.

6.1.53 Minimum acceptable flows are likely to exist for bullheads, as below a threshold value the deposition of fine sediment will occur over the preferred hard substrate, oxygen concentrations will reduce and temperatures increase in more slow-flowing water. Any threshold is likely to vary according to stream type and sediment load. It is not possible to state what either these thresholds or the minimum acceptable flows for bullhead actually are. As such, it is likely that '*no reduction in current flows*' will be the test to be applied.

Brook lamprey[32]

6.1.54 As in the case of water quality, there are few reliable data available on the specific water quantity requirements of brook lamprey, and most available data concern stream gradients and flow velocities.

Larvae

6.1.55 Schroll (1959)[33] found that the flow rate over ammocoete beds of *Lampetra planeri* was remarkably constant, with average values of 50 cm s^{-1} at the water surface and 40 cm s^{-1} at a depth of 25 cm. However, it is a common observation that larval nursery beds are at the edges of streams and rivers, well away from the main current, and that the current over them is often not only very slow, but is actually a backwater in reverse of the main current. Relatively slow speeds (8–10 cm s^{-1}) have been recorded over *Lampetra* burrows by Hardisty (1986)[34], which agrees with Hjulstrom (1935)[35], who found that the deposition of sand and silt occurs only at velocities less than 7 cm s^{-1}.

Adults

6.1.56 At two spawning sites in Czechoslovakia, Lohnisky (1966)[36] found that current speeds were 100 –140 and 400 cm s^{-1} respectively. These speeds seem very fast and presumably represent surface velocities. Hardisty & Potter (1971)[37] note velocities of 30–50 cm s^{-1}.

6.1.57 Given that it is not possible to stipulate definitive minimum flows, it is likely that '*no reduction in current flows'* will be the test to be applied.

Desmoulin's whorl snail

6.1.58 High groundwater levels throughout the year are considered to be one of the most important factors influencing the distribution of Desmoulin's whorl snail. In lowland river floodplains with

[32] Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough
[33] Schroll F (1959). Zur Ernahrungsbiologie der steirischen Ammocoten Lampetra planeri (Bloch) und Eudontomyzon danfordi (Regan). Int. Rev. ges. Hydrobiol. Hydrogr. 44, 395–429
[34] Hardisty MW (1986). Petromyzontiforma. In: Holcik J (ed). The freshwater fishes of Europe. Aula-Verlag,Wiesbaden
[35] Hjulstrom F (1935). Studies in the morphological activity of rivers as illustrated by the River Fyris. Geological Institute of the University of Uppsala Bulletin 25, 221–528
[36] Lohnisky K (1966).The spawning behaviour of the brook lamprey, *Lampetra planeri* (Bloch, 1784). Vestnik Ceskoslovenske Spolecnosti Zoologiocke 4, 289–307.
[37] Hardisty MW & Potter IC (eds) (1971). The biology of lampreys. Academic Press, London.

many snail inhabited sites, there are also numerous, apparently suitable sedge-dominated habitats where the snail is absent, probably due to unfavourable groundwater levels.

6.1.59 Detailed studies of the hydrological requirements of Desmoulin's whorl snail have been undertaken at Chilton Foliat and Thompson Common, which are respectively within the Kennet and Lambourn Floodplain and the Norfolk Valley Fens Special Areas of Conservation (Tattersfield & McInnes 2003)[38].

6.1.60 Water levels were gauged by taking repeated measurements from a grid of dip-wells installed on each site, while snail distribution and density were also recorded. Maximum snail densities, at locations where the hydrological conditions were considered to be at, or close to, the snail's optimum, were recorded where water levels were continuously above the ground surface throughout the year, and where mean annual water levels were more than 0.25 m above the surface. Annual fluctuations at these locations were between about 0 m and 0.6 m above ground level. Medium-density snail populations were associated with conditions where water levels fluctuated within 0.2 m of the surface, both above and below ground level. The critical minimum summer water level threshold, where the snail occurs but only at very low abundance, was estimated to be 0.5 m below surface ground level. However, it is unlikely that populations would be sustained under such conditions[39].

6.1.61 There is no indication that water flow rates are a limiting factor.

V. moulinsiana	**water level**	**fluctuation in water level**	**minimum water level**	**with ground surface**
Presence of *V. moulinsiana*			Summer –0.5 m Winter –0.4 m	
High population	Greater than +0.25 m	0 m to +0.6 m		Water level never/very rarely falls below ground
Medium population	0 m	–0.2 m to +0.2 m		Water level fluctuates between –0.2 m and +0.2 m during the year
Low population	Less than 0 m	–0.4 m to 0 m		Surface inundation rare

[38] Tattersfield P & McInnes R (2003).The hydrological requirements of *Vertigo moulinsiana* on three candidate Special Areas of Conservation in England (Gastropoda, Pulmonata:Vertiginidae). Heldia 5, part 7, 135–147.
[39] Killeen IJ (2003). Ecology of Desmoulin's Whorl Snail. Conserving Natura 2000 Rivers Ecology Series No. 6. English Nature, Peterborough

Appendix D: SuDS Types

Soakaways

6.1.62 Soakaways are traditionally built as square or circular pits, either filled with rubble or pre-cast perforated concrete pipes surrounded by suitable granular backfill (although their design and depth may vary depending on area draining into them). They can also be a crate system with a 90% void ration. Their use is generally subject to full infiltration testing.

6.1.63 There are a number of factors that should be considered prior to their inclusion in drainage design, such as:

- Relevant guidelines (such as BRE Digest 365) require that any soakaways should be constructed at least 5m from any building foundations. Dependent on the layout of sites in relation to their topography, this building restriction could limit the use of soakaways on some terraces or blocks of dwellings.
- In areas of steep topography of the site, soakaways should be aligned perpendicular to the slope direction, i.e. they should be 'contoured'.
- In areas of steep gradient, allowing water to freely infiltrate into surrounding ground may cause ground slumping, soil creep or similar effects.
- The base of the soakaway is required to be a minimum of 1m above the seasonally high groundwater.

Swales

6.1.64 Swales are shallow ditches designed to conduit and retain water, as well as facilitate infiltration where possible. Where ground conditions are suitable, infiltration will occur either naturally or via a filter drain located beneath the swale base. This can be filled with granular material and, if necessary, a perforated or half perforated pipe. Swales typically are grass covered but can also contain larger vegetation types (often scrub or reeds). This vegetation can aid water attenuation through encouraged evapotranspiration, uptake or infiltration. It can also reduce water velocities and filter particulate matter, such as hydrocarbons and particulate matter. Given these properties, they are typically located adjacent to roads or parking areas. Their efficiency of infiltrating water into underlying ground is dependant on full infiltration testing.

6.1.65 Swales are likely to be suitable for receiving surface water runoff generated from roads and communal parking areas. They could also be used to collate water from roofs in areas where soakaways are not available.

Permeable Surfacing

6.1.66 Permeable surfacing involves the use of permeable material in the place of impermeable surfacing. This is typically used for roads or parking areas. Where ground conditions are suitable, permeable paving allows infiltration into the surrounding ground, using a permeable sub base. Where conditions are not suitable, permeable paving can act as medium into a sub-surface attenuation tank beneath the paving from which it is discharged through to a watercourse, a further attenuation device or the sewer system at an agreed restricted rate, using a hydrobrake or similar.

6.1.67 There are a number of mediums that can be used in the attenuation facility including:

- Tanked systems whereby reinforced tanks situated beneath the permeable surfacing are located. Their design should be considered significant loadings from vehicular traffic.
- Granular fill typically has a void ratio of 0.3 (30%) and is readily available as graded gravel fill; and
- Crate systems have a higher void ratio (up to 90% in some cases) but are often costly and may require complex maintenance.

6.1.68 Depending on potential adoption issues, permeable paving has the potential to be used for all access roads and parking areas. The choice of system is dependant on the permeability of the underlying ground and therefore upon full infiltration testing of the underlying ground.

Detention Basins or Retention Ponds

6.1.69 Detention basins are depressions (often vegetated for landscape purposes) that are normally dry but allow storage of storm water to attenuate surface flows. Should ground conditions be suitable, infiltration will occur naturally. Retention ponds are similar to detention basins but retain a permanent level of water. If situated in permeable soil conditions, the base of the pond may require lining. Discharge from retention or detention ponds into the receiving watercourse can be through a pipe or overflow system.

6.1.70 These features may have wider benefits beyond flood risk by reducing the amount of pollutants or suspended material present in any potential outflows. In addition, they can add to the amenity and biodiversity value of a development (this is particularly relevant for retention ponds).

Rainwater Harvesting

6.1.71 Rainwater harvesting is the collection of water that would otherwise have gone down the drain, into the ground or been lost through evaporation. Large surfaces such as roofs or driveways are ideal for rainwater harvesting and can provide up to 100 m3 (100,000 litres) of water per year from a medium sized area. This water can be used to flush toilets, water gardens and even feed the washing machine.

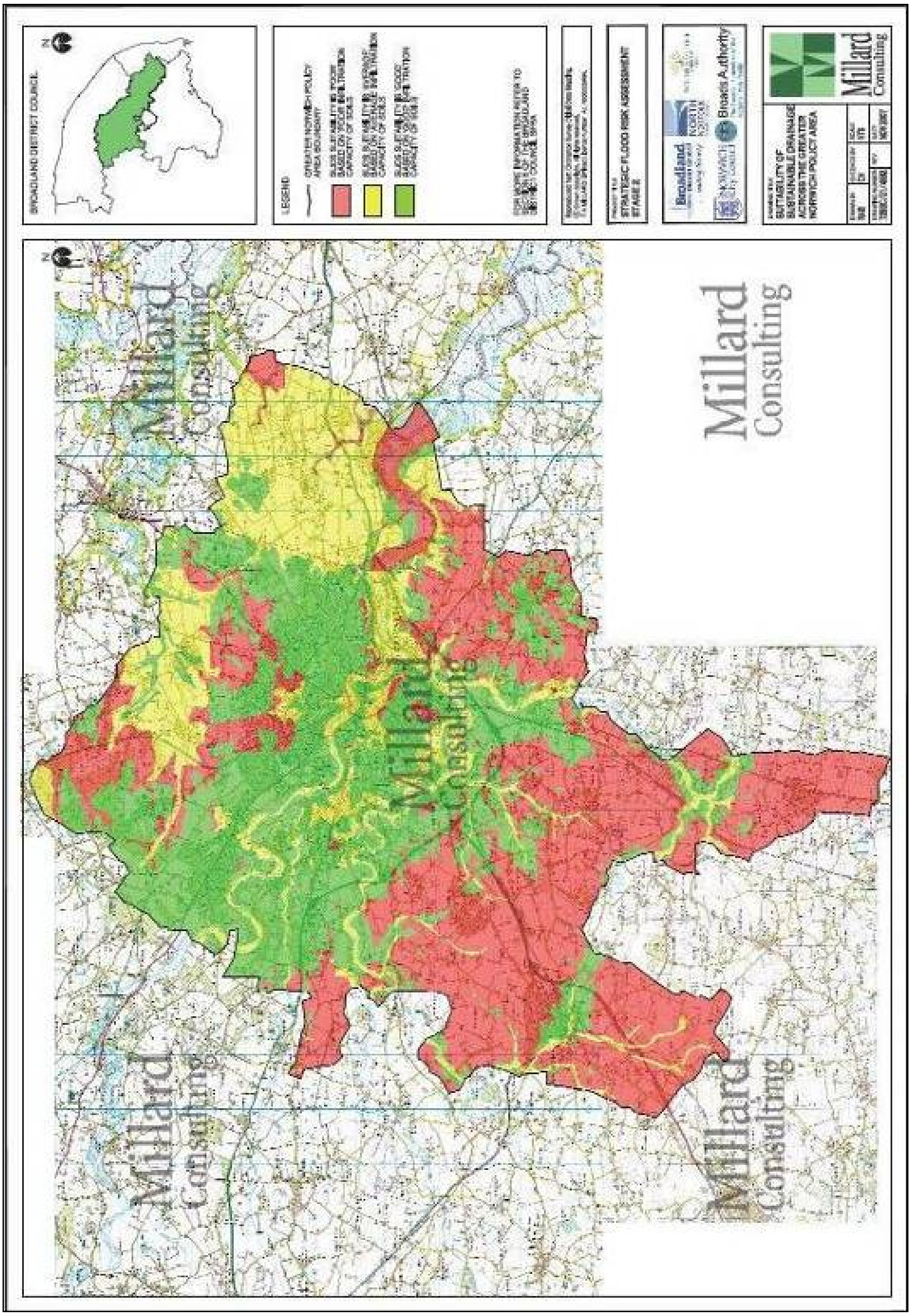
6.1.72 Rainwater harvesting systems can be installed in both new and existing buildings, and the harvested water used for purposes that do not require drinking water quality. Rainwater harvesting has the potential to save a large volume of mains water and therefore help reduce the pressure on water resources.

Other Methods

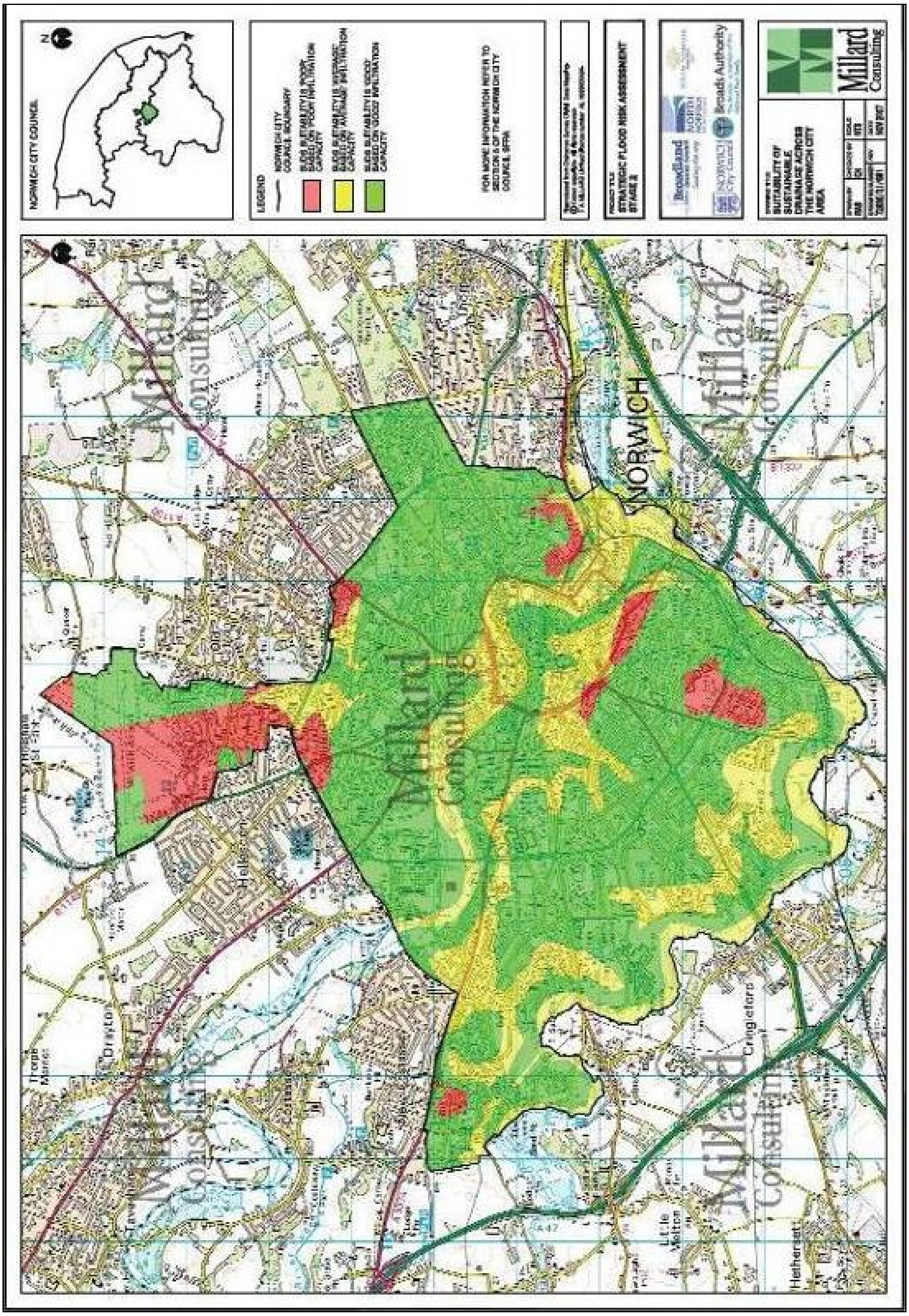
6.1.73 Other typical SuDS methods include techniques such as Greenroofs, wetlands, filter drains and filter strips. They are potentially viable options for the proposed site and can have wider sustainability benefits. However they do not generally constitute a significant volumetric input into attenuation

Appendix E: Suitability of SuDS (from Level 1 SFRA)

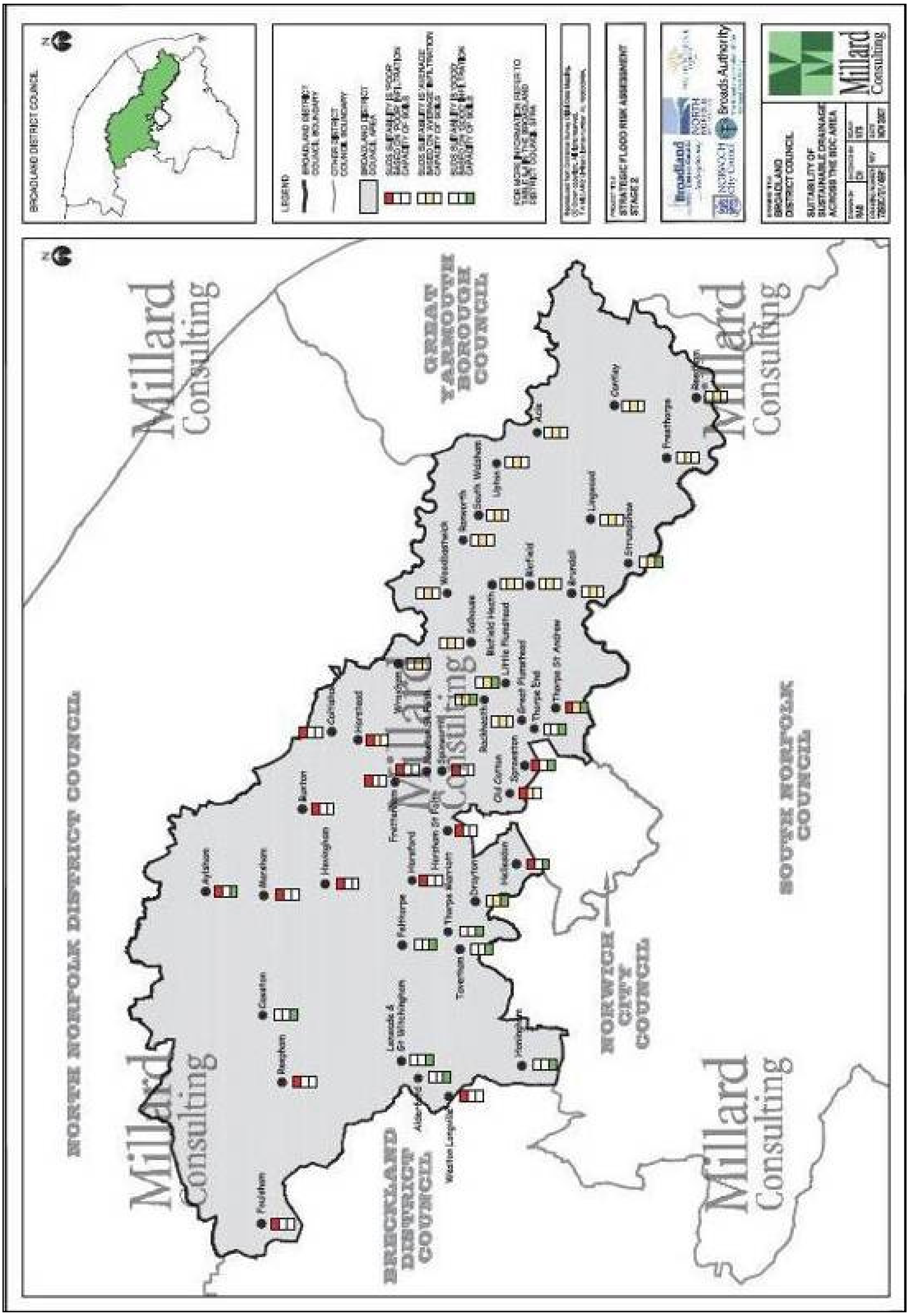
Greater Norwich



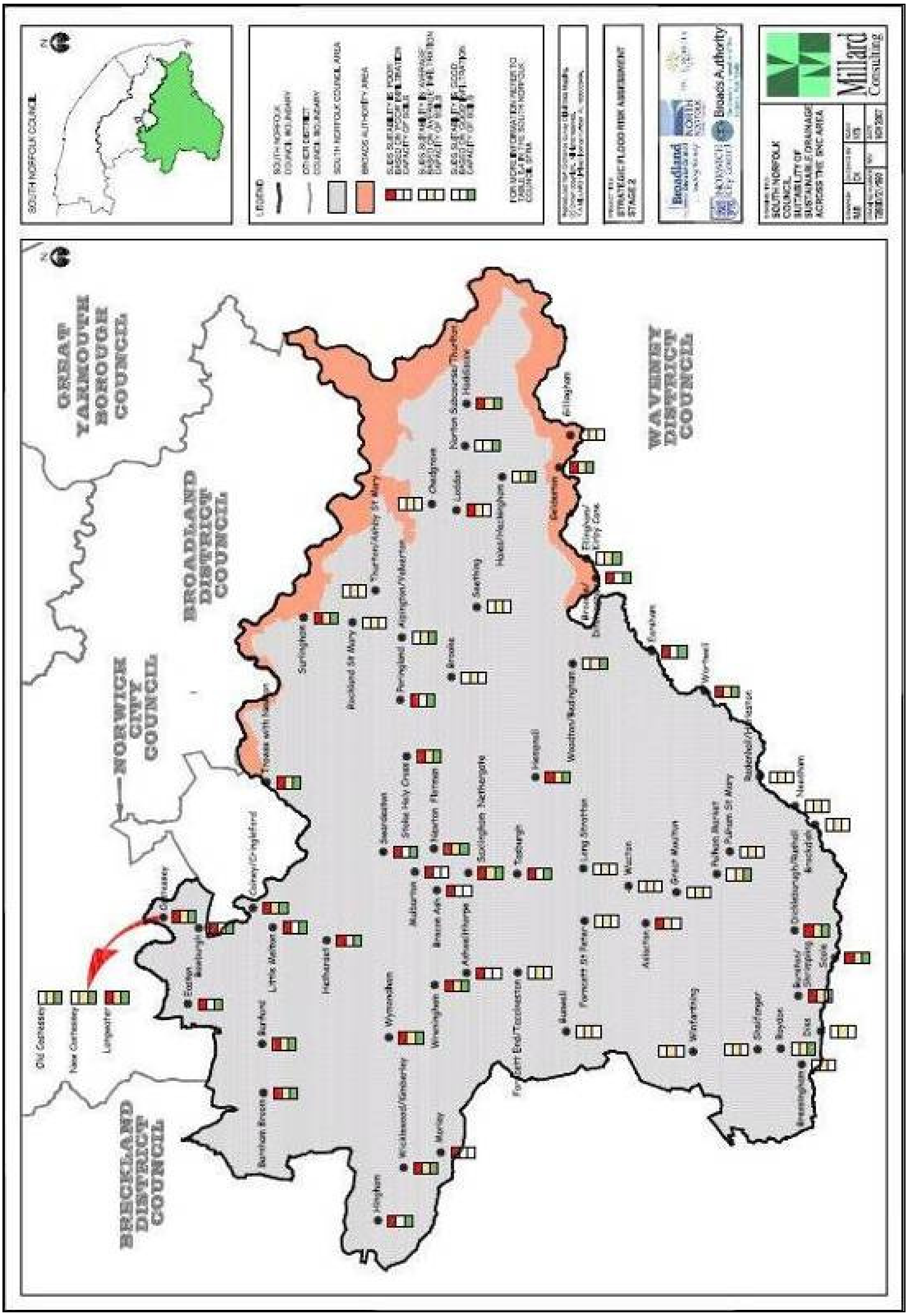
Norwich City Council



Broadlands District Council



South Norfolk Council



Appendix F: Water Framework Directive Detail

WFD - Introduction

6.1.74 Over the next two to three years, the existing statutory targets and legislation relating to water quality will be replaced with a new set of water quality standards under the umbrella of the Water Framework Directive (WFD) which was passed into UK law in 2003. The competent authority responsible for its implementation is the Environment Agency in England and Wales. The overall requirement of the directive is that all water bodies in the UK must achieve "good ecological and good chemical status" by 2015 unless there are grounds for derogation.

6.1.75 The WFD will for the first time combine water quantity and water quality issues together. The directive combines previous water legislation and in certain areas strengthens existing legislation. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level will be adopted. Involvement of stakeholders is seen as key to the success in achieving the tight timescales and objectives set by the directive. The WFD states that all countries in the European Union have to:

- prevent deterioration in the classification status of aquatic ecosystems, protect them and improve the ecological condition of waters;
- aim to achieve at least good status for all waters. Where this is not possible, good status should be achieved by 2021 or 2027;
- promote sustainable use of water as a natural resource;
- conserve habitats and species that depend directly on water;
- progressively reduce or phase out releases of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment;
- progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants; and
- contribute to mitigating the effects of floods and droughts.

6.1.76 The water environment within England and Wales has been divided into units called 'water bodies' and designated as rivers, lakes, estuaries, the coast or groundwater. Some water bodies have been designated as artificial or heavily modified if they are substantially modified or created for water supply, urban purposes, flood protection and navigation. This designation is important because it recognises their uses, whilst making sure that ecology is protected as far as possible. All water bodies will be designated a status. For surface waters, the status has an ecological and a chemical component; Ecological status is measured on the scale high, good, moderate, poor and bad; and good chemical status as pass or fail. For groundwater, good status has a quantitative and a chemical component, which together provide a single final classification: good or poor status. Good ecological status is defined as a slight variation from undisturbed natural conditions, but artificial and heavily modified waters are not able to achieve natural conditions. Instead the target for these waters is good ecological potential. This is also measured on the scale high, good, moderate, poor and bad. The chemical status of these water bodies is measured in the same way as natural water bodies.

6.1.77 In relation to development considered in this WCS, the key concerns are water availability, quantity and quality of runoff from urban areas and roads, and discharges from domestic houses.

These can all have a large impact on the water environment, and are interrelated. For example, river flow can affect concentrations of substances such as nitrate. However, existing schemes do not adequately assess the impact of such sources. In particular, they do not quantify the effect on the aquatic environment.

6.1.78 Standards are being developed with which to measure status covering a range of criteria including water quality, biological quality, and morphology. The environmental standards assess whether environmental conditions are good enough to support appropriate aquatic life for the system.

Water quality and the WFD

6.1.79 An indication of the proposed water quality standards is provided in Table A below. As stated, the aim is for all water bodies to reach 'good status' or higher by 2015. In order to do so, the Environment Agency are developing a series of River Basin Management Plans (RBMPs) for the major River Basins in England and Wales. The draft RBMPs, which sets out detailed proposals for the next six years, were published on 22nd December 2008 and contain the Programme of Measures to bring about the changes necessary in order to bring the water bodies which are currently failing the required standards up to good status. The measures in the draft plans have been developed with the assistance of the River Basin Liaison Panels, and include Government and Environment Agency actions, as well as actions delivered by others. The River Liaison Panels include representatives from businesses, planning authorities, environmental organisations, agriculture, forestry, consumers, fishing bodies, ports, drainage boards and regional government, which will all have key roles to play in implementing the plan. The draft plans are now subject to a six-month consultation period before the final versions are published in December 2009.

Table A: Water Framework Directive Standards for 'Good Ecological Status'

Determinand	Lowland and High Alkalinity	Upland and Low Alkalinity*
BOD (90%ile)	5 mg/l	4 mg/l
Ammonia (NH4-N) (90%ile)	0.6 mgN/l	0.3 mgN/l
DO (10%ile)	60% Sat	75% Sat
Phosphate (Mean)	0.12 mg/l	0.12 mg/l
Nitrate	No standard available	No standard available

Note: * (or Salmonid Designated Rivers with Lowland and High Alkalinity Typology)

6.1.80 The Draft RBMPs focus on achieving the protection, improvement and sustainable use of the water environment including surface freshwaters (lakes, streams and rivers), groundwater, ecosystems such as some wetlands that depend on groundwater, estuaries and coastal waters (out to one nautical mile). The draft plans set out the proposed measures to improve water quality to the required standard and achieve the set environmental objectives. The WFD allows the Environment Agency, where costs would be disproportionate or where it is not technically feasible to achieve the objectives by 2015, to work on a longer timescale (to 2021 or 2027) or to set lesser objectives, provided certain conditions are met.

6.1.81 The WFD water quality standards are currently in draft form and will not be finalised until the RBMPs are published in December 2009. However, because the WFD requirements will largely supersede the current statutory and guideline environmental standards from 2010, it is important that the WCS considers the requirements for meeting them such that the impact of growth on future compliance with legislative requirements is understood and can be managed at an early stage in the planning.

6.1.82 The Environment Agency's current system of measurement, the General Quality Assessment (GQA), shows over 70% of rivers in England and Wales are currently achieving a good standard. Under the new WFD classification system this figure falls to 23% of water bodies achieving good status. The rivers have not degraded in terms of quality but the WFD raises the bar, and things are being measured more thoroughly. That said, even under the WFD definition, looking at biology alone, rather than according to both biology and physico-chemistry, the number of water bodies achieving good status is currently 46%.

6.1.83 On that basis, the plans in their current form would bring the number of water bodies meeting good status to 28% by 2015. Some quite substantial improvements will be masked by that apparently modest degree of achievement. Many water bodies will improve significantly, maybe even from one class to another, without yet getting to good status, and many may only fail to reach good because of, say, one indicator in future compared with several at present.

Water Quality Baseline Assessment

6.1.84 Norwich's river systems are included in the Anglian River Basin District which covers an area of 27,890 km2. The landscape ranges from gentle chalk and limestone ridges to the extensive lowlands of the Fens and East Anglian coastal estuaries and marshes.

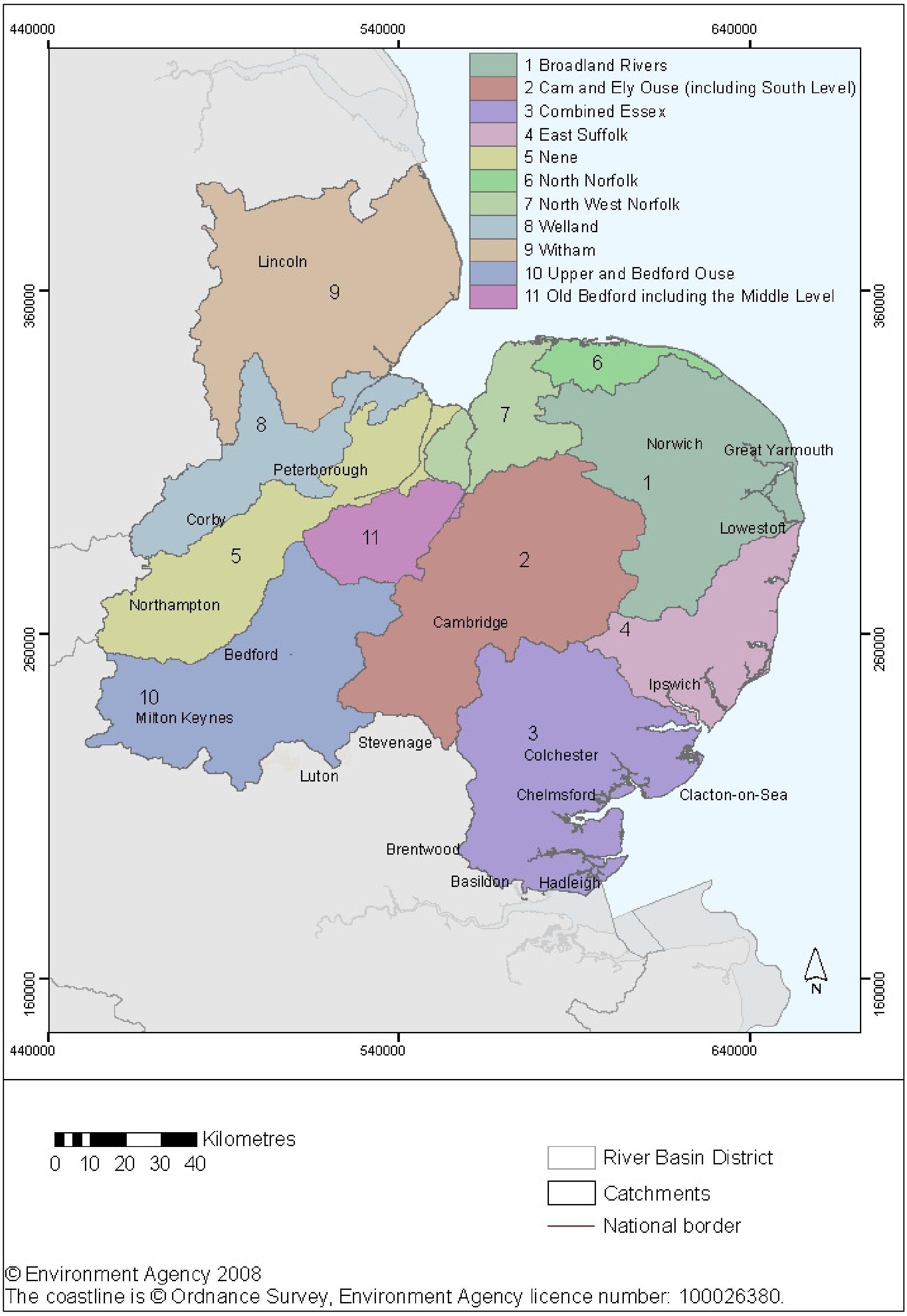
6.1.85 The River Basin District is the richest region in the UK for wetland wildlife. There are several protected areas within the Anglian River Basin District which have been established under European legislation and include the Broadlands Executive Area and several other Areas of Conservation (SAC) and Special Protection Area (SPA). The Broads, in particular, is Britain's largest nationally protected wetland and provides a habitat for a myriad of rare plants and animals.

6.1.86 The Greater Norwich area covers the Broadlands River Catchment, (Figure A below). The catchment is largely rural with significant pressure for urban development. The area covers seven main rivers: the Rivers Wensum, Yare, Tud, Ant and Bure to the North and the Rivers Tas and Waveney to the South. The area also includes the shallow lakes of the Broads. The water environment is used for a variety of activities including recreation, public water supply, fisheries and conservation.

6.1.87 The main land use in the catchment is arable agriculture, although there are pockets of water-dependent industries around Norwich. Tourism and water-based recreational pursuits such as boating and angling are vitally important to the Broadland Rivers economy. The tidal rivers in the Broadland Rivers area form the third largest inland navigation in Britain.

6.1.88 The Broadland Rivers area also encompasses the Broads Executive Area (status equivalent to a National Park Area) and has a high density of local and nationally important protected sites, including the Broads and River Wensum SACs and the Broadland SPA, both of which are protected under European law (Habitats Directive).

Figure A: Environment Agency River Basins in the Anglian River Basin District



6.1.89 Past and present activities within the river catchments put pressures on the water environment. Rural land management is a source of diffuse pollution from nutrients, sediments and pesticides. Sewage treatment works and other intermittent discharges from the sewerage network also increase nutrient levels whilst these and other point sources increase the pressure from ammonia and dangerous substances. Run-off and drainage from urban areas can contain a range of pollutants whilst historic mining activity has left a legacy of metal and other pollution. Abstractions from rivers and groundwater for public water supply, and to a lesser extent for industry and agriculture impact on river flows and groundwater levels. Many rivers and lakes have been subject to some form of physical modification which has had negative impacts on habitats and wildlife.

6.1.90 In particular, the River Yare suffers from excessive levels of nutrients from sewage works effluent. Proposed actions to tackle the issues in the catchment include phosphate removal and other improvements to discharges at several sewage treatment works and various actions to improve the management of water resources.

6.1.91 The majority of rivers within the Greater Norwich area are defined as lying within low altitude, calcareous catchments resulting in a WFD assignment of lowland and high alkalinity typology. The standards, are those as provided by UKTAG, required to achieve 'good ecological status' in the defined typology.

Ecological Classification

6.1.92 The Ecological classification system has five classes, from high to bad, and uses biological, physico-chemical, hydromorphological and chemical assessments of status.

- Biological assessment uses numeric measures of communities of plants and animals (e.g. fish and rooted plants);
- Physico-chemical assessment documents parameters such as temperature and nutrient concentrations; and
- Hydromorphological assessment to document water flow and physical habitat.

6.1.93 As of April 2008, UKTAG had derived standards for some of the more important chemical parameters in freshwaters. The standards differ based on the 'typology' of each water body; rivers, lakes, transitional and coastal waters, groundwater. The general typology for rivers is based on alkalinity and altitude, as shown in Table B. However, for dissolved oxygen and ammonia, the typology was simplified into just two types shown in Table C. These typologies should be used to define the dissolved oxygen standard for a particular watercourse typology, as shown in Table B. The standards in Table C were developed on the basis of oxygen conditions associated with macro invertebrates, as these are the most sensitive biota to Dissolved Oxygen (DO).

Table B : Basic Typology for Rivers (WFD)

Site Altitude	Alkalinity (mg/l CaCO3)				
	<10	10 to 50	50 to 100	100 to 200	>200
<80 m	Type 1	Type 1	Type 3	Type 5	Type 7
>80 m			Type 4	Type 6	

Table C: Final Typology for Oxygen and Ammonia for Rivers (WFD)

Final Typology	Basic Typology
Upland and low alkalinity	Types: (1+2), 4 and 6
Lowland and high alkalinity[40]	Types: 3, 5 and 7

Table D: Standards for Oxygen in Rivers (WFD)

Dissolved Oxygen (% saturation) – 10-Percentile				
Typology	High	Good	Moderate	Poor
Upland and low alkalinity	80	75	64	60
Lowland and high alkalinity	70	60	54	45

6.1.94 The impacts of elevated concentrations of nutrients in freshwater systems, especially phosphorus, are widely studied. The most common impact is enhanced growth of plants and algae, which can affect watercourses in several ways. River channels can become blocked, exacerbating low flow conditions; diurnal fluctuations of oxygen content in the water can occur due to respiration of macrophytes during the hours of darkness, potentially affecting fish; growths of blue-green algae can be stimulated which can cause adverse affects in animals.

6.1.95 For revised nutrient standards in rivers, UKTAG identified that ecological sensitivity could be related to alkalinity and altitude. The resulting river typology can be seen in Table D.

Table D: River Typology (WFD)

Altitude (above sea level)	Annual mean alkalinity (mg/l calcium carbonate)	
	< 50	> 50
< 80 m	Type 1n	Type 3n
> 80 m	Type 2n	Type 4n

6.1.96 When developing the standards for nutrients in rivers, Guthrie et al, reported that diatoms showed greater sensitivity to nutrients than macrophytes, and these were subsequently used to develop the standards shown in Table E. Also included in Table E, are guideline values

[40] Where a lowland, high alkalinity water body is a salmonid river, then the standards for the upland, low alkalinity type will apply.

produced by the Environment Agency which are commonly referred to, as well as values recommended by the Habitats Directive.

Table E: Phosphorus Standards in Rivers under WFD Standards, Existing GQA Guidelines and Habitats Directive, for Comparison

	SRP[41] (µg/l) (annual mean) under WFD				
Type	High	Good	Moderate	Poor	
1n	30	50	150	500	
2n	20	40	150	500	
3n & 4n	50	120	250	1,000	
	SRP (µg/l) (annual mean) under Existing GQA Guidelines				
	1	2	3	4	5
	20	60	100	200	1,000
	Very low	Low	Moderate	High	Very high
	SRP (µg/l) (annual mean) under Habitats Directive				
	Headwaters	Most rivers	Large rivers		
Natural (1)	0-20	20-30	20-30		
Guideline (2)	20-60	40-100	60-100		
Threshold (3)	40-100	60-200	100-200		

6.1.97 UKTAG recognise that the relationship between nutrients and water quality is not straightforward. Thus, it is recommended that an indication of 'actual or potential' biological impact is needed in addition to a finding of high concentrations of SRP.

6.1.98 Nitrate is already covered by legislation which proscribes a Statutory Limit of 50 mg NO3/l (11.3 mg NO3-N/l) as described previously. However, these limits are largely based on protection of freshwater for the purposes of drinking water. UKTAG consider that although nitrate may have a role in eutrophication in some types of freshwaters, there is insufficient understanding for new standards or conditions. For this reason, no new standards for nitrate in water have been recommended.

6.1.99 Due to the uncertainty surrounding the effect of applying these revised standards, UKTAG have estimated the change in classification due to the new standards, compared to the old GQA standards for England, Wales and Scotland. When the 95% confidence interval is applied to the data presented in Table F, approximately 12% of rivers in England currently fail the existing RQO for either BOD, DO or ammonia. Under the revised standards this increases to approximately 20%.

6.1.100 It should be emphasised again that the existing guidance for phosphorus is currently not usually used to base decisions on water quality. More detailed investigations are usually undertaken to demonstrate cause and effect with regards to impact on aquatic ecology.

[41] SRP = soluble reactive phosphorus, relating to the P which is readily available for uptake by organisms

Table F: Estimated Changes to Rivers Considered 'Less than Good Quality' under Existing and Proposed Standards in England

Percent of River Length Reported as 'Less than Good'							
BOD		DO		Ammonia		Phosphorus	
Existing	Proposed	Existing	Proposed	Existing	Proposed	Existing	Proposed
25.6	18.7	30.8	24.6	14.6	17.3	65	63.3

6.1.101 One of the key objectives of the WFD is to 'prevent deterioration of the status of all water bodies of surface water'. This states that there should be a prevention of deterioration between status classes, which applies to each water body. The status class reported for a surface water body will be dictated by the quality element worst affected by human activity. However, a 'less stringent objective' does not mean that (a) the other quality elements are permitted to deteriorate to the status dictated by the worst affected quality element or (b) the potential for improvement in the condition of other quality elements can be ignored (EU Commission, 2005).

WFD and Water Company Planning

6.1.102 An important consideration in the WFD planning process is the timing with respect to the statutory water company planning and funding process. At present, there is a discrepancy between the two planning timelines. The RBMPs are not due to be finalised until December 2009 and therefore the Programme of Measures which sets out what changes will need to be implemented in order to achieve 'good' status in all water bodies, will not be known until this point. Whilst it is not just water companies which will be affected by the programme of measures, it is considered that water companies such as AWS will have a key role to play in implementing the measures and helping to achieve 'good' status in time for the 2015 deadline as required by the WFD, or by 2027 as identified by the RBMP.

6.1.103 However, the current PR09 and AMP5 timelines are such that the water companies will be submitting their business plans, which set out the investment requirements for AMP5 (2010-2015), before the RBMPs plans are finalised. It is therefore uncertain how much of the investment required to meet with programme of measures can be planned for and funded in the next AMP period and that much of the investment required to meet good status will not be forthcoming until AMP6 (2015-2020).

6.1.104 Despite this, studies such as the WCS have a role to play in identifying likely impacts of the WFD and where future investment is most likely to be required in order to move key water bodies towards good status based on the interim risk characterisations. Use of the draft standards and draft risk characterisations is essential such that early decisions can be taken on where investment is most likely to be required in order to meet with the future programme of measures and attainment of 'good' status.

Appendix G: WwTW Quality Consent Calculations

SCENARIO A1: Planned consented – Consents Limited to BATNEEC *(Assuming volumetric consents can be increased, new consents must achieve WFD and HD targets downstream, but consents are limited to BATNEEC)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.275	220	0
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	-			
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	-			
				P	0.047	0.023	-			-	Mean	0.05	Mean	-			
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	4	90	-			
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	-			
				P	0.034	0.014	-			-	Mean	0.05	Mean	-			
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	-			
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	-			
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	-			
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	-			
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	1	0.45	360	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.06	48	0
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	-			
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	-			
				P	0.085	0.085	-			-	Mean	0.12	Mean	-			
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	5	1.500	1,875	0
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	1	0.275	220	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.01	8	0
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	-			
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	4	90	-			
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	-			
				P	0.085	0.085	-			-	Mean	0.12	Mean	-			
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	-			
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	-			
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			

SCENARIO A2: Planned Deterioration - % Deterioration Impact with BATNEEC *(Assuming volumetric consents can be increased, impact on downstream compliance if revised quality consents for these works were limited to BATNEEC)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Current & Future Downstream Water Quality							
		Mean (Ml/d)	95%ile (Ml/d)	Det	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Det.	Current Mean (mg/l)	Current St Dev (mg/l)	Current 90%ile (mg/l)	Future Mean (mg/l)	Future St Dev (mg/l)	Future 90%ile (mg/l)	% Det
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	BOD							
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	P	0.24	0.10	0.38	0.25	0.11	0.39	4%
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	-	BOD							
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	-	Ammonia							
				P	0.047	0.023	-			-	Mean	0.05	Mean	-	P							
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.85	30	95	4	90	-	BOD							
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	-	Ammonia							
				P	0.034	0.014	-			-	Mean	0.05	Mean	-	P							
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	-	BOD							
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	-	Ammonia							
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	-	P							
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	-	BOD							
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	-	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	-	P							
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	BOD							
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	1	Ammonia	3.42	1.79	6.00	0.34	0.13	0.52	90% (Imp)
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.39	0.17	0.64	0.53	0.21	0.82	35%
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	-	BOD							
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	-	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	-	P							
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	5	BOD	16.4	5.1	23.16	3.01	0.84	4.12	82% (Imp)
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	1	Ammonia	5.4	1.71	7.68	0.58	0.17	0.80	90% (Imp)
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.85	0.26	1.19	0.85	0.26	1.20	0.01%
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.43	0.429	20	95	4	90	-	BOD							
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	-	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	-	P							
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	BOD							
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	P							
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.12	0.336	15	95	4	90	-	BOD							
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	-	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	-	P							
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	-	BOD							
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	-	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	-	P							
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	-	BOD							
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	-	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	-	P							

SCENARIO A3: Planned Deterioration - Consents Beyond BATNEEC *(Assuming volumetric consents can be increased, what would the revised consents need to be to meet WFD and HD, ignoring limitations of BATNEEC)*

Red cells indicates where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow: Mean (Ml/d)	Upstream River Flow: 95%ile (Ml/d)	Upstream Water Quality: Determinand	Upstream Water Quality: Mean (mg/l)	Upstream Water Quality: St Dev (mg/l)	Upstream Water Quality: 90%ile (mg/l)	WwTW Future Flow: Mean (Ml/d) (DWF x 1.25)	WwTW Future Flow: St Dev (Ml/d) (Mean x 0.3)	Current WwTW Consent: Consent (mg/l)	Current WwTW Consent: %ile	Downstream Water Quality Objective: Objective (mg/l)	Downstream Water Quality Objective: %ile	Future WwTW Consent (mg/l)	Capacity Assessment – Development Allowable to still achieve compliance with WFD: Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.595	1,276	241
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	-			
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	-			
				P	0.047	0.023	-			-	Mean	0.05	Mean	-			
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	4	90	-			
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	-			
				P	0.034	0.014	-			-	Mean	0.05	Mean	-			
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	-			
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	-			
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	-			
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	-			
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	0.5	1.724	1,379	1,927
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	1.724	1,379	1,927
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	-			
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	-			
				P	0.085	0.085	-			-	Mean	0.12	Mean	-			
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	4.8	2.076	1,661	241
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	0.7	2.076	1,661	241
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	2.076	1,661	241
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	-			
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	4	90	-			
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	-			
				P	0.085	0.085	-			-	Mean	0.12	Mean	-			
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90				
				Ammonia	0.12	0.173	0.231			7	95	0.3	90				
				P	0.085	0.085	-			1	Mean	0.12	Mean				
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	-			
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	-			
				P	0.085	0.085	-			1	Mean	0.12	Mean	-			

SCENARIO B1: Compliance with WFD and HD Targets – Consents Limited to BATNEEC *(Assuming all watercourses need to meet WFD and HD targets (not just where DWF increases beyond consent) but limiting revised consent to BATNEEC)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.275	220	0
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	40	1.707	1,366	600
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	5	1.707	1,366	600
				P	0.047	0.023	-			-	Mean	0.05	Mean	1	0.75	600	0
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	4	90	30	2.833	2,266	2,406
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	10	2.833	2,266	2,406
				P	0.034	0.014	-			-	Mean	0.05	Mean	1.1	2.833	2,266	2,406
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	12	2.339	1,871	537
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	1	1.650	1,320	0
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	1	1.075	860	0
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	9.5	1.285	1,028	779
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	1	1.285	1,028	779
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.375	300	0
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	1	0.45	360	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.06	48	0
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	7.5	1.143	915	709
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.1	1.143	915	709
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.09	72	0
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	5	1.500	1,875	0
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	1	0.275	220	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.01	8	0
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	15	1.430	1,144	323
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.5	1.430	1,144	323
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.400	320	0
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	4	90	7.5	1.120	896	503
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	1	0.700	560	0
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.100	80	0
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	10.5	83.010	66,408	28,358
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	1	40.150	32,120	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	16.200	12,960	0
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	9.5	4.896	3,917	2,898
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.8	4.896	3,917	2,898
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.550	440	0

SCENARIO B2: Compliance with WFD and HD Target - % Deterioration Impact with BATNEEC *(Assuming all watercourses need to meet WFD targets (not just where DWF increases beyond consent), impact on downstream compliance if revised quality consents for these works were limited to BATNEEC)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Current & Future Downstream Water Quality							
		Mean (Ml/d)	95%ile (Ml/d)	Det	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Det.	Current Mean (mg/l)	Current St Dev (mg/l)	Current 90%ile (mg/l)	Future Mean (mg/l)	Future St Dev (mg/l)	Future 90%ile (mg/l)	% Det
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	BOD							
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	P	0.24	0.10	0.38	0.25	0.11	0.39	4%
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	40	BOD							
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	5	Ammonia							
				P	0.047	0.023	-			-	Mean	0.05	Mean	1	P	0.06	0.02	0.09	0.06	0.03	0.10	0%
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.85	30	95	4	90	30	BOD							
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	10	Ammonia							
				P	0.034	0.014	-			-	Mean	0.05	Mean	1.1	P							
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	12	BOD							
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	1	Ammonia	0.62	0.35	1.11	0.22	0.08	0.34	70% (Imp)
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	1	P	0.35	0.22	0.35	0.20	0.12	0.36	43% (Imp)
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	9.5	BOD							
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	1	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.16	0.10	0.29	0.19	0.11	0.34	19%
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	BOD							
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	1	Ammonia	3.42	1.79	6.00	0.34	0.13	0.52	90% (Imp)
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.39	0.17	0.64	0.53	0.21	0.82	35%
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	7.5	BOD							
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.1	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	P	0.31	0.14	0.52	0.37	0.16	0.60	19%
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	5	BOD	16.4	5.1	23.16	3.01	0.84	4.12	82% (Imp)
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	1	Ammonia	5.4	1.71	7.68	0.58	0.17	0.80	90% (Imp)
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.85	0.26	1.19	0.85	0.26	1.20	0.01%
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	15	BOD							
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.5	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.19	0.10	0.31	0.20	0.11	0.33	5%
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	BOD							
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	Ammonia							
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	P							
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.12	0.336	15	95	4	90	7.5	BOD							
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	1	Ammonia	0.83	0.46	1.49	0.23	0.10	0.37	75% (Imp)
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	P	0.50	0.30	0.93	0.54	0.31	0.97	8%
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	10.5	BOD							
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	1	Ammonia	0.74	0.40	1.28	0.21	0.16	0.35	72% (Imp)
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.21	0.11	0.36	0.23	0.11	0.39	9%
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	9.5	BOD							
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.8	Ammonia							
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	P	0.25	0.13	0.43	0.30	0.15	0.51	20%

SCENARIO B3: Compliance with WFD and HD Target - Consents Beyond BATNEEC *(Assuming all watercourses need to meet WFD targets (not just where DWF increases beyond consent), what would consents need to be ignoring limitations of BATNEEC)*

Red cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	10.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.2	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.595	1,276	241
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	40	1.707	1,366	600
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	5	1.707	1,366	600
				P	0.047	0.023	-			-	Mean	0.05	Mean	0.2	1.707	1,366	600
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	4	90	30	2.833	2,266	2,406
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	10	2.833	2,266	2,406
				P	0.034	0.014	-			-	Mean	0.05	Mean	1.1	2.833	2,266	2,406
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	12	2.339	1,871	537
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	0.8	2.339	1,871	537
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	0.5	2.339	1,871	537
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	9.5	1.285	1,028	779
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	1	1.285	1,028	779
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.4	1.285	1,028	779
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	7	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	0.5	1.724	1,379	1,927
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	1.724	1,379	1,927
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	7.5	1.143	915	709
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.1	1.143	915	709
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.143	915	709
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	4.8	2.076	1,661	241
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	0.7	2.076	1,661	241
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	2.076	1,661	241
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	15	1.430	1,144	323
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.5	1.430	1,144	323
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.3	1.430	1,144	323
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	10	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	4	90	7.5	1.120	896	503
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	0.7	1.120	896	503
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.120	896	503
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	10.5	83.010	66,408	28,358
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	0.7	83.010	66,408	28,358
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.3	83.010	66,408	28,358
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	9.5	4.896	3,917	2,898
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.8	4.896	3,917	2,898
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.2	4.896	3,917	2,898

SCENARIO C1: Meeting WFD and HD with the Exception of WFD P *(Assuming all watercourses need to meet WFD and HD targets (not just where DWF increases beyond consent) but limiting revised consent to BATNEEC and excluding requirement to meet WFD and HD standards for P)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	4	90	**10.5**	1.595	1,276	**241**
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	**1.2**	1.595	1,276	**241**
				P	0.085	0.085	-			-	Mean	0.12	Mean				
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	4	90	**40**	1.707	1,366	**600**
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	**5**	1.707	1,366	**600**
				P	0.047	0.023	-			-	Mean	0.05	Mean				
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	4	90	**30**	2.833	2,266	**2,406**
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	**10**	2.833	2,266	**2,406**
				P	0.034	0.014	-			-	Mean	0.05	Mean				
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	4	90	**12**	2.339	1,871	**537**
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	**1**	1.650	1,320	**0**
				P	0.032	0.022	0.032			2	Mean	0.12	Mean				
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	4	90	**9.5**	1.285	1,028	**779**
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	**1**	1.285	1,028	**779**
				P	0.085	0.085	-			1	Mean	0.12	Mean				
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	4	90	**7**	1.724	1,379	**1,927**
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	**1**	0.45	360	**0**
				P	0.085	0.085	-			1	Mean	0.12	Mean				
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	4	90	**7.5**	1.143	915	**709**
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	**1.1**	1.143	915	**709**
				P	0.085	0.085	-			-	Mean	0.12	Mean				
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	4	90	**5**	1.500	1,875	**0**
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	**1**	0.275	220	**0**
				P	0.085	0.085	-			1	Mean	0.12	Mean				
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	4	90	**15**	1.430	1,144	**323**
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	**2.5**	1.430	1,144	**323**
				P	0.085	0.085	-			1	Mean	0.12	Mean				
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	4	90	**50**	0.664	531	**177**
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	**10**	0.664	531	**177**
				P	0.085	0.085	-			-	Mean	0.12	Mean				
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	4	90	**7.5**	1.120	896	**503**
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	**1**	0.700	560	**0**
				P	0.085	0.085	-			-	Mean	0.12	Mean				
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	4	90	**10.5**	83.010	66,408	**28,358**
				Ammonia	0.12	0.173	0.231			7	95	0.3	90	**1**	40.150	32,120	**0**
				P	0.085	0.085	-			1	Mean	0.12	Mean				
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	4	90	**9.5**	4.896	3,917	**2,898**
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	**1.8**	4.896	3,917	**2,898**
				P	0.085	0.085	-			1	Mean	0.12	Mean				

SCENARIO D1: WFD Deterioration - High to Good - Consents Limited to BATNEEC *(Assuming all watercourses need to meet WFD and HD targets (not just where DWF increases beyond consent) but allowing downstream compliance to move from high to good status and limiting revised consent to BATNEEC)*

Orange cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	5	90	16.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.6	90	2.5	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.275	220	0
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	5	90	40	1.707	1,366	600
				Ammonia	0.041	0.019	0.058			5	95	0.6	90	5	1.707	1,366	600
				P	0.047	0.023	-			-	Mean	0.12	Mean	4	1.707	1,366	600
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	5	90	30	2.833	2,266	2,406
				Ammonia	0.045	0.021	0.073			10	95	0.6	90	10	2.833	2,266	2,406
				P	0.034	0.014	-			-	Mean	0.12	Mean	6	2.833	2,266	2,406
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	5	90	12	2.339	1,871	537
				Ammonia	0.132	0.062	0.206			5	95	0.6	90	2.3	2.339	1,871	537
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	1	1.075	860	0
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	5	90	17	1.285	1,028	779
				Ammonia	0.102	0.131	0.167			5	95	0.6	90	3	1.285	1,028	779
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.375	300	0
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	5	90	8.5	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.6	90	1.1	1.724	1,379	1,927
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.06	48	0
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	5	90	10.5	1.143	915	709
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.1	1.143	915	709
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.09	72	0
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	5	90	6	2.076	1,661	241
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	1	0.275	220	0
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.01	8	0
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	5	90	20	1.430	1,144	323
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.5	1.430	1,144	323
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.400	320	0
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	5	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.6	90	28	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	5	90	11	1.120	896	503
				Ammonia	0.07	0.04	0.13			5	95	0.6	90	1.7	1.120	896	503
				P	0.085	0.085	-			-	Mean	0.12	Mean	1	0.100	80	0
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	5	90	17	83.010	66,408	28,358
				Ammonia	0.12	0.173	0.231			7	95	0.6	90	2	83.010	66,408	28,358
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	16.200	12,960	0
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	5	90	12	4.896	3,917	2,898
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.8	4.896	3,917	2,898
				P	0.085	0.085	-			1	Mean	0.12	Mean	1	0.550	440	0

SCENARIO D2: WFD Deterioration - High to Good - Consents Beyond BATNEEC *(Assuming all watercourses need to meet WFD and HD targets (not just where DWF increases beyond consent) but allowing downstream compliance to move from high to good status and not limiting revised consent to BATNEEC)*

Red cells indicate where consent below BATNEEC is required to achieve WFD compliance

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent	Capacity Assessment – Development Allowable to still achieve compliance with WFD		
		Mean (Ml/d)	95%ile (Ml/d)	Determinand	Mean (mg/l)	St Dev (mg/l)	90%ile (mg/l)	Mean (Ml/d) (DWF x 1.25)	St Dev (Ml/d) (Mean x 0.3)	Consent (mg/l)	%ile	Objective (mg/l)	%ile	(mg/l)	Max Mean WwTW Flow (Ml/d)	Max DWF (m^3/d)	No. New Dwellings
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.1	1.595	0.478	29	95	5	90	16.5	1.595	1,276	241
				Ammonia	0.07	0.04	0.13			13	95	0.6	90	2.5	1.595	1,276	241
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.595	1,276	241
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.6	1.85	1.707	0.512	40	95	5	90	40	1.707	1,366	600
				Ammonia	0.041	0.019	0.058			5	95	0.6	90	5	1.707	1,366	600
				P	0.047	0.023	-			-	Mean	0.12	Mean	4	1.707	1,366	600
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.2	0.28	1.6	2.833	0.850	30	95	5	90	30	2.833	2,266	2,406
				Ammonia	0.045	0.021	0.073			10	95	0.6	90	10	2.833	2,266	2,406
				P	0.034	0.014	-			-	Mean	0.12	Mean	6	2.833	2,266	2,406
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.339	0.702	12	95	5	90	12	2.339	1,871	537
				Ammonia	0.132	0.062	0.206			5	95	0.6	90	2.3	2.339	1,871	537
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	0.5	2.339	1,871	537
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.285	0.386	17	95	5	90	17	1.285	1,028	779
				Ammonia	0.102	0.131	0.167			5	95	0.6	90	3	1.285	1,028	779
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.4	1.285	1,028	779
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.5	1.724	0.517	20	95	5	90	8.5	1.724	1,379	1,927
				Ammonia	0.055	0.042	0.081			16	95	0.6	90	1.1	1.724	1,379	1,927
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	1.724	1,379	1,927
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.1	1.143	0.343	18	95	5	90	10.5	1.143	915	709
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.1	1.143	915	709
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.143	915	709
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.1	2.076	0.623	30	95	5	90	6	2.076	1,661	241
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	0.7	2.076	1,661	241
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.1	2.076	1,661	241
SISLAND	TRIB OF RIVER CHET	16	3.4	BOD	2.21	0.23	2.85	1.430	0.429	20	95	5	90	20	1.430	1,144	323
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.5	1.430	1,144	323
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.3	1.430	1,144	323
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.6	1.51	0.664	0.199	50	95	5	90	50	0.664	531	177
				Ammonia	0.093	0.056	0.161			-	95	0.6	90	28	0.664	531	177
				P	0.085	0.085	-			-	Mean	0.12	Mean	2.5	0.664	531	177
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.1	1.120	0.336	15	95	5	90	11	1.120	896	503
				Ammonia	0.07	0.04	0.13			5	95	0.6	90	1.7	1.120	896	503
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2	1.120	896	503
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.010	24.903	20	95	5	90	17	83.010	66,408	28,358
				Ammonia	0.12	0.173	0.231			7	95	0.6	90	2	83.010	66,408	28,358
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.3	83.010	66,408	28,358
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.896	1.469	12	95	5	90	12	4.896	3,917	2,898
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.8	4.896	3,917	2,898
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.2	4.896	3,917	2,898

Appendix H: Water Demand Calculations Detail

Residential Water Demands in the GNDP study area[42]

Development Areas	PGA	Authority Control	Granted Permissions	Growth Numbers in 'Favoured' option	Total Nos. dwellings up to 2026	Water Company forecast Scenario 1a (Ml/d)*1	Water Company forecast Scenario 1b (Ml/d)*2	Code for sustainable homes rating 1/2 120 l/h/d Scenario 2 (Ml/d)*3	Code for sustainable homes rating 3/4 105 l/h/d Scenario 3 (Ml/d)*4	Code for sustainable homes rating 5/6 80 l/h/d Scenario 4 (Ml/d)*5	Range of Estimates Min (Col 11) Scenario 4 (Ml/d)	Range of Estimates Max (Col 7) Scenario 1 (Ml/d)	Including an allowance for headroom (Col 11) Scenario 4 (Ml/d)*6	Including an allowance for headroom (Col 7) Scenario 1 (Ml/d)*6
North Sector	NPA1	Norfolk PA	63	90	153	0.05	0.04	0.04	0.03	0.03	0.03	0.05	0.03	0.05
NE Sector (inside NNDR)	NPA2	Norfolk PA	1663	7454	9,117	2.98	2.49	2.30	2.01	1.53	1.53	2.98	1.68	3.28
NE Sector (outside NNDR/ vicinity of Rackheath)	NPA3a	Broadland	31	3420	3,451	1.13	0.94	0.87	0.76	0.58	0.58	1.13	0.64	1.24
East Sector	NPA3b	Norfolk PA	220	20	240	0.08	0.07	0.06	0.05	0.04	0.04	0.08	0.04	0.09
SE Sector	NPA4	Norfolk PA	686	500	1,186	0.39	0.32	0.30	0.26	0.20	0.20	0.39	0.22	0.43
S Sector	NPA5	Norfolk PA	128	4875	5,003	1.63	1.37	1.26	1.10	0.84	0.84	1.63	0.92	1.80
Long Stratton	NPA6	Norfolk PA	77	1850	1,927	0.63	0.53	0.49	0.42	0.32	0.32	0.63	0.36	0.69
Wymondham	NPA7	Norfolk PA	500	2250	2,750	0.90	0.75	0.69	0.61	0.46	0.46	0.90	0.51	0.99
SW Sector	NPA8	Norfolk PA	715	2500	3,215	1.05	0.88	0.81	0.71	0.54	0.54	1.05	0.59	1.16
W Sector	NPA9	Norfolk PA	1581	1525	3,106	1.01	0.85	0.78	0.68	0.52	0.52	1.01	0.57	1.12
NW Sector	NPA10	Norfolk PA	286	1200	1,486	0.49	0.41	0.37	0.33	0.25	0.25	0.49	0.27	0.53
NPA Total	-		5950	25684	31634	9.85	8.23	7.97	6.98	5.31	5.31	9.85	5.85	10.83
Reepham	RPA1	Broadland	83	200	283	0.09	0.08	0.07	0.06	0.05	0.05	0.09	0.05	0.10
Aylsham	RPA2	Broadland	265	350	615	0.20	0.17	0.15	0.14	0.10	0.10	0.20	0.11	0.22
Wroxham	RPA3	Broadland	25	200	225	0.07	0.06	0.06	0.05	0.04	0.04	0.07	0.04	0.08
Acle	RPA4	Broadland	73	200	273	0.09	0.07	0.07	0.06	0.05	0.05	0.09	0.05	0.10
Hingham	RPA5	South Norfolk	48	0	48	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02
Diss	RPA6	South Norfolk	237	0	237	0.08	0.06	0.06	0.05	0.04	0.04	0.08	0.04	0.09
Harleston	RPA7	South Norfolk	479	0	479	0.16	0.13	0.12	0.11	0.08	0.08	0.16	0.09	0.17
Loddon	RPA8	South Norfolk	123	0	123	0.04	0.03	0.03	0.03	0.02	0.02	0.04	0.02	0.04
RPA Total	-		1333	950	2283	0.75	0.62	0.58	0.50	0.38	0.38	0.75	0.42	0.82
Norwich City area	Norwich	Norwich CC	5911	3000	8911	2.91	2.43	2.25	1.96	1.50	1.50	2.91	1.65	3.20
Overall GNDP Total	-		13194	29634	42828	13.50	11.29	10.79	9.44	7.20	7.20	13.50	7.91	14.85

*1 Assuming 142 l/h/d supplied to AWS areas and an average occupancy rate of 2.3 (Ofwat 2007-08)

*2 Assuming 130 l/h/d supplied to AWS areas (target for 2030) and an average occupancy rate of 2.1 (as agreed with AWS on 28/8/08 at Outline Stage)

*3 Code for Sustainable Homes - Water consumption targets for Code 1/2 homes and an assuming occupancy rate of 2.1

*4 Code for Sustainable Homes - Water consumption targets for Code 3/4 homes

[42] Note – The calculations in this table estimate of the residential water demands up to 2026 i.e. it excludes the 12,000 additional new homes required under the RSS between 2026 and 2031.

*5 Code for Sustainable Homes - Water consumption targets for Code 5/6 homes
*6 Allowance for headroom in-line with WCS Methodology (4/6/08) [+10%]
(Ofwat 2007-08)

Key to Residential Water Demands in the GNDP study area table

Type of Demand Calculations	Colour Code
Residential demands	
Non-residential demands (NRD)	Not used
Total demands (residential and NRD)	Not used
Including headroom	

Appendix I: Water Neutrality Calculations

Water Neutrality Calculations

Option
1 - Meter, Low flush toilet and low flow shower in 40% of existing homes that are currently unmetered. Water consumption in the remaining 60% of existing homes (already metered) is assumed to remain unchanged at 142 l/h/d.
2 - Meter and low use fittings in 40% of existing homes that are currently unmetered. Water consumption in the remaining 60% of existing homes (already metered) is assumed to remain unchanged at 142 l/h/d.
3a - Low flow toilet and low flow shower in all existing homes.
3b - Low flow toilet and low flow shower in currently metered houses (60% of total houses). Water consumption in remaining 40% of existing homes (currently unmetered) is assumed to remain unchanged at 142 l/h/d.
4a - Low use fittings in all existing homes.
4b - Low use fittings in currently metered houses (60% of total houses). Water consumption in remaining 40% of existing homes (currently unmetered) is assumed to remain unchanged at 142 l/h/d.

Greater Norwich	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-2.81	-4.92	-6.18	-8.04
Option 2	-3.40	-5.51	-6.78	-8.63
Option 3a	1.13	-0.97	-2.24	-4.09
Option 3b	-2.02	-4.12	-5.39	-7.24
Option 4a	-0.35	-2.45	-3.72	-5.57
Option 4b	-2.91	-5.01	-6.28	-8.13
Option 1 & 3b	1.91	-0.19	-1.46	-3.31
Option 2 & 3b	1.32	-0.79	-2.05	-3.90
Option 1 & 4b	1.02	-1.08	-2.35	-4.20
Option 2 & 4b	0.43	-1.68	-2.94	-4.79

Hingham	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	0.02	0.02	0.02	0.02
Option 2	0.02	0.01	0.01	0.01
Option 3a	0.05	0.05	0.05	0.05
Option 3b	0.03	0.03	0.02	0.02
Option 4a	0.04	0.04	0.04	0.03
Option 4b	0.02	0.02	0.02	0.01
Option 1 & 3b	0.06	0.05	0.05	0.05
Option 2 & 3b	0.05	0.05	0.05	0.05
Option 1 & 4b	0.05	0.05	0.05	0.04
Option 2 & 4b	0.05	0.04	0.04	0.04

Norwich City	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-2.31	-4.06	-5.12	-6.66
Option 2	-2.81	-4.56	-5.61	-7.15
Option 3a	1.00	-0.76	-1.81	-3.35
Option 3b	-1.65	-3.40	-4.45	-5.99
Option 4a	-0.25	-2.00	-3.05	-4.59
Option 4b	-2.39	-4.14	-5.19	-6.73
Option 1 & 3b	1.65	-0.10	-1.15	-2.70
Option 2 & 3b	1.15	-0.60	-1.65	-3.19
Option 1 & 4b	0.90	-0.85	-1.90	-3.44
Option 2 & 4b	0.41	-1.35	-2.40	-3.94

Loddon	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	0.02	0.01	0.01	0.00
Option 2	0.01	0.00	0.00	-0.01
Option 3a	0.05	0.05	0.04	0.04
Option 3b	0.02	0.02	0.01	0.01
Option 4a	0.04	0.03	0.03	0.02
Option 4b	0.02	0.01	0.01	0.00
Option 1 & 3b	0.06	0.05	0.05	0.04
Option 2 & 3b	0.06	0.05	0.04	0.04
Option 1 & 4b	0.05	0.05	0.04	0.04
Option 2 & 4b	0.05	0.04	0.04	0.03

Acle	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	0.01	0.00	0.00	-0.01
Option 2	0.00	0.00	-0.01	-0.02
Option 3a	0.05	0.04	0.03	0.03
Option 3b	0.02	0.01	0.00	0.00
Option 4a	0.03	0.03	0.02	0.01
Option 4b	0.01	0.00	-0.01	-0.01
Option 1 & 3b	0.06	0.05	0.04	0.03
Option 2 & 3b	0.05	0.04	0.04	0.03
Option 1 & 4b	0.05	0.04	0.03	0.03
Option 2 & 4b	0.04	0.03	0.03	0.02

Long Statton	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-0.27	-0.37	-0.43	-0.52
Option 2	-0.28	-0.38	-0.44	-0.53
Option 3a	-0.22	-0.32	-0.38	-0.47
Option 3b	-0.26	-0.36	-0.42	-0.51
Option 4a	-0.24	-0.34	-0.40	-0.49
Option 4b	-0.27	-0.37	-0.43	-0.52
Option 1 & 3b	-0.21	-0.31	-0.37	-0.46
Option 2 & 3b	-0.22	-0.32	-0.38	-0.47
Option 1 & 4b	-0.22	-0.32	-0.38	-0.47
Option 2 & 4b	-0.23	-0.33	-0.39	-0.48

Aylesham	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-0.02	-0.05	-0.07	-0.10
Option 2	-0.03	-0.06	-0.08	-0.11
Option 3a	0.07	0.04	0.02	-0.01
Option 3b	0.00	-0.03	-0.05	-0.08
Option 4a	0.04	0.00	-0.02	-0.04
Option 4b	-0.02	-0.05	-0.07	-0.10
Option 1 & 3b	0.09	0.05	0.03	0.01
Option 2 & 3b	0.07	0.04	0.02	-0.01
Option 1 & 4b	0.07	0.03	0.01	-0.01
Option 2 & 4b	0.05	0.02	0.00	-0.03

Reepham	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-0.01	-0.03	-0.04	-0.05
Option 2	-0.02	-0.03	-0.04	-0.05
Option 3a	0.02	0.01	0.00	-0.01
Option 3b	-0.01	-0.02	-0.03	-0.04
Option 4a	0.01	-0.01	-0.01	-0.03
Option 4b	-0.01	-0.03	-0.04	-0.05
Option 1 & 3b	0.03	0.02	0.01	-0.01
Option 2 & 3b	0.02	0.01	0.00	-0.01
Option 1 & 4b	0.02	0.01	0.00	-0.01
Option 2 & 4b	0.02	0.00	-0.01	-0.02

Diss	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	0.06	0.04	0.04	0.03
Option 2	0.04	0.03	0.02	0.01
Option 3a	0.15	0.14	0.13	0.12
Option 3b	0.08	0.06	0.06	0.05
Option 4a	0.12	0.10	0.10	0.09
Option 4b	0.05	0.04	0.03	0.02
Option 1 & 3b	0.17	0.16	0.15	0.14
Option 2 & 3b	0.16	0.15	0.14	0.13
Option 1 & 4b	0.15	0.14	0.13	0.12
Option 2 & 4b	0.14	0.12	0.12	0.11

Wroxham	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	0.00	-0.01	-0.01	-0.02
Option 2	0.00	-0.01	-0.01	-0.02
Option 3a	0.02	0.02	0.01	0.01
Option 3b	0.01	0.00	-0.01	-0.01
Option 4a	0.01	0.01	0.00	0.00
Option 4b	0.00	-0.01	-0.01	-0.02
Option 1 & 3b	0.03	0.02	0.02	0.01
Option 2 & 3b	0.02	0.02	0.01	0.01
Option 1 & 4b	0.02	0.02	0.01	0.01
Option 2 & 4b	0.02	0.01	0.01	0.00

Harleston	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-0.02	-0.05	-0.06	-0.08
Option 2	-0.03	-0.06	-0.07	-0.09
Option 3a	0.04	0.01	0.00	-0.03
Option 3b	-0.01	-0.04	-0.05	-0.07
Option 4a	0.01	-0.01	-0.03	-0.05
Option 4b	-0.02	-0.05	-0.06	-0.09
Option 1 & 3b	0.05	0.02	0.01	-0.01
Option 2 & 3b	0.04	0.01	0.00	-0.02
Option 1 & 4b	0.03	0.01	-0.01	-0.03
Option 2 & 4b	0.03	0.00	-0.01	-0.04

Wymondham	CfSH 5&6	CfSH 3&4	CfSH 1&2	Existing Use
Option 1	-0.28	-0.43	-0.51	-0.64
Option 2	-0.31	-0.45	-0.54	-0.67
Option 3a	-0.10	-0.25	-0.33	-0.46
Option 3b	-0.25	-0.39	-0.48	-0.60
Option 4a	-0.17	-0.31	-0.40	-0.53
Option 4b	-0.29	-0.43	-0.52	-0.64
Option 1 & 3b	-0.07	-0.21	-0.30	-0.42
Option 2 & 3b	-0.09	-0.24	-0.32	-0.45
Option 1 & 4b	-0.11	-0.25	-0.34	-0.47
Option 2 & 4b	-0.13	-0.28	-0.37	-0.49

Appendix J: Network Assessment Summary

The following assessment is taken from Table 9-4 of the Stage 2a GNWCS report.