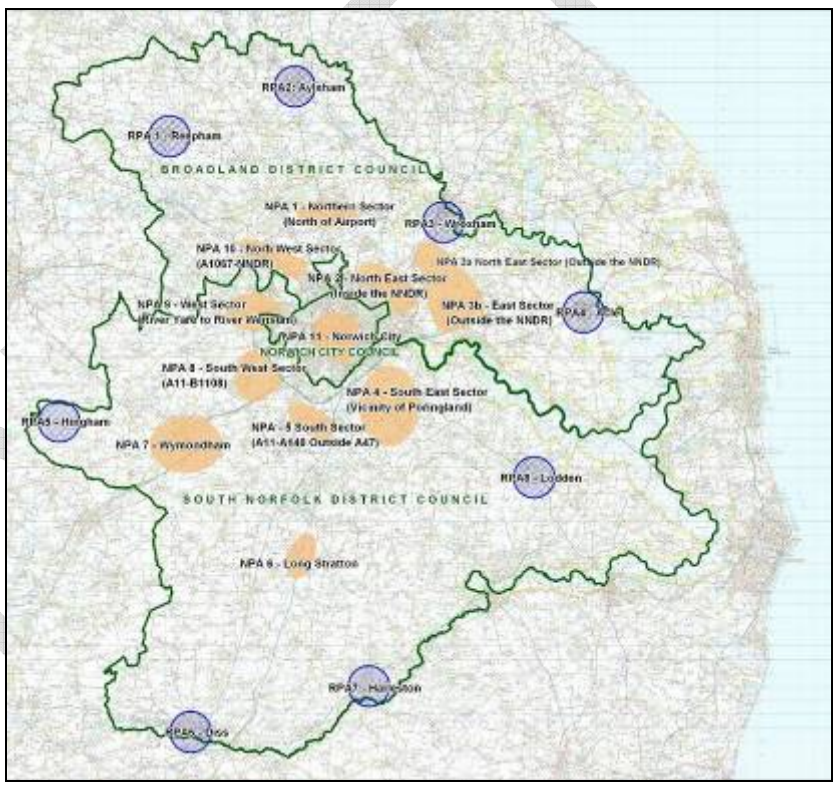
Greater Norwich Development Partnership

Stage 2b Water Cycle Study

Draft Final Report
September 2009



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 – Draft Final Report
September 2009

Rev	Date	Details	Prepared by	Reviewed by	Approved by
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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
LIDAR	Light Detection and Ranging
Ml/d	Megalitres per day (1000m3/day)
NE	Natural England
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
PPS	Planning Policy Statement
RoC	Review of Consents (under the Habitats Directive)
RPA	Rural Policy Area

Abbreviation	Description
RSS	Regional Spatial Strategy
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SOP	Site Options 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
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

Executive Summary

1.1 Introduction

1.1.1 Significant growth in housing and employment is proposed for the Greater Norwich development Partnership (GNDP) planning area. In order to support the Joint Core Strategy (JCS) for the partner authorities (Norwich City Council, Broadlands District Council and South Norfolk Council), a Water Cycle Study (WCS) has been undertaken to demonstrate that water supply, water quality, sewerage and flood risk management issues can be addressed in the three Local Authorities and appropriate water services infrastructure can be provided for to enable the growth planned to 2031. It is a key part of the evidence base for the Joint Core Strategy (JCS) and is required by the East of England Plan.

1.1.2 The Greater Norwich WCS (GNWCS) has been undertaken in several key stages to inform the different stages of the JCS and in keeping with current guidance on undertaking WCSs. This report represents the finings of Stage 2b which has assessed each of the Potential Growth Areas (PGAs) chosen as the Favoured Option, providing detail on the specific infrastructure required for to take the favoured growth options forward.

1.1.3 The favoured option includes for growth in all of the Norwich Policy Areas (NPAs) and Rural Policy Areas (RPAs), and with the inclusion of completed housing within the existing baseline, includes for a further 40,000 homes to be delivered over the remaining plan period. These homes, plus requirements for employment have been assessed in the Stage 2b WCS.

1.1.4 This Stage 2b final findings report should be read in conjunction with the Stage 1 and Stage 2a reports of the GNWCS.

1.2 Wastewater Strategy

1.2.1 The additional 40,000 homes and proposed jobs that still need to be delivered in the GNDP area will generate additional wastewater, which will need to be collected, transmitted to a treatment facility and treated prior to discharge to a water body.

1.2.2 A wastewater strategy was developed which was required to:

- minimise the requirement for new infrastructure thereby maximising opportunity for early phasing and minimising cost (in keeping with Policy WAT2 of the Easy of England Plan);
- minimise distance required for transfer of wastewater flows to treatment facilities to minimise energy requirements and costs associated with operational pumping for the lifetime of development;
- ensure that increases in treated discharges will not cause watercourses to fail water quality targets under the Water Framework Directive (WFD) and Habitats Directive (HD); and
- determine what additional treatment and sewer infrastructure is required to deliver growth that exceeds existing capacity and meets with WFD and HD standards.

1.2.3 In order to do this, the Stage 2b study undertook the following assessments:

- calculated the treatment capacity at each of the Wastewater Treatment Works (WwTW);

- modelled the likely quality standards required for consenting the additional discharges in order to meet WFD and HD standards;
- reviewed capacity in the existing sewer network in terms of receiving more wastewater discharge; and
- determined requirements for upgrades to WwTW, and upgrades to existing sewer or provision of new strategic sewers to allow the wastewater to be transferred to the appropriate WwTW.

1.2.4 In undertaking the assessments, an optimal strategy was developed which utilised capacity at each WwTW local to the PGA first and then used spare capacity at Whitlingham WwTW to the east of Norwich which has a very large treatment capacity for further growth.

1.2.5 The wastewater strategy developed shows that, with some upgrades, all of the increases in wastewater flow generated as a result of new housing and employment can be transferred and treated at existing WwTW without the need for further treatment facilities.

1.2.6 A key element of the strategy is that a near circular strategic sized interceptor sewer is required around the northern and southern boundary of Norwich which intercepts flow from several of the bordering PGAs and transfers flows to Whitlingham WwTWs. This is required to prevent exacerbation of sewer flooding within Norwich and to prevent increases in discharges of polluting Combined Sewer Overflows (CSO) into the River Wensum including the Special Area of Conservation (SAC). In most cases the RPAs can make use of existing sewer network, although growth in the majority of NPAs will also need to consider a variety of sewer upgrade options in addition to the proposed interceptor sewer before they can be built and connected for wastewater treatment.

1.2.7 The assessment has shown that the wastewater strategy requires some significant upgrades in both process capacity and volumetric capacity to be undertaken at several of the WwTW in order to meet compliance with the WFD and HD and hence protect downstream sites of European important i.e. the Broads SAC and the Broadland Special Protection Area (SPA).

1.2.8 The most significant investment required is the need to install treatment processes which remove phosphorous (P) from treated discharges at WwTW that do not currently have this capability. This is required to ensure that there is no increase (and in some cases an overall decrease) in the total load of the nutrient entering the Broadland catchment and help to ensure downstream compliance with WFD and HD targets thus protecting the SAC and SPA. This investment is significant and will need to be coordinated over the next and subsequent Asset Management Periods (AMP) that Anglian Water Services (AWS) operate under; however it is considered that the removal of P required to meet HD targets can be achieved using treatment technology that is currently available and effective and within realistic costs constraints (also referred to as 'Best Available Technology Not Entailing Excessive Cost', or BATNEEC).

1.2.9 The assessment has shown that 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 and is already occurring in several cases without further housing and employment 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.

1.3 Water Supply Strategy

1.3.1 AWS are yet to finalise the statutory Water Resources Management Plan (WRMP) which sets out how water demand in its operational area will be met for the next 35 year period. At the time of completing the Stage 2b WCS, the Department for the Environment, Food and Rural Affairs (Defra) have asked that AWS submit further information on its plan before it can be published.

1.3.2 Despite this position, the Stage 2b WCS has utilised information provided by AWS in its draft WRMP and in their Statement of Response to the consultation on the draft WRMP. The Environment Agency's response to the draft WRMP (EA, 2008) has also been considered and a proposed water supply strategy put forward which shows that sufficient water resources will be available to meet the proposed increase in water demand.

1.3.3 As a result of growth in housing and employment, demand for water in the GNDP over the next 35 years has been calculated by the WCS to increase over a range from 10 million litres a day (Ml/d) up to 17 Ml/d. The lowest estimate could result if all new homes were as water efficient as possible thereby meeting levels 5 or 6 in the Code for Sustainable Homes (CfSH). The highest estimate is based on water consumption remaining as it is for current average use.

1.3.4 AWS aims to meet this demand through a 'twin-track' approach whereby existing demand for water is reduced (e.g. by installing more water meters), combined with providing new strategic sources of raw water supply to treat for potable consumption.

1.3.5 The current proposed strategy for water supply is to provide 4Ml/d additional supply through capacity in existing abstraction licences for groundwater in the area. A further 4Ml/d will be provided from a new groundwater source and in excess of 12Ml/d will be provided longer term from a flow transfer scheme which will transfer treated effluent flow from Whitlingham WwTW up catchment to 'compensate' for water lost at the main Costessey abstraction point west of Norwich city Centre.

1.3.6 The Costessey abstraction licence is currently being considered for a reduction in permitted maximum volumes that can be abstracted as part of a review process of all abstractions licences and consents that could impact ecological sites listed under the HD (SACs, SPAs and Ramsar sites). It is considered that the Costessey abstraction is impacting on the integrity of the Wensum SAC and the level of abstraction licence reduction (called a sustainability reduction) is currently being considered to mitigate the impact. For reasons of statutory consultation, at the time of completing the Stage 2b WCS, the exact size of the sustainability reduction is not known; however, the implications of this have been assessed in the Stage 2b WCS and it is proposed that the effluent transfer scheme could be considered as a potential replacement to the potential loss of abstraction.

1.3.7 The East of England (with the exception of coastal districts on north Essex and South Suffolk) is classified by the Environment Agency as being under 'severe' water stress, meaning demand for water is high compared to available raw resources. Water supply is therefore reliant on strategic transfers within Anglian Water's supply region and development of strategic water resource schemes. It is therefore imperative that water efficiency is maximised in both existing and new homes and non residential building as part of the growth plan proposed to minimise future demand and minimise additional 'stress' on resources. A Water Efficiency Plan is proposed which has the potential to allow a position of 'water neutrality' to be achieved in the GNDP area as a whole. This would mean that by reducing demand in existing housing and non-residential buildings and by making all new homes as water efficient as possible, there could be no net

increase in water demand (compared to 2009) after development has been completed at the end of the plan period.

1.3.8 Several of the NPAs will be required to provide water quality protection to any surface water infiltrated to ground and to restrict certain types of development in order to protect the quality of groundwater abstracted for supply in the study area.

1.3.9 Assessment of water supply mains has concluded that in the majority of cases, each of the PGAs can be largely serviced through existing mains using Heigham Water Treatment Works (WTW) as the focal point for distributing new resources. Local connections (along with pumping stations) will be required in several PGAs depending on which sites are taken forward within each of the broad scale areas assessed.

1.4 Infrastructure Phasing and Funding

1.4.1 Advice has been provided on both phasing and funding of development. Significant upgrades are required to WwTW, strategic sewers and water resource development. Water Resource development will have sufficient phasing allowance to meet proposed growth; however some limitations on phasing for some PGAs will be required between 2009 2020 (end of AMP6) as funding for wastewater treatment and sewer infrastructure is sought by AWS and construction time is allowed for. This detail has been provided for each PGA in turn.

1.4.2 Significant infrastructure upgrades are required to deliver several of the required treatment upgrades (complete in 2017) and the proposed intecptor sewers (2020 at the earliest).

1.4.3 Mechanisms for developer contributions and funding to the strategic infrastructure has been identified. Although there are limits on the provision of developer funding for wastewater treatment and water resources, mechanisms for securing funding to strategic water supply mains and sewers has been identified where it is clear that the infrastructure is required solely to service specific development.

1.4.4 Significant funding will be required to deliver management of surface water from the proposed developments. The cost for this will vary according to each PGA as the variability of ground conditions and abstractions means that effectiveness of preferred Sustainable drainage Systems (SuDS) which naturally infiltrate water to the ground is also variable. Advice is provided on which SuDS systems are most suitable for each PGA.

1.5 Recommendations

1.5.1 Several Key Water Cycle policies have been put forward to include within the JCS or for potential Area Action Plans (AAP) and Supplementary Planning Guidance (SPG) documents. These polices are proposed to both aid the delivery of water services infrastructure required, but also to help meet the key requirements of the water strategy developed in the WCS. This includes policy recommendations on water efficiency for new homes and policy on drainage management.

1.5.2 A developer checklist to ensure individual developments comply with the strategy has been provided.

1.5.3 Several key statutory water related outputs and plans were not finalised in time to fully inform this Stage 2b WCS. It is therefore recommended that the WCS remains a live document and is

revisited at key stages of release of key information. Likely dates for review are included in the appendices.

2 Introduction

2.1 Purpose of the Water Cycle Study

2.1.1 Through Policy WAT2 (Infrastructure) the RSS for the East of England (The East of England Plan) requires a programme of WCSs to be undertaken to:

- ensure a co-ordinated approach to the timely provision of the appropriate additional infrastructure for water supply and wastewater treatment to cater for levels of development as proposed in the RSS;
- address issues of water supply, water quality, wastewater treatment and flood risk in receiving watercourses related to development proposed in the RSS; and
- provide an evidence base for Local Development Documents (LDD) so they can demonstrate that location of new development has:
    - maximised potential of existing infrastructure; and hence
    - minimised the need for new infrastructure.

2.1.2 This study is needed to ensure that water supply, water quality, sewerage and flood risk management issues can be addressed in the three Local Authorities (Norwich City Council, Broadlands District Council and South Norfolk Council) to enable the growth planned to 2031. It is a key part of the evidence base for the JCS and is required by the East of England Plan.

2.1.3 The main aims of the WCS are to ensure:

- water services infrastructure can be put in place to support housing and employment growth;
- there is a strategic, co-ordinated approach to the management and usage of water; and
- there are no adverse impacts on the water environment with specific importance given to European environmental sites e.g. SPAs and SACs.

2.1.4 It will therefore:

- inform Local Development Framework (LDF) site choice and enable phasing;
- minimise infrastructure costs and the need for new infrastructure;
- inform developers of any flood mitigation needs and costs;
- provide evidence for Anglian Water investment plans with the Office of Water Services (Ofwat); and
- promote water efficient development.

2.1.5 It is considered that WCS are “living” documents and that although they are based on the best available data, they should be updated once further data becomes available.

2.2 Previous Water Cycle Study Stages and Findings

2.2.1 The GNWCS has been undertaken in several key stages to inform the different stages of the JCS. Each stage of the WCS has been undertaken by Scott Wilson and the key findings of each are summarised here.

Stage 1 Outline GNWCS

Background

2.2.2 Stage 1 provided a WCS for the GNDP in light of their required housing and employment growth targets, as set out in the RSS. It was undertaken prior to the selection of favoured growth locations and undertook a strategic broad scale assessment of the water and wastewater issues in the region and undertook initial testing of each of the Proposed Growth Area (PGA). The Stage 1 report therefore provided the following:

- a review of the PGAs in terms of the integrated water related features, such as flood risk, water supply, wastewater treatment and the environment;
- identified, using a traffic light system, the level of risk for each of the PGA to enable a visual representation of the suitability of development within these areas with respect to the water cycle;
- identified the financial contribution methodologies which could be sourced from third parties;
- undertook an initial screening stage of an Appropriate Assessment of the findings of the study[1;] and
- provided a scope and fee proposal for Stage 2 of the WCS.

Outcomes of Stage 1

2.2.3 The results of Stage 1 are summarised below:

- Stage 1 identified water infrastructure and environmental constraints related to development of PGA locations in both the NPA and the RPAs, based on existing infrastructural and environmental capacity;
- each NPA was assessed for development of up to 20,000 dwellings at each location and for up to 2,000 dwellings at RPA locations;
- it was concluded that within existing constraints, 33,000 new dwellings could be developed in the NPA and 2,300 in the RPA;
- flood risk is most relevant on some brownfield sites in Norwich and in NPA8;
- Whitlingham WwTW has high volumetric capacity available but there is a need for wastewater network mains improvements and technological improvements (to reduce phosphorus in the discharge) to protect The Broads SAC; and
- limited sewer capacity in central Norwich reduces the potential for development to the north and west of Norwich unless new strategic sewerage infrastructure is provided and may be an issue for future development of brownfield sites in the city centre.

[1] The Appropriate Assessment for the RSS had not been agreed at the time of writing

Stage 2a Detailed GNWCS

2.2.4 The Stage 2 has used and developed the Stage 1 findings and has been undertaken in two sub-stages. The first sub-stage was undertaken to provide the water inputs to the planning decisions on selection of favoured options, whilst the second sub-stage was to complete the detailed assessment of the favoured options once chosen.

2.2.5 This report covers the findings of the Stage 2b study.

Stage 2a

2.2.6 This sub-stage informed the Favoured Options decisions of the JCS. It identified how the Stage 1 constraints for all the PGAs could be overcome through investment in new infrastructure which was costed and compared for each growth area. It then made recommendations on which were the most appropriate locations for growth based on a ranking system covering:

- costs of providing infrastructure to the PGA;
- Impact on environment; and
- Flood risk considerations.

Outcomes of Stage 2a

2.2.7 Stage 2a of the WCS identified the strategic infrastructure requirements of developing each of the PGAs for different levels of growth to give a comparison for each PGA in relation to water cycle issues. It identified that:

- strategic infrastructure options are available for each of the PGAs to provide sufficient wastewater and water supply infrastructure;
- the estimated costs in providing this infrastructure varied considerably dependent on water environment impacts and location, and hence several NPAs and RPAs were more preferable from a water cycle perspective than others; and
- it was identified that even with Best Available Technology for wastewater treatment, that levels of phosphorous in the WwTW discharges have a high potential to impact on in stream P targets set for both the WFD and the Habitats Directive HD.

Stage 2b

2.2.8 This sub-stage has assessed each of the PGAs chosen as the Favoured Options in greater detail, providing detail on the specific infrastructure required for the favoured growth options taken forward.

2.2.9 The key purpose of the Stage 2b study is to:

- complete any assessments required to define capacity and the water supply and wastewater strategy;
- develop the preferred wastewater and water supply strategies for the favoured options;
- provide advice on the timing of infrastructure upgrades required to deliver the strategies for the favoured growth sites;
- provide advice on policy required to deliver the overall water strategy including a developer checklist; and

- provide guidance on developer contributions to the strategic infrastructure identified as required.

2.2.10 This report represents the Stage 2b final findings, and should be read in conjunction with Stage 1 and Stage 2a reports of the GNWCS.

2.3 Stage 2b Methodology

Assumptions Carried Forward from Stages 1 and 2a.

2.3.1 It was agreed at the inception of Stage 2b that several assumptions would be carried forward into the Stage 2b study on the basis that findings of several key inputs (such as the WFD and the Review of Consents [RoC]) were still not finalised during undertaking the assessment. 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 PGAs. It has not been possible to determine site specific infrastructure requirements such as household connections, local pumping stations or site specific SUDS.

2.3.2 These assumptions and the reasons for them are detailed below. It is recommended that the Stage 2b Water Cycle Study remains a live document and its recommendations and findings are reviewed and reassessed as updates are made to key inputs and legislation such as the WFD, and HD RoC process.

Assumption I: PGAs

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

2.3.4 *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

2.3.5 AWS have advised that there is limited capacity within the wastewater network in and around Norwich; hence for the NPAs in and around the city centre, it has been assumed 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 RPAs, 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.

2.3.6 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);
- additional flow from in-fill development within the existing developed areas.

2.3.7 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

2.3.8 There are a number of 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[2]. Therefore, optimising the existing capacity will ensure that early phasing of the development can take place.

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

Assumption IV: Water Supply infrastructure

2.3.10 It is assumed that the existing water supply network is at capacity, hence all new development will require a new mains system. This does not apply to infill development, which will utilise any existing capacity in the system. It is assumed that the new infrastructure will be main supply pipes only and that the developer will pay for the distribution network costs within the development.

2.3.11 Reason: Current AWS position.

Assumption V: Heigham Water Treatment Works (WTW)

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

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

Assumption VI: Development and Flood Risk

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

2.3.15 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 VII: Costing

2.3.16 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

[2] 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

2.3.17 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 (as outlined in table Table 3-1). It also identifies infrastructure that can be funded by the developer and mechanisms for this funding. Finally, it identifies policy requirements and developer guidance in relation to the infrastructure requirements and some of the environmental issues with water service provision.

2.3.18 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
- and policy required to ensure that development meets with the overall 'water cycle strategy'.

2.3.19 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 figure 4.

3 Favoured Growth Option

3.1.1 Following submission of the Stage 2a WCS report, the information provided on PGA rankings was utilised by the GNDP along with other planning considerations, to determine where the growth in the study area would be located with respect to the PGAs identified.

3.2 Description of Favoured Option

3.2.1 In total a target of approximately 51,000 new homes are to be provided in the GNDP study area to meet with the new housing requirement for the areas as set out in the East of England Plan. The favoured location for these target dwellings includes for some level of growth within each of the NPA and RPA areas assessed in previous stages of the GNWCS. The targets for each PGA are shown in Table 3-1 and detailed geographically (Appendix A: Figures).

3.2.2 Of the approximate target of 51,000 new dwellings, 11,089 have already been completed up to the point of undertaking this study, leaving a residual target of approximately 40,000 new homes to be built.

3.2.3 Of the 40,000 new homes, 13,194 have been granted permission and await completion, leaving a target of approximately, 27,000 new homes to be constructed on new or regenerated sites in the study area.

3.2.4 For the purposes of assessing capacity for new infrastructure and determining the type and phasing of this new infrastructure, only the 40,000 new dwellings to be built have been assessed. It has been assumed that the 11,089 dwellings already completed have formed part of the baseline and have already been taken into account in the baseline data provided.

3.2.5 Growth to be delivered in the proposed Eco-Town near Rackheath has been included in this assessment (as part of NPA2). It should be noted however, that only the numbers of houses have been included within the wastewater treatment and water supply strategy. It is not intended to act as a full WCS assessment of the proposed Eco-Town which would need to be undertaken as part of the supplementary planning policy statement to PPS1.

Table 3-1: Favoured Option Detail

PGA	PGA Description	Parishes included	Completions 01/08/2009	Granted Permissions & Allocations	Total Growth numbers in "Favoured" Option	Total	Total assessed[3]
NPA1	North Sector (North of Airport)	Horsham and Newton St Faiths, Horsford and Spixworth.	132	63	90	285	153
NPA2[4]	North East Sector (inside NNDR)	Thorpe St Andrew, Sprowston, Rackheath, Gt & Lt Plumstead, Old Catton, Beeston and Postwick with Witton.	938	1663	7454	10055	9117
NPA3a	North East Sector (outside NNDR, vicinity of Rackheath)	Rackheath, Salhouse	150	31	3420	3601	3451
NPA3b	East Sector (outside of NNDR)	Gt & Lt Plumstead, Postwick with Witton	189	220	20	429	240
NPA4	South East Sector (vicinity of Poringland)	Bixley, Bramerton, Caistor St. Edmund, Framingham Earl, Framingham Pigot, Kirby Bedon, Poringland, Stoke Holy Cross, Surlingham, Trowse,	363	686	500	1549	1186
NPA5	South Sector (A11-A140 Outside A47)	Bracon Ash, East Carleton, Flordon, Mulbarton, Newton Flotman, Swainsthorpe, Swardeston, Tasburgh	518	128	2375	3021	2503
NPA6	Long Stratton	Long Stratton, Tharston	419	77	1850	2346	1927
NPA7	Wymondham	Wymondham	608	500	2250	3358	2750
NPA8	South West Sector (A11-B1108)	Colney, Cringleford, Great Melton, Hethersett, Keswick, Ketteringham, Little Melton, Marlingford	334	715	2500	3549	3215

[3] Total assessed assumed completions are already part of the water cycle baseline, therefore only those granted permission (but not yet built) and total growth numbers in 'favoured options' have been used in the Stage 2b assessments.
[4] NPA2 includes for the 'number' of new developments in the proposed Eco-town near Rackheath

PGA	PGA Description	Parishes included	Completions 01/08/2009	Granted Permissions & Allocations	Total Growth numbers in "Favoured" Option	Total	Total assessed[3]
NPA9	West Sector (River Yare to River Wensum)	Bawburgh, Easton, Costessey	719	1581	1525	3825	3106
NPA10	North West Sector (A1067-NNDR)	Hellesdon, Drayton and Taverham.	274	286	1200	1760	1486
RPA1	Reepham	Reepham	60	83	100 – 200	243 - 343	283
RPA2	Aylsham	Aylsham	238	265	350	350	615
RPA3	Wroxham	Wroxham	9	25	100 – 200	125 - 225	125
RPA4	Acle	Acle	32	73	100 – 200	173 – 273	173
RPA5	Hingham	Hingham	104	48	0	152	48
RPA6	Diss	Diss	348	237	0	585	237
RPA7	Harleston	Harleston	115	479	0	594	479
RPA8	Loddon	Loddon	55	123	0	178	123
Norwich City	Norwich City area	City administrative area	5484	5911	3000	14395	8911
	TOTALS		**11089**	**13194**	**26834 – 27134**	**51117 - 51417**	**40128**

3.3 Employment Growth

3.3.1 An Employment Growth and Sites & Premises Study was completed for the Greater Norwich Area (ARUP and Oxford Economics 2008). This assessed the capacity and implications of planned employment growth within the Greater Norwich Area up to 2026 and identified the quantity, quality and location of employment sites and premises provision.

3.3.2 The overall aggregate employment growth planned within the Greater Norwich area is as follows:

- 35,215 jobs in the period 2001 – 2021 (directly compatible with the RSS);
- 40,212 in the period 2001 – 2026, 2026 being the end date of the plan period; and
- Overall growth of 25,000 jobs between 2007 and 2026 (the plan implementation period).

3.3.3 Eight sites/areas have been identified for major employment development up to 2026 (Table 3-2). For each of these sites the area for the identified employment has been provided but no indication of the overall number of jobs to be allocated has been supplied. As such, for the purposes of the WCS assessment, the overall land requirement (190 hectares) had been divided by the total employment requirement (25,000 jobs) to determine the number of jobs per hectare (131.5 ha) and this factor applied to the individual employment site allocations. The figure of 131.5 jobs per hectare correlates well to other WCS undertaken in East Anglia, with an average of around 140 jobs per hectare.

Table 3-2: Key Employment Growth Areas within Greater Norwich

PGA	Employment Zone/Name	Employment Type	Area (Ha)	No. Jobs Equivalent
NPA1	Norwich City Centre	Offices	10	1,315
	Airport	Airport Related Industries	30	3,950
NPA2	Rackheath	General Employment	25	3,290
NPA3b	Extension to Broadland Business Park	General Employment	25	3,290
NPA7	Hethal	High Tech Engineering	20	2,630
	Wymondham	General Employment	15	1,975
NPA8	Norwich Research Park	Health and Life Sciences/Offices	55	7,235
NPA9	Longwater	General Employment	10	1,315
TOTALS			**190**	**25,000**

4 Wastewater Strategy

4.1.1 The additional 40,000 homes and additional jobs that remain to be delivered in the GNDP area will generate additional wastewater, which will need to be collected, transmitted to a treatment facility and treated prior to discharge to a water body.

4.2 Assumptions

4.2.1 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).

4.2.2 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'[5] 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 (NB - this has been addressed on an individual basis for each RPA in section 6.2);

4.3 Methodology

4.3.1 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 for the WwTW most relevant to the location of growth within each PGA.

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

Calculation of Spare WwTW Treatment Capacity

4.3.2 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 4-1 along with the watercourse that receives the treated discharges.

Table 4-1 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

4.3.3 AWS have provided measured Dry Weather Flow (DWF) for all fourteen WwTWs. The measured flows were compared to calculated flows and where there was a large variation between the two, it was agreed with AWS that the calculated DWF would be used for the purposes of the wastewater treatment capacity calculations; this was only the case for Rackheath and Stoke Holy Cross WwTW.

4.3.4 The measured flow at Acle-Damgate Lane, Rackheath, Reepham and Stoke Holy Cross is close to the amount AWS are allowed to discharge under their current consent and therefore, the Environment Agency have agreed that where the measured discharge flow (DWF) is greater than consent, they will increase the amount of discharge that can be consented with a degree of 'headroom' (10%). For the purposes of this assessment, the proposed new flow consents, which the Environment Agency is likely to approve, have been used to assess current and future volumetric capacity at the WwTW.

4.3.5 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.

4.3.6 The capacity calculations were based on a number of assumptions and used industry standard calculations to determine the volume of additional flow. The calculations for each WwTW and the assumptions behind them are included as worksheets in Appendix B: Wastewater Capacity Calculations. The results are summarised in the following section.

WwTW Treatment Capacity Results

4.3.7 Table 4-2 gives the results of spare treatment capacity at each WwTW. Using assumptions on average Occupancy Rate[6] 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.

Table 4-2: Existing WwTW dwelling capacity

Name	DWF Consent (m^3/d)	Current Volumetric Capacity			
		Measured/ Calculated DWF (m^3/d)	DWF Headroom (m^3/d)	Dwelling Headroom[7]	Capacity (%)
ACLE-DAMGATE LANE	1,189	775	295	-	25%
AYLSHAM	1,440	1,150	290	806	20%
BELAUGH	2,273	1,401	872	2,425	38%
DISS	4,032	1,678	2,354	6,546	58%
HARLESTON	1,392	748	644	1,791	46%
LONG STRATTON	1,200	686	514	1,429	43%
PORINGLAND	930	660	270	751	29%
RACKHEATH	426	296	87	-	20%
REEPHAM	1,889	882	818	-	43%
SISLAND	1,600	1,026	572	1,591	36%
STOKE HOLY CROSS	560	295	209	-	37%
SWARDESTON-COMMON	1,100	715	385	1,071	35%
WHITLINGHAM TROWSE	66,250	55,639	10,611	29,506	16%
WYMONDHAM	4,400	2,746	1,655	4,602	38%
TOTAL CAPACITY (excluding WwTW with proposed consents and therefore theoretically at capacity)				**46,240**	-

4.3.8 The results show that there is sufficient 'dwelling' capacity in all of the WwTW combined (46,240 dwellings) to treat wastewater from the proposed 40,000 new dwellings. It was therefore

[6] (see Appendix B: Wastewater Capacity Calculations)
[7] For four WwTWs (Acle, Rackheath, Reepham and Stoke Holy Cross, new consents have been agreed which whilst measured flow provided indicates capacity, the Environment Agency have requested that these works are shown as having no capacity a the actual DWF is larger than the measured figure given. There is therefore no capacity at these WwTWs.

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).

4.3.9 Using the assumptions as listed in section 4.2.2, 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 the intercepting sewer main for treatment at Whitlingham WwTW has been considered. Only if the both the above options where not suitable, was an upgrade to the existing works, or the construction of a new works considered.

The Wastewater Strategy

4.3.10 The optimisation exercise showed that, with the assumption of an intercepting wastewater main connecting NPA 10 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;

4.3.11 The assessment 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 all growth will be drained to Whitlingham WwTW.

4.3.12 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 the end of the year (2009). These consents have a built in 10% headroom allowance for variability and are not considered to have any additional capacity for the treatment of further effluent. 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 and upgrades to the works may be required to treat the additional flow. Because spare capacity was 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.

4.3.13 The assessment shows that the remaining WwTW are currently treating effluent within their current or proposed 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.

4.3.14 Whitlingham and Long Stratton WwTW will exceed their current DWF consents by 1% (367 m^3/d) and 15% (179 m^3/d) respectively if the development as planned goes ahead and is drained to these works. A new flow consent will need to be sought from the Environment Agency for both Whitlingham and Long Stratton WwTW and upgrades to the works may be required to treat the additional flow.

4.3.15 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.

4.3.16 The overall wastewater strategy and the proposed strategic wastewater connections are shown in Figure 1 (Appendix A: Figures). 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 section 6.2). The timing and phasing implications are discussed in section 7.

Table 4-3: Existing and future treatment capacity at the WwTW following treatment connection optimisation

Name	PGA	% of PGA draining to WwTW	DWF Consent (m^3/d)	Future Volumetric Capacity					
				Proposed No. Dwellings	Proposed No. Jobs	Calculated DWF (m^3/d)	DWF Headroom (m^3/d)	Dwelling Headroom	Capacity (%)
ACLE-DAMGATE LANE	RPA4	100%	1,189	173		837	-	-	19%
AYLSHAM	RPA2	100%	1,440	615		1,371	69	192	5%
BELAUGH	NPA3a	65%	2,273	2,368		2,253	20	56	1%
	RPA3	100%							
DISS	RPA6	100%	4,032	237		1,763	2,269	6,309	43%
HARLESTON	RPA7	100%	1,392	479		920	472	1,312	34%
LONG STRATTON	NPA6	100%	1,200	1,927		1,379	-179	-498	-15%
PORINGLAND	NPA4	60%	930	712		916	14	39	2%
RACKHEATH	N/A	N/A	426	-		296	-	-	20%
REEPHAM	RPA1	100%	1,889	283		984	-	-	38%
SISLAND	RPA8	100%	1,600	123		1,072	528	1,468	33%
STOKE HOLY CROSS	NPA4	40%	560	474		465	-	-	7%
SWARDESTON-COMMON	NPA5	40%	1,100	1,001		1,075	25	70	2%
WHITLINGHAM TROWSE	NPA1	100%	66,250	28,938	20,395	66,617	-367	-1,021	-1%
	NPA2	100%							
	NPA3a	35%							
	NPA3b	100%							
	NPA5	60%							
	NPA8	100%							
	NPA9	100%							
	NPA10	100%							
	Norwich	100%							
WYMONDHAM	NPA7	100%	4,400	2,798	4,605	3,881	519	1,443	12%
	RPA5	100%							

Capacity to accommodate planned development | No or limited capacity to accommodate planned development – new DWF consent will be required to treat additional flow

4.4 Wastewater Strategy - Environmental Assessment

4.4.1 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

4.4.2 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.

4.4.3 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.

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

4.4.5 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.

4.4.6 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.

4.4.7 At the time of production of this Stage 2b WCS, the RBMP are in draft form and have been subject to a round of publication consultation. The RBMPs will not be finalised until the end of 2009 and hence the final standards and classifications and POMs specific to the GNDP will not be known until after this WCS has been completed. Therefore, the draft standards, classifications and POMs have been used in this assessment.

4.4.8 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 still maintained). 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.

4.4.9 Further detail on the WFD, the Anglian RBMP and the context of the rivers within the study area is provided in (Appendix G: Water Framework Directive). 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.

Water Quality Baseline

4.4.10 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.

Water Framework Directive Standards

4.4.11 The UKTAG proposed standards for lowland and high alkalinity typology water and upland and low alkalinity typology water bodies are provided in Table 4-4 and Table 4-5. 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. However, where a water body has been designated as a Salmonid Fishery, the 'upland and low alkalinity' standards will be applied for BOD and Dissolved Oxygen (DO) which is because in these conditions the standards required by fish are tighter than those required by invertebrates.

Table 4-4 Proposed WFD Standards for Lowland and High Alkalinity Typology Waters

Proposed WFD Targets (Lowland and High 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

Table 4-5 Proposed WFD Standards for Upland and Low 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)	3	4	6	7.5
Ammonia (90%ile)	0.2	0.3	0.75	1.1
Dissolved Oxygen (DO) (10%ile)	80	75	64	50
Orthophosphate (Mean)	0.05	0.12	0.25	1

4.4.16 The River Bure, River Waveney, Hempnall Beck, Blackwater Drain, Intwood Stream and the River Yare (Tidal) are classed as 'Candidate Heavily Modified' (cHMWB). These water bodies may have been modified to facilitate land drainage and reduce flood and subsidence 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.

4.4.17 The majority of ecological determinands fall within the high status category for most rivers, and it is phosphate, often classed as 'Poor', which results in the overall classification of 'Moderate'. Even with proposed measures 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.

4.4.18 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.

4.4.19 Within the Broadland Rivers Catchment as a whole, 30km 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. Measures proposed are expected to result in there being 33km 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 in 200km or rivers in the catchment. Invertebrate communities will improve in over 19km of river and dissolved oxygen in over 40km.

Figure 4-1: Current and Predicted Water Quality Status under the Water Framework Directive for Broadland Rivers

[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).

4.4.20 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.

4.4.21 The assessment shows that Ammonia and BOD is typically of good or high status in the majority of the rivers (Table 4-6). 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 upstream WwTWs.

4.4.22 Dissolved Oxygen concentrations within the River Waveney and River Chat catchments are assessed as being poor or bad 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'.

4.4.23 With the exception of the River Bure catchment, Phosphate is generally poor throughout the Norwich study area. This is a situation that is common throughout East Anglia and will require catchment initiatives to address the problem. As stated previously, the Environment Agency have confirmed that the issues associated with meeting the proposed WFD standards for Orthophosphate can largely only be dealt with outside the remit of the WCS, as it is a catchment/regional/national issue that will not be possible to address within the WCS for point sources of discharge. However, measures to reduce the impact of P discharges to a minimum have been assessed as part of this Stage 2b WCS.

4.4.24 The only current legislative driver that requires reductions in 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 PE greater than 10,000 (2 mgl-1 limit – annual average) or 100,000 (1 mgl-1 – annual average).

4.4.25 Currently, four of the WwTW considered in this study have P discharge limitations:

- Whitlingham WwTW is consented for a discharge of 1mg/l P (mean);
- Harleston and Diss 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).

4.4.26 The results of the current waterbody classification are shown in Table 4-6.

Water Quality Capacity Assessment

4.4.27 In order to ensure that the additional treated wastewater discharge as a result of proposed development in the GNDP study area does not impact against attainment of WFD water quality standards, indicative 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 4.3.9 onwards). The required downstream water quality standards that need to be achieved under the WFD are provided in Table 4-7.

4.4.28 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.

4.4.29 For the majority of WwTWs upstream and downstream monitoring information was available. 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, 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 H: WwTW Quality Consent Calculations.

4.4.30 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. This has been undertaken for all WwTWs in the GNDP area and used upstream water quality information where available. The data used for the RQP modelling is provided in Appendix H: WwTW Quality Consent Calculations. The results of the RQP modelling, i.e. the required consent standards for each of the WwTW, are discussed in further in this section.

4.4.31 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 AWS's AMP programme.

Table 4-6 WFD Assessment of Environment Agency Monitoring Results

WwTW Name	Receiving Watercourse	Water Quality Monitoring Point		Candidate Heavily Modified Water Body	Current Overall Status	Current Ecological Status	Current Chemical Status	BOD	Ammonia	Dissolved Oxygen	Ortho-phosphate (P)
		u/s	d/s								
ACLE-DAMGATE LANE	RIVER BURE	-	-	×	Moderate	Moderate	Not Good	High	High	Good	Good
AYLSHAM	RIVER BURE	BUR070	BUR070	✓	Moderate	Moderate	Not Good	High	High	High	High
BELAUGH	RIVER BURE	BUR120	BUR120	✓	Moderate	Moderate	Not Good	High	High	High	High
DISS	RIVER WAVENEY	WAV020	WAV020	✓	Moderate	Moderate	N/A	High	High	Poor	Moderate
HARLESTON	RIVER WAVENEY	WAV100	WAV100	×	Moderate	Moderate	Good	High	High	Moderate	Bad
LONG STRATTON	HEMPNALL BECK	-	-	✓	N/A	N/A	N/A	High	High	Good	Poor
PORINGLAND	RIVER CHET	-	-	×	Moderate	Moderate	Good	High	Good	Moderate	Bad
RACKHEATH	DOBBS BECK, TRIB OF RIVER BURE	BUR137	BUR137	×	N/A	N/A	N/A	High	Good	Good	Good
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	-	-	✓	N/A	N/A	N/A	High	Good	Good	Good
SISLAND	TRIB OF RIVER CHET	CHT004	CHT004	×	Moderate	Moderate	Good	High	Good	Bad	Poor
STOKE HOLY CROSS	RIVER TAS	TAS084	TAS084	×	Moderate	Moderate	N/A	High	High	High	Poor
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF YARE	-	-	✓	Moderate	Moderate	N/A	High	High	High	Poor
WHITLINGHAM TROWSE	RIVER YARE	YAR190	YAR190	✓	Moderate	Moderate	N/A	High	High	High	Moderate
WYMONDHAM	RIVER TIFFEY	TIF050	TIF050	×	Moderate	Moderate	N/A	High	Good	High	Poor

WFD Classification Status					
High Status	Good Status	Moderate Status	Poor Status	Bad Status	N/A - Not Assessed

Table 4-7 : WwTWs and Water Quality Assessment Criteria

Name	Receiving Watercourse	WFD Target to be met Downstream to achieve Good Ecological Status and Good Ecological Potential (for cHMWB)		
		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)

Proposed Consent Changes: WwTW specific issues

Overview

4.4.32 The watercourses downstream of the WwTWs 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'[9], and those currently achieving less that 'good' status will need to improve to this status by 2015[10].

4.4.33 This assessment has considered compliance with WFD standards at the downstream point from the WwTW. Table 4-8 provides the current and proposed future consents for WwTWs in the Norwich and surrounding area.

4.4.34 The table has been colour coded to demonstrate the likely achievability of the proposed new consents, based on how close the upgrades would be to Best Available Technology Not Entailing Excessive Cost (BATNEEC).

4.4.35 To achieve the WFD standards under future growth conditions the majority of the effluent discharge consents will need to be tightened. Based on industry standards it is considered that, although tight, most of these standards are achievable with BATNEEC, which for the sanitary determinands of BOD and Ammoniacal-N is considered to be 5mg/l and 1 mg/l respectively. However, for Diss, Long Stratton[11], Reepham WwTW[12], Swardeston and Whitlingham the Ammonia consent would need to be lower than the current BAT standard of 1mg/l. However, insensitivities in the modelling would likely mean that a 1mg/l consent would meet downstream compliance.

4.4.36 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'), Rackheath and Stoke Holy Cross WwTW. All other works will require a consent of less than 1 mg/l to achieve the proposed WFD standard of 0.12 mg/l (Mean) for 'good ecological status' and 0.05 mg/l (Mean) for 'high ecological status' (at Aylsham and Belaugh 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. As such, P should be considered on a catchment basis and hence it is covered in section 4.5.1 onwards. Table 4-8 shows the consents required.

[9] Except where it can be demonstrated that the proposed measures to maintain this status would require disproportionate costs
[10] Except where it has been agreed that a 2015 is unachievable and instead a 2027 deadline has been set
[11] It should be noted Long Stratton WwTW 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.
[12] 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.

Table 4-8 WwTW Consent and Water Quality Capacity Assessment

Name	Current WwTW Quality Consents			Future WwTW Quality Consents		
	BOD (95%ile) (mg/l)	Ammonia (95%ile) (mg/l)	P (Mean) (mg/l)	BOD (95%ile) (mg/l)	Ammonia (95%ile) (mg/l)	P (Mean) (mg/l)
ACLE-DAMGATE LANE	29	13	-	13.5	1.7	0.35
AYLSHAM	40	5	-	No change required	No change required	0.20
BELAUGH	30	10	-	No change required	No change required	1.15
DISS	12	5	2	No change required	0.9	0.55
HARLESTON	17	5	2	10.5	1.1	0.40
LONG STRATTON	20	16	-	7	0.6	0.15
PORINGLAND	18	-	-	7.5	1.2	0.20
RACKHEATH	11	3	-	No change required	No change required	1.05
REEPHAM	30	10	-	5.1	0.8	0.10
SISLAND	20	5	-	15.5	2.9	0.35
STOKE HOLY CROSS	50	-	-	No change required	11.8	3
SWARDESTON-COMMON	15	5	-	7	0.7	0.25
WHITLINGHAM TROWSE	20	7	1	10.5	0.7	0.30
WYMONDHAM	12	4	-	10	1.9	0.20

Key			
Future Consent Risk assessment			Colour coding definition
BOD (95%ile)	Ammonia (95%ile)	P (Mean)	
> 10mg/l	> 3mg/l	No consent or ≥ 2mg/l	Consent Achievable (within BAT)
> 5mg/l and ≤ 10mg/l	> 1mg/l and ≤ 3mg/l	>1mg/l and < 2mg/l	Consent within BAT but difficult to achieve
≤ 5 mg/l	≤ 1mg/l	≤ 1mg/l	Consent Unachievable with current technology

Habitats Directive Compliance

4.4.37 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.

4.4.38 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').

4.4.39 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.

4.4.40 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 ordinarily be most likely to receive treated effluent – the River Wensum, the River Yare and the River Bure.

4.4.41 Since the development of the wastewater strategy for the Stage 2b, it is evident that discharge of wastewater from new development will not impact on water quality in relation to the Wensum SAC. Figure 1 (Appendix A) shows that all additional discharges will occur downstream of the SAC. Despite this, the water supply strategy (see section 5.3 onwards) includes for the option of a Whitlingham flow augmentation scheme, involving the pumping of treated wastewater discharge upstream on the Wensum. For this reason, the Wensum SAC water quality impacts are included in Appendix D: Stage 3 RoC Detailed Findings; however they are not discussed in relation to the wastewater strategy for growth in the GNDP planning area.

4.4.42 As well as information on the Wensum SAC, water quality background and trends for the Broads SAC & Broadland SPA (Yare Broads & Marshes SSSI and Bure Broads & Marshes SSSI) is also included in Appendix D: Stage 3 RoC Detailed Findings, and the summary included below. These sites have the potential to be affected by discharges from the wastewater strategy and hence need to be considered in detail.

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

4.4.43 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

4.4.44 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

4.4.45 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.

4.4.46 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.

4.4.47 The consents considered to potentially impact on the site are included in Table 4-9.

Table 4-9: Consents Reviewed for impact on Yare Broads & Marshes SSSI

Number	Type Receiving	Volume m3	NGR
AEENF12073	WTW	3000*	TG2105009750
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

Number	Type Receiving	Volume m3	NGR
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

4.4.48 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.

4.4.49 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.

4.4.50 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%.

4.4.51 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

4.4.52 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.

4.4.53 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.

4.4.54 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.

The Broads SAC & Broadland SPA – Impacts Assessment

4.4.55 The WCS will need to ensure that any solutions that are proposed for the River Yare or River Bure 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 phosphorus or below for ditches/dykes; and
- A minimum of 0.05 mg/l total phosphorus or below for lakes.

4.4.56 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 are described in Table 4-10 under 'nutrients'.

4.4.57 The conclusion from this process was that as long as these consents are not exceeded, then compliance with downstream targets for P could be met.

4.4.58 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, Stoke Holy Cross and Whtilingham. With the exception of Reepham, the increase in flow is relatively small compared to the consented limit and hence is not likely to be an issue in terms of negotiating higher DWF consents; however, 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.

4.4.59 Mitigation is therefore needed to protect the downstream HD sites as indentified and the proposed solution to this is described in the following sections.

AWS committed upgrades

4.4.60 Anglian Water's Periodic Review 2009 and the Environment Agency's RBMP and National Environment Programme (NEP), has identified the measures provided in Table 4-10 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 under taken to date at a catchment level.

Table 4-10: 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, Long Stratton WwTW, and Poringland 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 • Poringland	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

Proposed Consent Changes - Catchment wide issues

4.4.61 This section assesses the significance of the overall increase in P into the Broadland catchment and mitigation that is likely to be required to ensure that HD targets can be met and that WFD targets at downstream compliance points (i.e. not immediately downstream of the WwTWs) can be met.

4.4.62 It has not been possible to demonstrate that the P targets for the WFD will be achieved immediately downstream of all WwTWs within the limits of BATNEEC for wastewater treatment at all WWTW (with the exception of Belaugh, Poringland and Rackheath would could achieve WFD standards with BATNEEC). It is accepted that this is the case for the current condition of wastewater treatment and also in many cases in catchments across the UK. Similarly, it has not been possible to demonstrate no increase in current consented flows or loads as assessed under the HD RoC process. However, it is important to consider compliance at different points downstream, and this has been the approach for many of the SIMCAT catchment models undertaken to determine how to comply with the WFD and HD P targets for catchments in the UK (notably for the River Thet in neighbouring Breckland).

4.4.63 The Stage 2b study has therefore looked at a mass loading of P into receiving watercourse both currently and after additional development is undertaken by 2026. It has determined what P consents (within BATNEEC) would have to be applied to each WwTW to ensure that Overall P load into the watercourses (and hence at downstream designated sites) is not increased above current levels permitted under current consents.

4.4.64 As described, only some of the WwTWs currently have a consent for P, as such monitoring data for the other WwTWs has been used to determine current P loading. It should also be noted that this basic 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. The assessment is therefore very much conservative; yet demonstrates that a treatment solution that complies with both the WFD requirements and HD requirements is achievable for the proposed growth strategy by resulting in a net decrease in overall P loading with new consents applied to existing and future wastewater effluent as a result of growth.

4.4.65 The results of the assessment are provided in Table 4-11.

Table 4-11: Current and Future P Loading from WwTWs in GNDP

WwTW	RECEIVING WATERCOURSE	Current DWF (Measured/ Calculated (Ml/day)	Current Mean Flow (DWF x 1.25) (Ml/day)	Future DWF Calculated (Ml/day)	Future Mean Flow (DWF x 1.25) (Ml/day)	Current Consent P (Mean mg/l)	Current P Load (kg/day)	Future P Load (kg/day)	Future Consent (Mean) (mg/l)	Future P Load (kg/day)
ACLE-DAMGATE LANE	RIVER BURE	0.78	0.97	0.84	1.05	-	5.2	5.6	2	2.1
AYLSHAM	RIVER BURE	1.15	1.44	1.37	1.71	-	0.4	0.4	2	3.4
BELAUGH	RIVER BURE	1.40	1.75	2.25	2.82	-	0.8	1.2	2	5.6
DISS	RIVER BURE	1.68	2.10	1.76	2.20	2	4.2	4.4	2	4.4
HARLESTON	RIVER WAVENEY	0.75	0.94	0.92	1.15	2	1.9	2.3	1	1.2
LONG STRATTON	HEMPNALL BECK	0.69	0.86	1.38	1.72	-	4.8	9.7	1	1.7
PORINGLAND	RIVER CHET	0.66	0.82	0.92	1.15	-	5.2	7.2	1	1.1
RACKHEATH	DOBBS BECK, TRIB OF RIVER BURE	0.30	0.37	0.30	0.37	-	0.2	0.2	2	0.7
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WAVENEY	0.88	1.10	0.98	1.23	-	6.5	7.3	1	1.2
SISLAND	TRIBUTARY OF RIVER CHET	1.03	1.29	1.07	1.34	-	8.5	8.8	1	1.3
STOKE HOLY CROSS	RIVER TAS	0.30	0.37	0.47	0.58	-	3.0	4.7	2	1.2
SWARDESTON-COMMON	INTWOOD STREAM	0.72	0.89	1.08	1.34	-	5.4	8.1	2	2.7
WHITLINGHAM TROWSE	RIVER YARE	55.64	69.55	66.62	83.27	1	69.5	83.3	1	83.3
WYMONDHAM	RIVER TIFFEY	2.75	3.43	3.88	4.85	-	23.3	32.9	2	9.7
TOTAL							**139**	**176**	-	**120**

Note: As under identified under NEP/AWS measures by 2012 (2015 for Sisland)
2mg/l applied to all other works

4.4.66 The assessment shows that based on current monitoring data and existing P consents, the current load entering the various watercourses is 139kg-P/day. Without altering the consents, the future load with growth as proposed would be 176kg-P/day. By applying the proposed NEP improved consents and applying a 2mg/l P limit to all other works, it can be shown that overall P load could be reduced to 120kg-P/day.

4.4.67 This assessment demonstrates that a P reduction can theoretically be achieved with a policy of applying P limits (within BATNEEC) to all of the existing WwTW identified to receive wastewater from growth and this benefit should accrue at the point of compliance for the HD sites. It demonstrates that, in areas where immediate downstream compliance for WFD standards is unlikely to be achievable, compliance at further points downstream is feasible within BATNEEC.

4.4.68 This high level assessment 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.

4.4.69 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 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.

4.5 WwTW Consent Assessments

4.5.1 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 already operating close to BATNEEC will have more difficulty and likely incur more costs in achieving tighter consents under future growth conditions. This information is presented in Table 4-12.

Table 4-12: 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
ACLE-DAMGATE LANE	Acle 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 • BOD - 29mg/l • Amm-N - 13mg/l • P - N/A	**LOW – 8%**	The downstream quality of the River Bure is at **high status** for all determinands, and uncharacteristically for rivers in the East of England, is achieving a high status classification for Phosphorus. Downstream ecology however is only **moderate.**	The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement to quality consent to ensure no deterioration in existing river quality as result of increased discharge volume: • DWF - 1,189 m^3/d • BOD - 29mg/l • Ammonia - 13mg/l	To maintain downstream quality, the Acle WwTW consent would need to be tightened to: • **BOD – 13.5mg/l** • **Amm – 1.7mg/l** • **P – 0.4mg/l (WFD – immediate d/s compliance)** • **P – 2mg/l (catchment approach for HD)** In addition the WwTW would need a negotiation for an increase in DWF discharge	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 are unlikely to be possible before end of AMP6 (2020). It is considered unlikely that upgrades will be required to achieve the increase in volumetric capacity required 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.
AYLSHAM	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. • BOD - 40mg/l • Amm-N - 5mg/l • P - N/A	**LOW – 19%**	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 Phosphorus. Downstream ecology however is only **moderate.**	No NEP schemes planned.	To maintain downstream quality, the Aylsham WwTW consent would need to be tightened to: • **BOD – No Change** • **Amm – No Change** • **P – 0.2mg/l (WFD – immediate d/s compliance)** • **P – 2mg/l (catchment approach for HD)**	Modelling has indentified that no upgrades in process capacity are required for sanitary determinands (BOD and Amm-N) 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. In addition, The works would require P removal to be installed for HD and beyond BATNEEC for WFD compliance (immediately downstream of works). Upgrades are unlikely to be possible until the middle of AMP6 at the earliest (2017).
BELAUGH	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 • BOD - 30mg/l • Amm-N - 10mg/l • P - N/A	**HIGH – 61%**	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 Phosphorus. Downstream ecology however is only **moderate.**	No NEP schemes planned.	To maintain downstream quality, the Belaugh WwTW consent would need to be tightened to: • **BOD - No Change** • **Amm - No Change** • **P – 1.2mg/l (WFD & HD)**	Modelling has indentified that no upgrades in process capacity are required for sanitary determinands (BOD & Amm-N) and no volumetric upgrades are required; however, the works would require close to BATNEEC for P removal to be upgraded although **this would ensure compliance with WFD and HD targets**. Given that P stripping already occurs, meeting the new consent could be achieved by the start of AMP6 (2015).
DISS	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 Phosphorus consent issued under the UWWTD. • BOD - 12mg/l • Amm-N - 5mg/l • P – 2mg/l	**LOW – 5%**	The downstream quality of the River Waveney is **high status** for ammonia, **bad status** for DO and **moderate status** for Phosphorus. Downstream ecology is assessed as **moderate.**	No NEP schemes planned.	To maintain downstream quality, the Diss WwTW consent would need to be tightened to: • **BOD - No Change** • **Amm – 0.9mg/l** • **P – 0.6mg/l (WFD – immediate d/s compliance)** • **P – No Change for (catchment approach for HD)**	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. No investment is required to reduce BOD in the discharge. The works would require beyond BATNEEC technology for P removal to be installed for WFD compliance (immediately downstream of works). Such upgrades are unlikely to be possible before

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
						end of AMP6 (2020).
HARLESTON	Harleston WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has a 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 Phosphorus consent issued under the UWWTD. • BOD - 17mg/l • Amm-N - 5mg/l • P – 2mg/l	**MEDIUM – 23%**	The downstream quality of the River Waveney is **high status** for ammonia, **bad status** for DO and **moderate status** for Phosphorus. Downstream ecology is assessed as **moderate.**	The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement to Phosphorous discharge consent to protect downstream ecological sites: • P - 1mg/l	To maintain downstream quality, the Harleston WwTW consent would need to be tightened to: • **BOD – 10.5mg/l** • **Amm – 1.1mg/l** • **P – 0.4mg/l (WFD – immediate d/s compliance)**	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. The works would require beyond BATNEEC technology for P removal to be installed for WFD compliance (immediately downstream of works); however it would not need investment in P stripping based on the HD catchment assessment. Such upgrades are unlikely to be possible before the middle of AMP6 (2017).
LONG STRATTON	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 • BOD - 20mg/l • Amm-N - 16mg/l • P - N/A	**HIGH –101%**	The downstream quality of the River Tas is **high status** for ammonia, **moderate status** for DO and **moderate status** for Phosphorus. Downstream ecology is assessed as **moderate**	The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement to Phosphorous discharge consent to protect downstream ecological sites: • P - 1mg/l • Investigations to quantify risk from chemicals in discharges through effluent screening to protect downstream ecological sites.	To maintain downstream quality, the Long Stratton WwTW consent would need to be tightened to: • **BOD - 7mg/l** • **Amm – 0.6mg/l** • **P – 0.15mg/l (WFD – immediate d/s compliance)**	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 compliance (immediately downstream of works); however it would not need investment in P stripping based on the HD catchment assessment and existing proposal for a 1mg/l P standard . Such upgrades are unlikely to be in place until AMP7 (2021 onwards).
PORINGLAND	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 • BOD - 18mg/l • Amm-N – N/A • P - N/A	**MEDIUM – 39%**	The downstream quality of the River Chet is **good status** for ammonia, and **poor status** for DO and Phosphorus. Downstream ecology is assessed as **moderate**	The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement to Phosphorous discharge consent to protect downstream ecological sites: • P - 1mg/l	To maintain downstream quality, the Poringland WwTW consent would need to be tightened to: • **BOD – 7.5mg/l** • **Amm – 1.2mg/l** • **P – 0.2mg/l (WFD – immediate d/s compliance)**	There is unlikely to be process capacity at the works to increase the nitrification required to achieve the Ammonia consent which will be close to BATNEEC in order to meet WFD requirements. In addition, improvements in BOD removal will also be required to meet the proposed BOD consent. The works would require beyond BATNEEC technology for P removal to be installed for WFD compliance (immediately downstream of works); however it would not need investment in P stripping based on the HD catchment assessment and existing proposal for a 1mg/l P standard . Such upgrades are unlikely to be in place until the end of AMP6 (2020).
REEPHAM	Reepham WwTW currently has a relatively relaxed water quality consent	**LOW – 12%**	The downstream quality of the Blackwater Drain is **high status** for	The following NEP schemes are proposed, either to meet HD,	To maintain downstream quality, the Reepham WwTW consent would	There is unlikely to be process capacity at the works to increase the nitrification required to

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
	condition and hence it has a large 'theoretical' capacity for process improvements before restrictions due to BAT would limit further discharge • BOD - 30mg/l • Amm-N - 10mg/l • P - N/A		ammonia and DO and **good status** for Phosphorus. Downstream ecology has not been assessed.	WFD or other local driver requirements: • Improvement to Phosphorous discharge consent to protect downstream ecological sites: • P - 1mg/l	need to be tightened to: • **BOD – 5.1mg/l** • **Amm – 0.8mg/l** • **P – 0.1mg/l (WFD – immediate d/s compliance)**	achieve the 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 which is very close to BATNEEC. The works would require beyond BATNEEC technology for P removal to be installed for WFD compliance (immediately downstream of works); however it would not need investment in P stripping based on the HD catchment assessment and existing proposal for a 1mg/l P standard . Such upgrades are unlikely to be in place until the end of AMP6 (2020). It is considered unlikely that upgrades will be required to achieve the increase in volumetric capacity required
SISLAND	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. • BOD - 20mg/l • Amm-N - 5mg/l • P – N/A	**LOW – 5%**	The downstream quality of the Tributary of the River Chet is **good status** for ammonia, **bad status** for DO **poor status** for Phosphorus. Downstream ecology is assessed as **moderate**	The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement to Phosphorous discharge consent to protect downstream ecological sites: • P - 1mg/l	To maintain downstream quality, the Sisland WwTW consent would need to be tightened to: • **BOD – 15.5mg/l** • **Amm – 2.9mg/l** • **P – 0.4mg/l (WFD – immediate d/s compliance)**	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. The works would require beyond BATNEEC technology for P removal to be installed for WFD compliance (immediately downstream of works); however it would not need investment in P stripping based on the HD catchment assessment and existing proposal for a 1mg/l P standard . Given that P stripping is already proposed to occur, meeting the new consent could be achieved by the start of AMP6 (2015).
STOKE HOLY CROSS	Stoke Holy Cross 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 • BOD - 50mg/l • Amm-N – N/A • P - N/A	**HIGH – 58%**	The downstream quality of the River Tas is **high status** for ammonia and DO and **poor status** for Phosphorus. Downstream ecology is assessed as **moderate**	No NEP schemes planned.	To maintain downstream quality, the Stoke Holy Cross WwTW consent would need to be tightened to: • **BOD – No Change** • **Amm – 11.8mg/l** • **P – 3mg/l**	Modelling has indentified that no upgrades in process capacity are required for BOD removal. Some 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 (3mg/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 before the middle of AMP6 (2017).
SWARDESTON-COMMON	Swardeston WwTW currently has a relatively relaxed water quality consent condition for BOD and hence it has a large 'theoretical' capacity for process	**HIGH – 50%**	The downstream quality of the Inwood Stream is **high status** for ammonia and DO and **poor status** for Phosphorus.	No NEP schemes planned.	To maintain downstream quality, the Swardeston WwTW consent would need to be tightened to:	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

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
	improvements before restrictions due to BAT would limit further discharge. However the ammonia consent is tighter and has less 'theoretical' capacity for process improvements. • BOD - 15mg/l • Amm-N - 5mg/l • P – N/A		Downstream ecology is assessed as **moderate**		• **BOD – 7mg/l** • **Amm – 0.7mg/l** • **P – 0.3mg/l** • **P – 2mg/l (catchment approach for HD)**	meet WFD requirements. In addition significant improvements in BOD removal will also be required to meet the proposed BOD consent. P Stripping will be required, beyond BATNEEC technology for WFD compliance (immediately downstream of works); and for HD directive. such upgrades are unlikely to be possible before the middle of AMP6 (2017).
WHITLINGHAM	Whitlingham 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. The works has a BAT Phosphorus consent issued under the UWWTD and therefore tightening of the consent would be restricted. • BOD - 20mg/l • Amm-N – 7mg/l • P – 1mg/l	**MEDIUM – 20%**	The downstream quality of the River Yare is **high status** for ammonia and DO and **moderate status** for Phosphorus. Downstream ecology is assessed as **moderate**	Improvements to the inlet works will be undertaken in AMP5 which will allow full use of the DWF. The following NEP schemes are proposed, either to meet HD, WFD or other local driver requirements: • Improvement of polluting discharge (continuous) at Whitlingham WwTW	To maintain downstream quality, the Whitlingham WwTW consent would need to be tightened to: • **BOD – 10.5mg/l** • **Amm – 0.7mg/l** • **P – 0.3mg/l**	There may be process capacity at the works to increase the nitrification at the works but some investment is likely due to the need 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. P Stripping will be required, beyond BATNEEC technology for WFD compliance (immediately downstream of works) however it would not need investment in P stripping based on the HD catchment assessment and existing 1mg/l P consent. It is considered unlikely that upgrades will be required to achieve the increase in volumetric capacity required, although alterations will have to be made to the inlet works to allow full capacity to be reached. Negotiations will also be required for a new DWF consent. Improvements are likely to be needed moving into AMP6 for nitrification
WYMONDHAM	Wymondham WwTW currently has a relatively tight water quality consent condition and hence it has less 'theoretical' capacity for process improvements. • BOD - 12mg/l • Amm-N - 4mg/l • P – N/A	**MEDIUM – 41%**	The downstream quality of the River Tiffey is **good status** for ammonia, **high status** for DO and **poor status** for Phosphorus. Downstream ecology is assessed as **moderate**	No NEP schemes planned.	To maintain downstream quality, the Wymondham WwTW consent would need to be tightened to: • **BOD – 10mg/l** • **Amm – 1.9mg/l** • **P – 0.2mg/l** • **P – 2mg/l (catchment approach for HD)**	Modelling has indentified that increases to process capacity are required for BOD removal and an increase in nitrification may be required to meet a proposed new tighter Ammoniacal-N consent; however it has been assumed that this can be achieved with current process capacity. P Stripping will be required, beyond BATNEEC technology for WFD compliance (immediately downstream of works); and for HD directive. such upgrades are unlikely to be possible before the middle of AMP6 (2017).

5 Water Supply Strategy

5.1.1 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.

5.1.2 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.

5.2 Deriving a Water Supply Strategy

5.2.1 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.

5.2.2 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.

5.3 Water Resources

Purpose of Water Resources Assessment

5.3.1 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.

5.3.2 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' (EA, 2008).

5.3.3 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 calculated in Table 3-1 to ensure consistency with the figures used by AWS in its water resource management planning.

5.3.4 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

5.3.5 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 5-1.

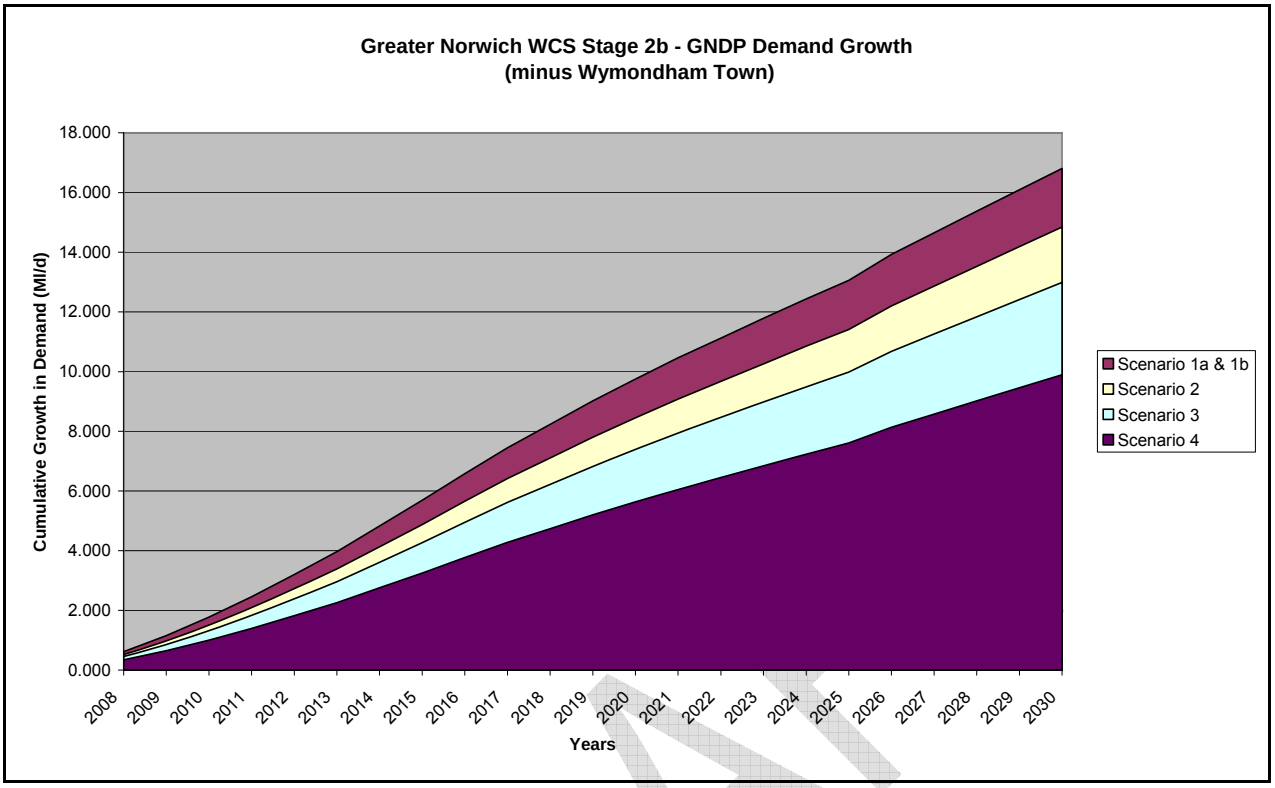
Table 5-1: Water Use Scenarios modelled

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. 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 the Environment Agency's proposed target for water usage for all new homes as met. It is also reflects the 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

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

5.3.7 Figure 5-1 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

Figure 5-1: Demand Growth for four different water use scenarios



Available Water Resources

5.3.8 Estimates of the extra Deployable Output[13] (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 5-2.

Table 5-2: Available Water Resources in Greater Norwich

Resource Options [14]	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**

[13] 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

5.3.9 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'.

5.3.10 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 5.5), 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.

5.3.11 Further details on the environmental constraints associated with each of the above resource options are included in section 5.5.

5.4 Phasing of Water Resources Developments

Without the effects of Climate Change

5.4.1 Table 5-3 summarises the phasing of schemes required under Scenario 1 (high demands) and Scenario 4 (low demands).

Table 5-3: 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)

5.4.2 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

5.4.3 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.

5.4.4 In the case of surface water, this is shown in Table 5-4.

Table 5-4: 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.

5.4.5 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 5-5.

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

	Sources	Without CC (from Table 3.5)	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

5.4.6 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

5.4.7 Specifically for the water resources and the GNWCS, the key consents being considered as part of the RoC are the abstractions direct from the Wensum at Costessey Abstraction Point (AP) as well as from boreholes in close proximity to the Wensum located at Costessey AP, potentially impacting the Wensum SSSI and SAC.

5.4.8 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 Option Plan (SOP) 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 owner was ongoing, the full Stage 4 SOP was not made available in time for completion of the Stage 2b GNWCS report.

5.4.9 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 SOP (without full figures and outputs).

5.4.10 The conclusions drawn from the interim information provided is that the groundwater abstractions at Costessey are unlikely to be impacting on the integrity of the SAC. However, the current surface water abstraction from the Wensum at Costessey is determined to be preventing the Wensum from achieving the Habitats Directive conservation objectives downstream of the abstraction.

5.4.11 River flow objectives termed Habitats Directive Ecological River Flow (HDERF) objectives have been set for the River Wensum based on the perceived environmental sensitivity (weighting) of the river at various assessment points and these HDERF are considered necessary to support the ecological features for which the river is designated. Modelling has shown that under historical operation of all licences, the surface water abstractions are considered to be reducing river flows significantly below the HDERF objectives and because the Costessey abstraction licence represents 93% of the licensed abstraction volume, it the Costessey licence which is considered to be having the largest impact. Under scenarios where the licenses are used to their theoretical maximum limit, the reduction is even more significant. Alterations are therefore considered to be required for the Costessey licence in terms of reducing the licensed volumes permitted to be abstracted and this is termed a sustainability reduction.

5.4.12 Although the proposed sustainability reduction to the licence have not been made available, comments from Natural England provided immediately prior to the completion of this Stage 2b report suggest that the a reduction of between 10Ml/d and 20Ml/d to the maximum permitted abstraction limits could be set on the Costessey licence in order to allow the River Wensum to reach its environmental outcomes.

5.4.13 Until such a time as the decision is taken to revoke or amend the current licence, the impact of this sustainability reduction cannot be fully assessed in this current Stage 2b WCS report. At the time of completion of this Stage 2b study, the draft WRMP had not made any allowance for a sustainability reduction in the Costessey licence. Under the RoC process, there will be a lengthy period over which the licence alterations will be discussed between Natural England, the

Environment Agency and AWS and through the course of these discussions, various solutions will be considered.

5.4.14 It is also noted that the assessments used in the review of consents process are conservative in that the HDERF objectives set are generic and not developed for the specific conditions in the River Wensum. Aquatic habitat and ecological requirements are more directly related to hydraulic conditions such as water velocity, water level and wetted perimeter (the area of river bed or river bank covered by water) as opposed to flow, and the magnitude of changes in these hydraulic conditions as a result of abstractions are related to several factors such as river morphology and in river structures (e.g. weirs, sluices and dams). Therefore, how an abstraction actually affects specific aquatic habitats for a given river is not a directly linear relationship as is implied by the setting of river flow objectives such as HDERFs. In many cases across the UK where the RoC is taking place, the conclusions of Stage 4 assessments are being challenged on the basis that the assessments are overly conservative and the proposed licence changes may not actually precipitate a direct improvement in ecological function or integrity of a habitat. It cannot therefore be concluded at this point in the WCS what the actual change in the abstraction licence will be and hence what the solution would be to replacing any reduction imposed.

5.4.15 As present, the proposed effluent compensation scheme could be considered to be both a new resource but also a solution to any sustainability reduction imposed on the Costessey licence. The WCS has shown that the increase in treated flow proposed for Whitlingham would result in DWF of over 66Ml/d allowing plenty of transfer capacity to both compensate for the sustainability reduction and provide additional resource.

5.4.16 However, once a decision is made on the final sustainability reduction, the WCS will have to be revisited to alter the baseline of available water supply and reconsider what the water resource scheme developments will need to be.

5.5 Environmental Effects from Water Resource Developments

Ecological Consequences of Different Resource Options

5.5.1 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; 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.

5.5.2 A summary of the ecological consequences of the different resource options is included in Table 5-6.

Table 5-6: 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

5.5.3 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;

5.5.4 "*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*".

5.5.5 As mentioned in 5.3.2, 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

5.5.6 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[15])' but instead only permitting these soakaways to be constructed on areas of 'Glacial Boulder Clays' would appear to be a sensible policy.

5.5.7 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.

5.5.8 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 5-7, and is discussed under the PGA specific assessments (See section 6.2)

Table 5-7: 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

Groundwater Source Protection Zones (SPZ)

5.5.9 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).

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

5.5.10 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.

5.5.11 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

5.5.12 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 6.2)

5.5.13 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.

5.6 Water Supply strategy

5.6.1 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,

5.6.2 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.

5.6.3 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 is likely to occur; however, the screening assessment for HD sites has determined that this is unlikely to impact on HD sites

5.6.4 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 reduction 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 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.

5.6.5 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 NGAs. 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 6.2.

5.7 Water Efficiency Strategy

5.7.1 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.

5.7.2 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

5.7.3 A comparison with average water use by different groups of AWS's customers is shown in Table 5-8.

Table 5-8: Summary of Water Usage by AWS and Average UK WASC Customers

Customer Type	AWS Customers ($lh^{-1}d^{-1}$)	Average UK WASC[16] Customers ($lh^{-1}d^{-1}$)
Metered	142	131
Un-metered	158	151
Overall	150	145

Source: Ofwat Report 2007-08

5.7.4 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.

5.7.5 Levels of meter penetration[17] 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).

5.7.6 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%.

[16] WASC = Water and Sewerage Companies
[17] 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)

5.7.7 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

5.7.8 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.

5.7.9 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.

5.7.10 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.

5.7.11 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[18] (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.

5.7.12 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.

5.7.13 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 5-1**) 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.

[18] 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

5.7.14 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'.

5.7.15 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

5.7.16 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.

5.7.17 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

5.7.18 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.

5.7.19 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.

5.7.20 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.

5.7.21 Table 5-9 outlines the amount of water that can be saved in existing households through retrofitting of various water saving devices and methods.

Table 5-9: 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.

5.7.22 The water savings in Table 5-9 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 5-10.

Table 5-10: 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

5.7.23 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).

5.7.24 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 K: Water Neutrality Calculations.

Water Neutrality Results

5.7.25 Table 5-11 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

5.7.26 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 5-11). All new houses would be required to be built to CfSH levels 5 & 6 (80 l/h/d) to achieve the water neutral state.

5.7.27 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.

5.7.28 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).

5.7.29 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 K: Water Neutrality Calculations, also shows that neutrality cannot be achieve in several of the villages or smaller towns when considered individually.

Table 5-11: 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[19]
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

5.7.30 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.

5.7.31 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 5-9).

Water Efficiency in New Homes

5.7.32 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.

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

5.7.33 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 5-12 outlines the water efficiency that needs to be achieved to reach each of the sustainable levels.

Table 5-12 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	

5.7.34 The examples of water efficiency measures include in Table 5-12 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[20] 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.

5.7.35 New developments offer the opportunity to work towards a much higher level of water efficiency. The eco-towns water cycle worksheet[21] 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. However, it is acknowledged that attainment of levels 5 and 6 is generally restricted to high grade eco-homes which are purpose built to reach status such as carbon neutral and that attainment of this level (on the basis of water consumption) is unlikely for the new housing planned for Norwich.

[20] 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.

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

6 Infrastructure Requirements

6.1 Introduction

6.1.1 This section presents the detail on the water services infrastructure requirements for each of the policy areas that have significant growth levels. It includes:

- detail of the strategic infrastructure required to service the areas with wastewater and water supply provision;
- advice on phasing of wastewater and water supply infrastructure both spatially and temporally (i.e. when and where); and
- detail of the strategic mitigation infrastructure required for surface water management in new development areas and assessment of cost[22]; and

6.2 Policy Area Assessments

6.2.1 Each of the policy assessment areas has been considered in detail in the proceeding sections. An accompanying map of key water cycle issues is included based on the assessments undertaken in this Stage 2b study. In some places, these assessments have been supplemented by additional info provided as appendices or taken from the previous WCS stages reports or the SFRA as described below:

- an indication of flood risk has been provided based on the location of mapped flood zones from Level 1 SFRA, and the Stage 1 and Stage 2a WCS;
- assessment of SuDS suitability has been undertaken using suitability information developed in the Level 1 SFRA, the Stage 1 and Stage 2a WCSs and topographic information. This supporting information is provided in Appendix E: SUDS Types, and Appendix F: Suitability of SUDS (from Level 1 SFRA) and is mapped on the accompanying figures;
- groundwater SPZs are mapped separately in Appendix A, however summary information is provided in each assessment;
- assessment of existing capacity in the existing wastewater network has been taken from the Stage 2a WCS report (Tables 9-4 to 9-12). These assessments are indicative and would need to be confirmed via detailed network modelling on a case by case basis for each proposed developer. The information provided here is considered as a guide for phasing only; and
- potential water supply connections have been assessed using mapped water mains network as provided in each areas assessment accompanying figure.

6.2.2 It is important to note that whilst broad phasing is available for 'town areas' in the study area, proposed phasing for each NPA is not currently known, hence best estimates have been made of when infrastructure will need to be phased in. With the exception of growth proposed for NPA2 as a result of the proposed Rackheath Ecotown, new development will not commence until 2015. detail on the AMP timing process is given in Appendix L: The Periodic Review and AMP process;

[22] It was agreed at Stage 2b inception that costing of infrastructure to be provided solely by Anglian Water would not be undertaken for the Stage 2b WCS

however, Table 6-1 provides a summary of the AMP periods and the years they will span. At the time of completing the GNWCS, AWS are within the AMP4 cycle.

Table 6-1: AMP periods and corresponding Years

AMP	Years
AMP5	2010 - 2015
AMP6	2015 - 2020
AMP7	2020 - 2025
AMP8	2025 - 2035
AMP9	2035 - 2040

6.3 NPA1 - North Sector (North of Airport)

Growth Summary

6.3.1 A total of 153 new dwellings are proposed for NPA 1.

Wastewater Treatment

6.3.2 Due to a lack of capacity at nearby WwTWs, the preferred treatment strategy is to transfer wastewater flow to Whitlingham WwTW. Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at the works to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA1 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.3.3 There are no 'strategic'[23] sewers within the proposed NPA1 area; however, the existing sewer as shown in the accompanying figure (75mm leading to 80mm) is likely to have sufficient headroom to allow approximately 500 properties which is adequate to take all the proposed flow from this NPA.

6.3.4 Despite this, the existing sewer eventually flows through Norwich City Centre before it reaches Whitlingham WwTW. AWS have indicated that any spare capacity in sewers in the city is required for climate change impacts. The options for connecting to Whitlingham for this NPA are:

- The number of housing proposed in NPA1 is small (153 dwellings); hence it may be that this development can be accommodated in the existing network through Norwich. This would have to be agreed with AWS through network modelling dependent on connection of other NPAs;
- The developer(s) requisitions a wastewater sewer to connect the NPA to the existing 450mm strategic sewer running to the west of Norwich City (see Appendix M: Network Assessment Summary) – this is estimated to have a capacity for a further 4,300 dwellings;
- Development here is phased such that it starts during AMP7 (2020 onwards) to make use of the strategic northern connection proposed as part of the WCS wastewater strategy.

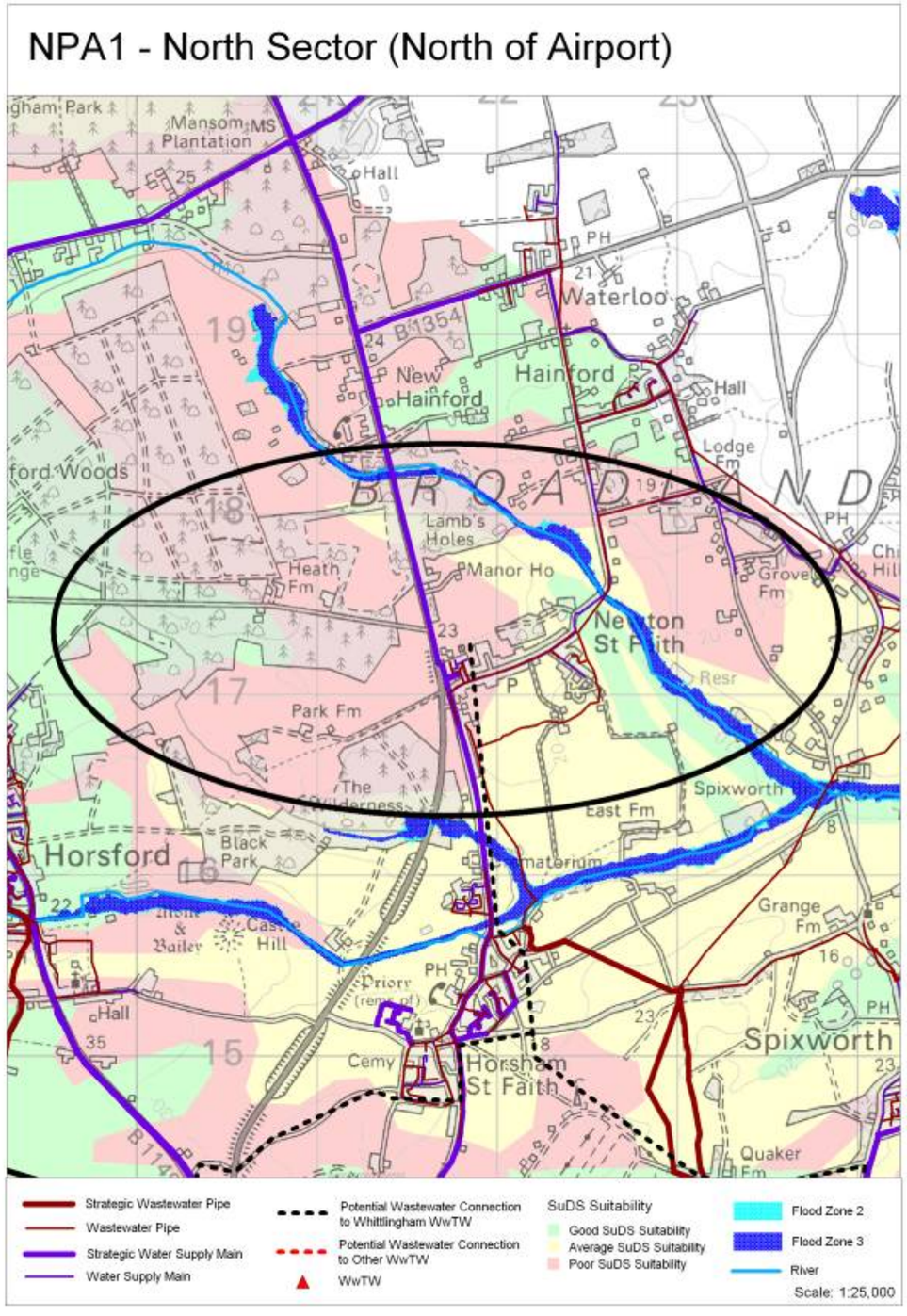
Local Connection

6.3.5 Extensive local connections will be required at developer level if development is proposed to the north, west or east of the NPA which will need to be funded through requisition under the Water Resources Act 1991.

Water Resources

Water Supply Infrastructure

6.3.6 The accompanying figure highlights that a strategic water supply main runs through the centre of the NPA which should have sufficient capacity to supply the proposed 153 dwellings once raw water resources are developed. Local connections will be required at a developer level which will need to be funded through requisition under the Water Resources Act 1991.



[23] Strategic in this case is defined as greater than 200mm

Water Neutrality (WN)

6.3.7 Due to limited existing population in the NPA, WN for NPA1 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.3.8 Only a small area of the NPA running through the east of the area is located within Flood Zone 3 (1% annual probability of a flood) or Flood Zone 2 (between 1% and 0.1% probability of river flooding), hence development should be able to proceed outside of the floodplain and the NPA will hence be able to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.

SuDS Suitability

6.3.9 Approximately 65% of the NPA including the western half has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy), hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds which could be developed for strategic linkage with the river.

6.3.10 Development around the existing village of Newton St Faith will have greater suitability for SuDS due to higher permeability soil and geology. SuDS such as Swales and Soakaways are more likely to be suitable here.

6.3.11 There are no SPZs in the NPA; hence any type of development or SuDS type should be suitable in this NPA in terms of water abstraction protection.

6.4 NPA 2 - North East Sector (Inside NNDR)

Growth Summary

6.4.1 A total of 9,117 new dwellings are proposed for NPA 2, which includes the dwelling numbers for the proposed Rackheath Ecotown

Wastewater Treatment

6.4.2 Due to a lack of capacity at Rackheath WwTW, the preferred treatment strategy is to transfer wastewater flow to Whitlingham WwTW. Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at the works to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA2 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.4.3 There is a large 'strategic' sewer within NPA2 which is estimated to have capacity for an additional 4,300 dwellings to transfer to Whitlingham WwTW. This sewer does not run through Norwich City and hence its capacity could be utilised by development in this NPA. However, slightly less than half of the proposed growth could be accommodated and this figure would be reduced further if growth from up catchment (NPAs 1 and 10 – a total of 1,639 dwellings) also utilises this existing main.

6.4.4 Depending of phasing within this NPA, new strategic mains will therefore likely be required into AMP 7. The options for providing this additional network would be:

- The developer(s) requisitions a wastewater sewer to connect the remaining development direct to Whitlingham for use in AMP7;
- Development here is phased such that the second half commences during AMP7 (2020 onwards) to make use of the strategic northern connection proposed as part of the WCS wastewater strategy.

Local Connection

6.4.5 Extensive local connections will be required at developer level if development is proposed anywhere other than bordering the current north eastern boundary of Norwich City.

Water Resources

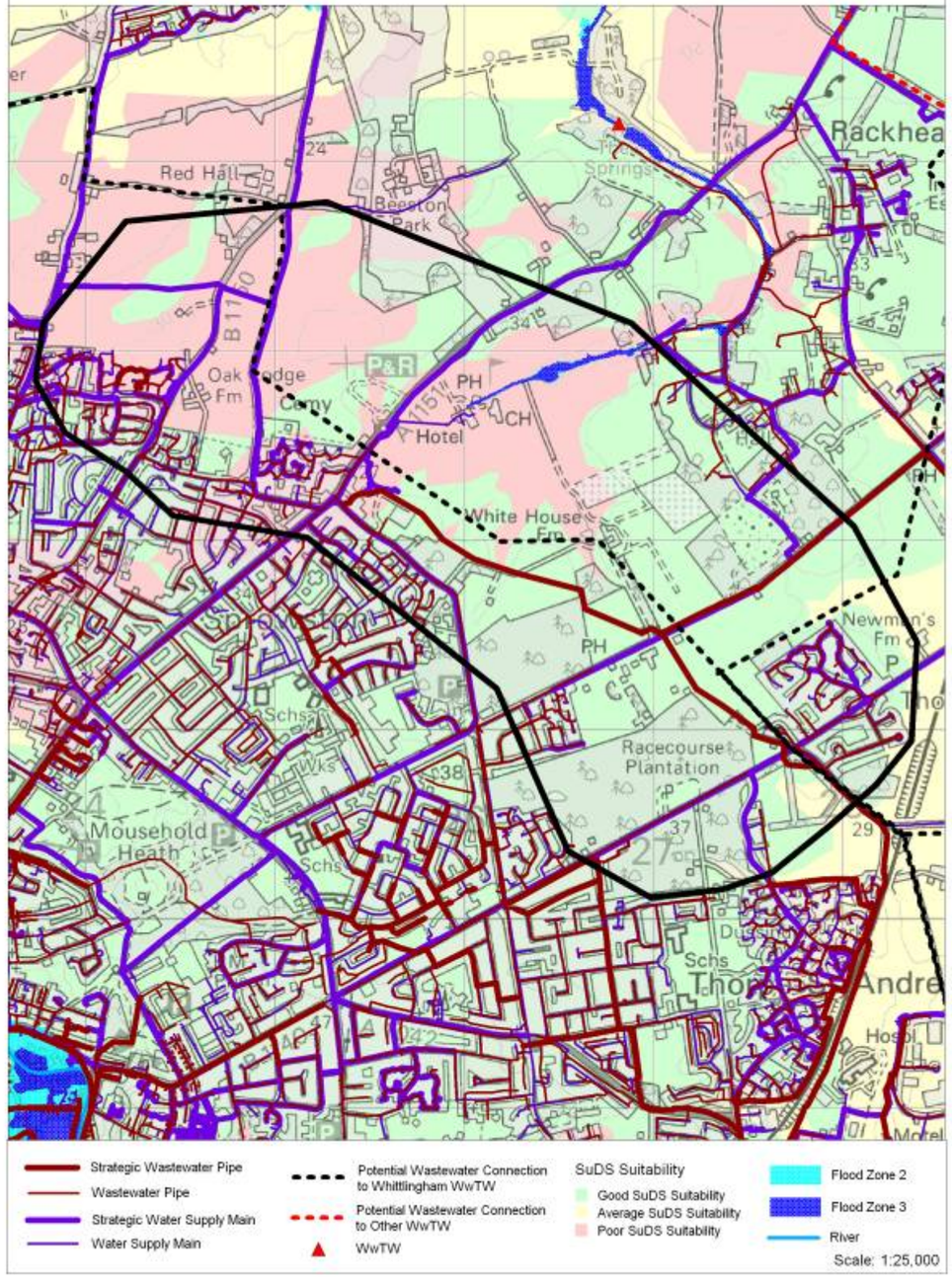
Water Supply Infrastructure

6.4.6 The accompanying figure highlights strategic water supply mains to the centre, north west and south east of the NPA. Connection to these mains should be sufficient for new development, although local pumping stations /connections will be required if development is proposed south of the centre of the NPA.

Water Neutrality (WN)

6.4.7 Due to limited existing population in the NPA, WN for NPA2 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

NPA2 - North East Sector (inside NNDR)



Flood Risk & Management

Flood Risk & the Sequential Test

6.4.8 The extent of Flood Zones 3 and 2 within this NPA is minimal hence development should be able to proceed outside of the floodplain and the NPA will hence be able to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.

SuDS Suitability

6.4.9 Approximately 60% of the NPA including the southern half has good SuDS suitability and is therefore likely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy), hence greenfield attenuation requirements can be partly met through infiltration SuDs such as Swales and Soakaways. Runoff that can be infiltrated will however be slightly restricted in the central southern section of this NPA due to the presence of a total catchment area of a source protection zone, Infiltration SuDS in the central and southern half of the NPA will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed.

6.4.10 The use of infiltration SuDS in the northern half of the NPA is variable with pockets of land suitable for these preferred SuDS and which will not be limited by SPZs. Developers will need to refer to the accompanying figure to determine whether surface water storage suds are more likely than infiltration.

6.5 NPA 3a - North East Sector (Inside NNDR)

Growth Summary

6.5.1 A total of 3,451 new dwellings are proposed for NPA 3a.

Wastewater Treatment

6.5.2 Wastewater generated at NPA3 will be split between nearby Belaugh WwTW to the north east (65%) and a strategic transfer to Whitlingham WwTW (35%).

6.5.3 No upgrades are required to Belaugh WwTW in terms of meeting sanitary determinands; however, it is predicted that a P consent limit of at 1mg/l will be required to meet WFD standards. Significant growth before AMP6 will therefore not be possible until P stripping is introduced at the WwTW. It is recommended that flow is therefore transferred to Whitlingham WwTW first (approx 2,240 dwellings can be transferred according to the wastewater strategy).

6.5.4 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA3a and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.5.5 There is a large 'strategic' sewer to the west of NPA3a; however, it would connect to the existing strategic sewer which is likely to accommodate NPA2 and hence is unlikely to have capacity to utilise it unless development in these two NPAs is co-ordinated and phased.

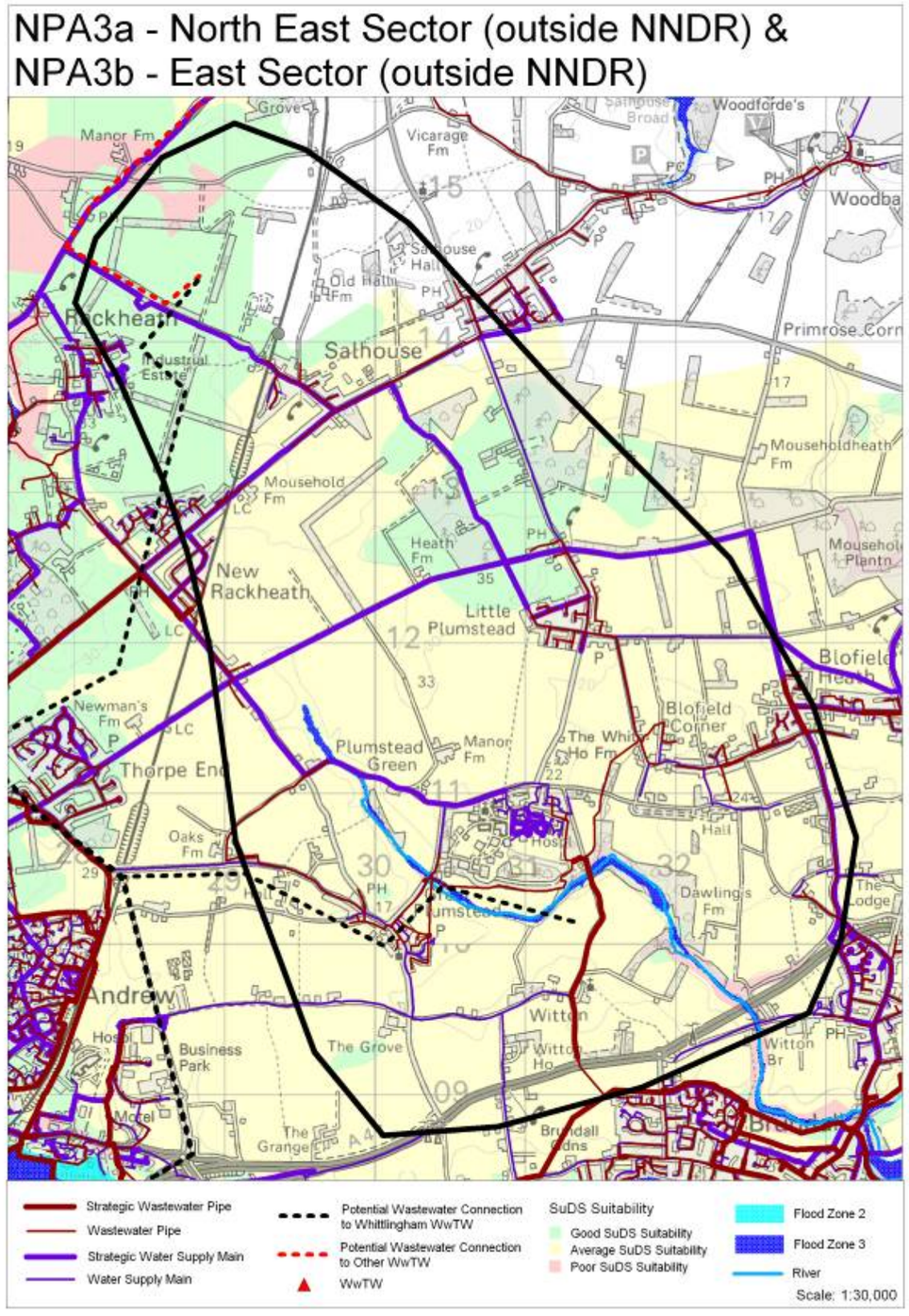
6.5.6 There are no strategic sewers running to Belaugh WwTW although minor sewers are present. Capacity in these sewers would need to be assessed through modelling with AWS; but they are likely to have some capacity for early phasing and before Belaugh requires P stripping to be installed. Development however will most likely be required to be phased to start in the middle of AMP6 to allow enforcements to be made to the network draining to Belaugh and to allow for P stripping to be introduced at the WwTW.

6.5.7 Depending of phasing within this NPA, new strategic mains will therefore likely be required for AMP 6 moving into AMP 7. The options for providing this additional network would be:

- The developer(s) requisitions a wastewater sewer to connect the remaining development direct to Whitlingham for use in AMP7 and to Belaugh for use in AMP6;
- Development here is phased such that the development draining to Whitlingham commences during AMP7 (2020 onwards) to make use of the strategic northern connection proposed as part of the WCS wastewater strategy. This is not preferable in light of the requirement for Belaugh to be upgraded for P stripping up to AMP6

Local Connection

6.5.8 Extensive local connections will be required at developer level for the majority of the NPA other than development in proximity to Salhouse and New Rackheath.



Water Resources

Water Supply Infrastructure

6.5.9 The accompanying figure highlights strategic water supply mains to the centre, north west and central south of the NPA. Connection to these mains should be sufficient for new development, although local pumping stations and connections will be required

Water Neutrality (WN)

6.5.10 Due to limited existing population in the NPA, WN for NPA3a is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.5.11 There are no designated Flood Zones 3 and 2 within this NPA.

SuDS Suitability

6.5.12 The NPA has an average (to the south) and good (to the north) suitability for infiltration SuDS; hence a mixture of surface water storage features and infiltration SuDS will be required. There are no significant SPZs in this NPA, although the presence of a small area of total catchment to the north west will mean that Infiltration SuDS proposed in this area will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed.

6.6 NPA 3b - East Sector (Outside NNDR)

Growth Summary

6.6.1 A total of 240 new dwellings are proposed for NPA 3b.

Wastewater Treatment

6.6.2 Due to a lack of a local WwTW, the preferred treatment strategy is to transfer wastewater flow to Whitlingham WwTW. Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at the works to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA3b and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.6.3 There is a large 'strategic' sewer to the south of NPA3b (450mm); which is estimated to have sufficient capacity to accept the additional dwellings (240) although the smaller connections associated with the hospital have an approximate capacity of only 200 new and will need reinforcements to be requisitioned by the developer(s) in AMP5.

Local Connection

6.6.4 Some small scale local connections will be required at developer level for the NPA.

Water Resources

Water Supply Infrastructure

6.6.5 The accompanying figure to NPA3a (Covers NPA3b also) highlights a strategic water supply main to the centre of the NPA. Connection to these mains should be sufficient for new development.

Water Neutrality (WN)

6.6.6 Due to limited existing population in the NPA, WN for NPA3b is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.6.7 The extent of Flood Zones 3 and 2 within this NPA is minimal hence development should be able to proceed outside of the floodplain and the NPA will hence be able to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.

SuDS Suitability

6.6.8 The majority of the NPA has an average suitability for infiltration SuDS; hence a mixture of surface water storage features and infiltration SuDS will be required. Runoff that can be infiltrated will however be restricted in the central southern section of this NPA due to the presence of a SPZs 1 and 2 associated with a local abstraction close to the hospital. Types of development will therefore also be restricted around the hospital. Infiltration SuDS in the majority of the NPA will require some form of water quality control such as oil interceptors of runoff (other than clean roof runoff) due to a total catchment across the whole NPA.

6.7 NPA 4 - South East Sector (vicinity of Poringland)

Growth Summary

6.7.1 A total of 1,186 new dwellings are proposed for NPA 4.

Wastewater Treatment

6.7.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in NPA4 will have wastewater treated at both Poringland WwTW (60%) and Stoke Holy Cross WwTW (40%).

6.7.3 Significant upgrades to reduce organic load (BOD) and increase nitrification (Ammonia) will be required at Poringland WwTW. It is predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. Significant growth before the end of AMP6 will therefore not be possible until P stripping is introduced and the process capacity of the works is increased. It is therefore recommended that later phases of development (to the south of the NPA) are transferred to Poringland after 2020 (712 dwellings).

6.7.4 Stoke Holy Cross WwTW requires less significant upgrades, although an increase in nitrification is likely to be required to meet the Ammonia consent. In addition, P stripping will have to be introduced to meet a consent of 3mg/l although this should be achievable in AMP6. A new volumetric consent will also have to be negotiated. Development in the north of the NPA is therefore preferred for early phasing of development from 2015 onwards (474 dwellings).

Wastewater Transmission

Strategic Connection

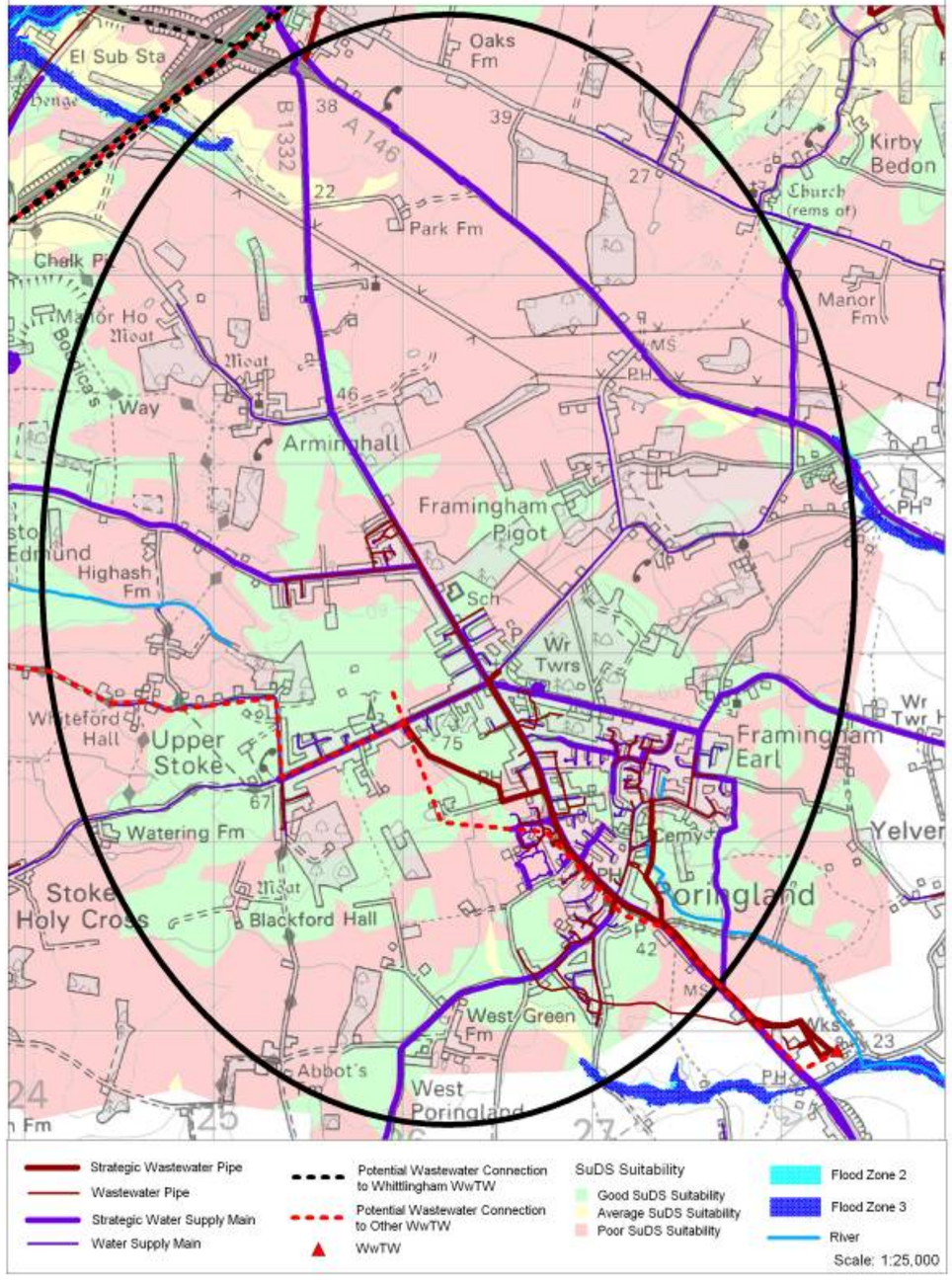
6.7.5 There is a large 'strategic' sewer to the north of NPA4 (which flows northwest to Stoke Holy Cross) which is estimated to have capacity for an additional 800 dwellings to transfer to Stoke Holy Cross WwTW; therefore early phasing of the 475 dwellings in the north of the NPA should be feasible.

6.7.6 A strategic sewer is located to the south of the NPA close to Poringland WwTW; hence a new strategic sewer is unlikely to be required. This should be confirmed as part of pre-development applications with AWS utilising network modelling.

Local Connection

6.7.7 Extensive local connections will be required at developer level if development is proposed anywhere other than around Poringland town.

NPA4 - South East Sector (vicinity of Poringland)



Water Resources

Water Supply Infrastructure

6.7.8 The accompanying figure highlights a strategic water supply mains throughout the NPA. Connection to these mains should be sufficient for the proposed new development.

Water Neutrality (WN)

6.7.9 Due to limited existing population in the NPA, WN for NPA4 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.7.10 There are no designated Flood Zones 3 and 2 within this NPA, though Flood Zones 3 and 2 cross the northwest, east and southeast boundary of the area.

SuDS Suitability

6.7.11 Most of the NPA (particularly in the north) has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds.

6.7.12 Development around Poringland and Upper Stoke will have greater suitability for SuDS due to higher permeability soil and geology. SuDS such as Swales and Soakaways are more likely to be suitable here.

6.7.13 Development and certain infiltration types to west will be restricted by SPZ 1, 2 and 'total catchment' designations due to two water abstractions to the west and northwest of the NPA. Infiltration SuDS in the majority of the west of NPA will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed due to a 'total catchment' across the whole of the western part of the NPA.

6.7.14 The use of infiltration SuDS in the eastern half of the NPA is variable with pockets of land suitable for these preferred SuDS and which will not be limited by SPZs. Developers will need to refer to The accompanying figure to determine whether surface water storage SuDS are more likely than infiltration.

6.8 NPA 5 – South Sector

Growth Summary

6.8.1 A total of 2,503 new dwellings are proposed for NPA 5.

Wastewater Treatment

6.8.2 Wastewater generated at NPA3 will be split between nearby Swardeston WwTW (40%) to the west and a strategic transfer to Whitlingham WwTW (60%).

6.8.3 Significant upgrades to increase nitrification (Ammonia) and reduce organic load (BOD) will be required at Swardeston WwTW. It is predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. Significant growth before the end of AMP6 will therefore not be possible until P stripping is introduced and the process capacity of the works is increased slightly.

6.8.4 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA5 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.8.5 There is no strategic sewer linking the majority of the NPA to Swardeston WwTW which lies within the NPA; however smaller sewers are located which would likely require reinforcement to accept the proposed 1,011 dwellings that will connect to it. These could be requisitioned by the developer for early phasing.

6.8.6 Connection to Whitlingham WwTW is reliant on a new connecting sewer to link to the proposed southern section of the strategic wastewater interceptor sewer proposed around the southern boundary of Norwich.

6.8.7 Depending of phasing within this NPA, new strategic mains will therefore likely be required for AMP 6 moving into AMP 7. Development will have to phased to use capacity at Swardeston first (during AMP6 once treatment upgrades are made) with connection to Whitlingham for the remaining growth (1,502) occurring mostly in AMP7 (2020 onwards).

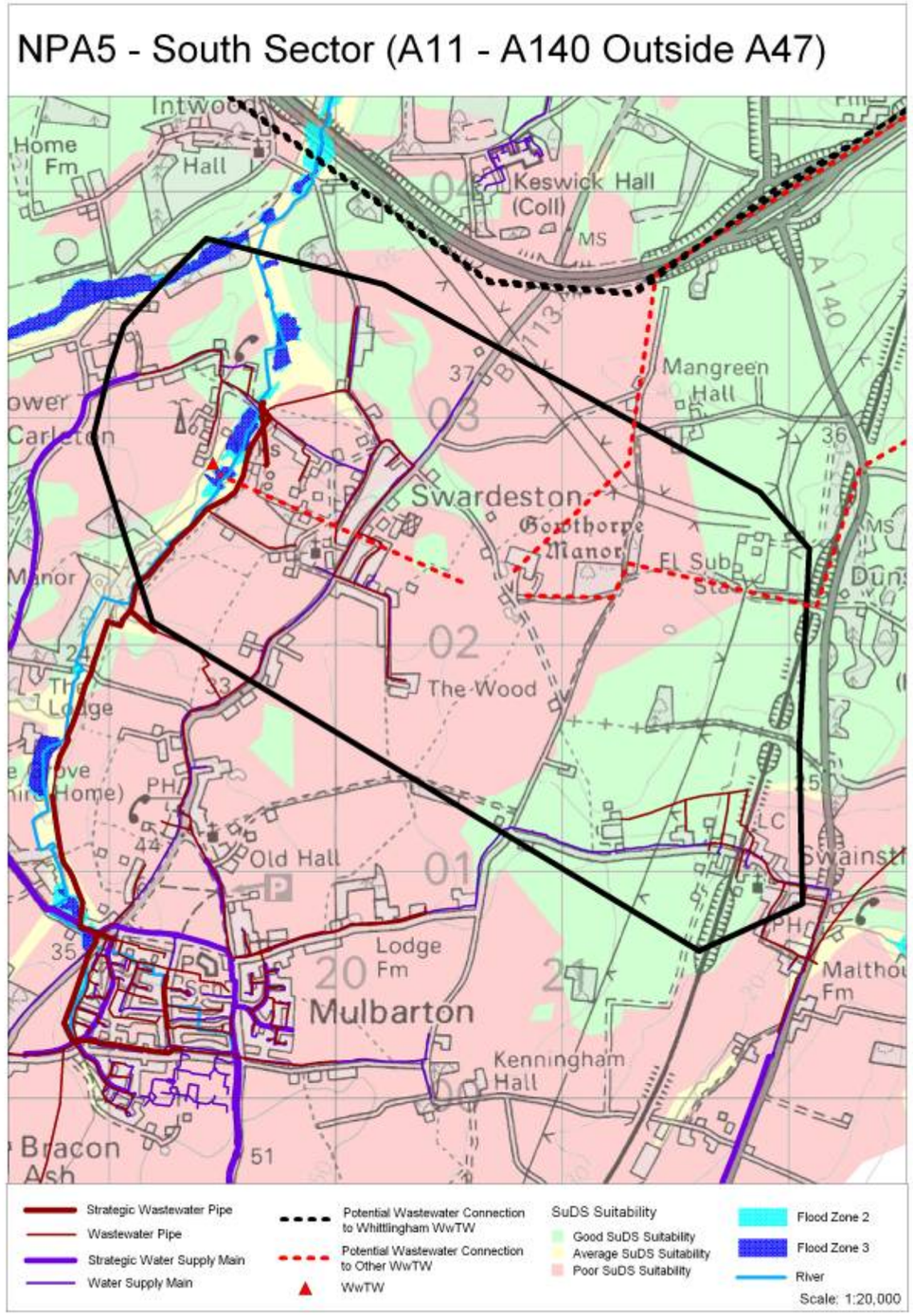
Local Connection

6.8.8 Extensive local connections will be required at developer level for the majority of the NPA other than development in proximity of Swardeston.

Water Resources

Water Supply Infrastructure

6.8.9 The accompanying figure highlights a single strategic main at the western boundary of the NPA – extensive local connections with pumping stations will therefore be required to service the NPA with water supply.



Water Neutrality (WN)

6.8.10 Due to limited existing population in the NPA, WN for NPA5 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.8.11 The extent of Flood Zones 3 and 2 within this NPA is minimal hence development should be able to proceed outside of the floodplain and the NPA will hence be able to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.8.12 Most of the NPA (particularly central) has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy), hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds.

6.8.13 Development to the east will have greater suitability for SuDS due to higher permeability soil and geology. SuDS such as Swales and Soakaways are more likely to be suitable here. However an SPZ 2 designation will restrict development and certain infiltration types in this location, requiring some form of water quality control such as oil interceptors of runoff (other than clean roof runoff).

6.9 NPA 6 – Long Stratton

Growth Summary

6.9.1 A total of 1,927 new dwellings are proposed for NPA 6.

Wastewater Treatment

6.9.2 To make use of capacity at local WwTWs and to reduce pumping and transmission costs, development in NPA6 will have wastewater treated at the existing WwTW at Long Stratton. This will require an increase in the volume of discharge to be consented, but it is considered that this is preferable to transferring flows a long distance to the next nearest WwTW. Additional development will not be possible until the consent has been negotiated (assumed 1 year lead in time).

6.9.3 Significant upgrades to reduce organic load (BOD) and increase nitrification (Ammonia) will be required at Long Stratton WwTW and this will put the treatment works at the limit of BATNEEC for Ammonia. It is also predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD has suggested that a tighter consent (most likely unachievable) will be needed to achieve immediate downstream compliance with WFD targets. Significant growth before the end of AMP6 will therefore not be possible until P stripping is introduced and the process capacity of the works is increased (likely requiring significant increase in process streams. It is therefore recommended that development in Long Stratton will need to be phased such that the majority of development does not commence until 2020 (AMP7).

Wastewater Transmission

Strategic Connection

6.9.4 There is a single strategic sewer linking the NPA to Long Stratton WwTW which lies to the north west of the NPA. Smaller sewers are located in and around the town, which would likely require reinforcement to accept the proposed dwellings that will connect to it; these could be requisitioned by the developer.

Local Connection

6.9.5 Extensive local connections will be required at developer level for the majority of the NPA other than development in proximity of Long Stratton.

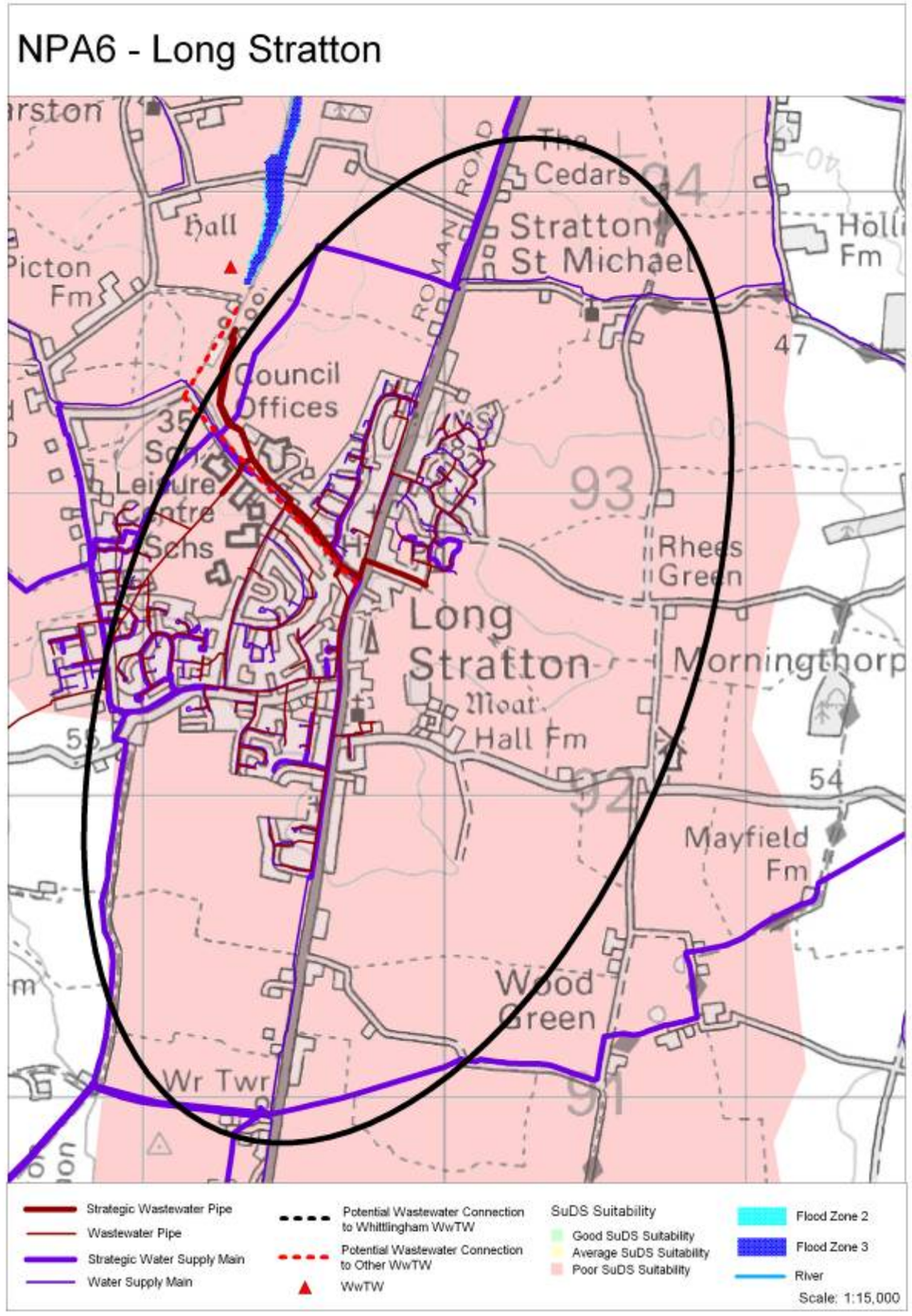
Water Resources

Water Supply Infrastructure

6.9.6 The accompanying figure highlights a single strategic main at the western boundary of the NPA which should be sufficient to service the proposed NPA; however, fairly extensive local connections with pumping stations will be required to service the rest of the NPA with water supply.

Water Neutrality (WN)

6.9.7 NPA6 has been assessed for WN as a single town. WN is not feasible for the town given the proposed growth levels but to meet the aspirations of the GNDP development area new homes in this NPA should aim to achieve high code levels under the CfSH.



Flood Risk & Management

Flood Risk & the Sequential Test

6.9.8 There are no designated Flood Zones 3 and 2 within this NPA.

SuDS Suitability

6.9.9 All of the NPA has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds.

6.9.10 Development will also be potentially restricted due to the presence of a 'total catchment' area across all of the NPA.

6.10 NPA 7 – Wymondham

Growth Summary

6.10.1 A total of 2,750 new dwellings are proposed for NPA 7.

Wastewater Treatment

6.10.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in NPA7 will have wastewater treated at the existing WwTW at Wymondham. Only relatively small upgrades to increase nitrification (Ammonia) and reduce organic load (BOD) will be required at Wymondham WwTW which are within BATNEEC. However, it is predicted that the current P consent limit of 2mg/l would need to be tightened as modelling for WFD has suggested that a tighter consent (most likely unachievable) will be needed to achieve immediate downstream compliance with WFD targets. As P stripping is already in place however, immediate connection of some development is likely to be possible and upgrades to the P stripping process can be phased in over AMPs 6 and 7 if required.

Wastewater Transmission

Strategic Connection

6.10.3 Sewer connections in the town are good; however development located to the south of the town would likely require reinforcement to accept the proposed dwellings that will connect to the WwTW; these could be requisitioned by the developer.

Local Connection

6.10.4 Extensive local connections will be required at developer level for the majority of the NPA other than development in proximity of Wymondham.

Water Resources

Water Supply Infrastructure

6.10.5 The accompanying figure highlights several significant strategic mains throughout the NPA which should be sufficient to service the proposed NPA.

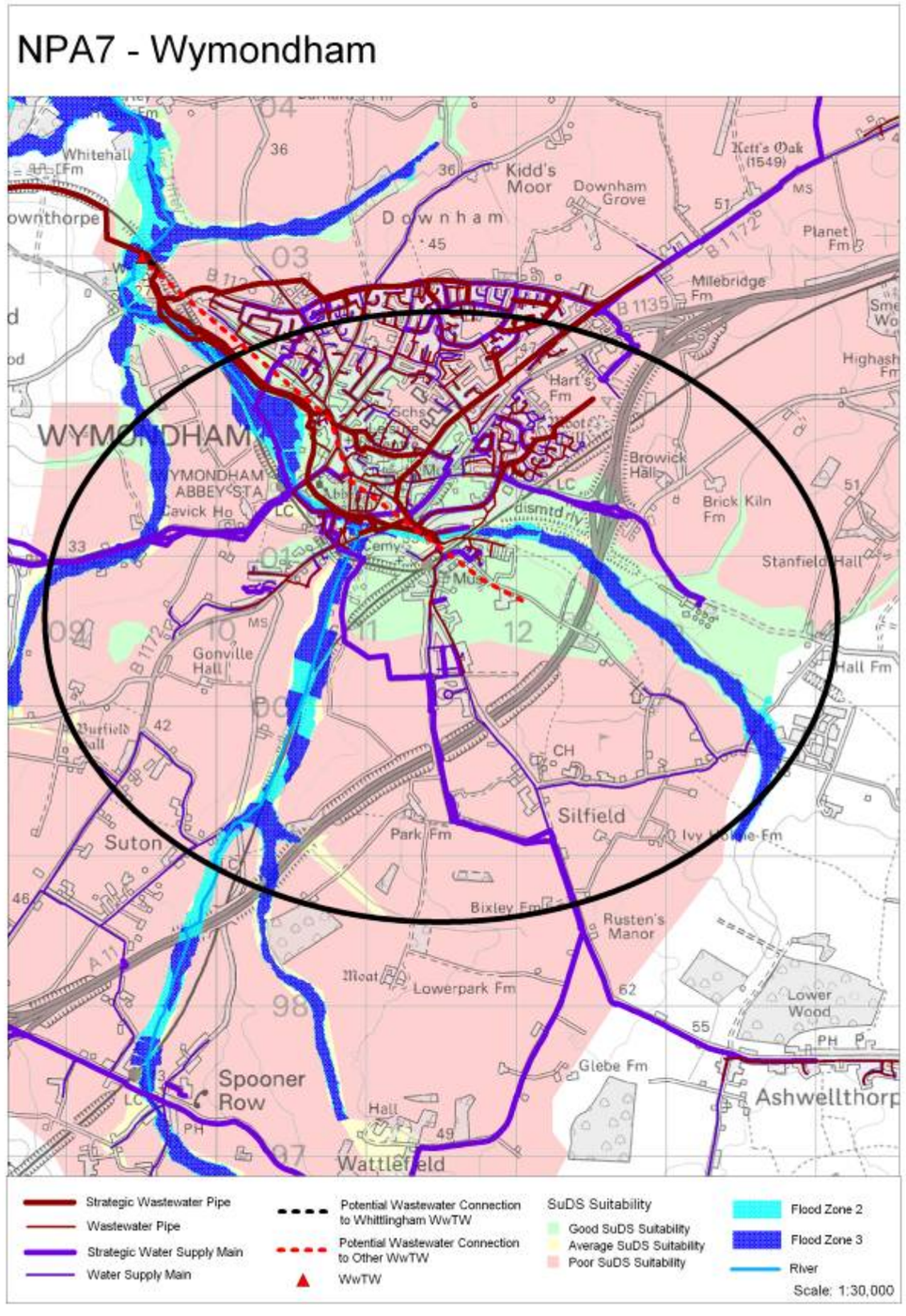
Water Neutrality (WN)

6.10.6 NPA7 has been assessed for WN as a single town. WN is not feasible for the town given the proposed growth levels but to meet the aspirations of the GNDP development area new homes in this NPA should aim to achieve high code levels under the CfSH.

Flood Risk & Management

Flood Risk & the Sequential Test

6.10.7 Areas of Flood Zones 3 and 2 transect the NPA from west to east and south to central. Development will therefore have to be carefully planned in these areas to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.



SuDS Suitability

6.10.8 Most of the NPA (except the existing developed area) has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds. Some development to the central and central east areas could be feasible for infiltration SuDs (Swales and Soakaways) and these should be promoted in the first instance.

6.10.9 There are no SPZs in the NPA; hence any type of development or SuDS type should be suitable in this NPA in terms of water abstraction protection.

6.11 NPA 8 – South West Sector

Growth Summary

6.11.1 A total of 3,215 new dwellings are proposed for NPA 8,

Wastewater Treatment

6.11.2 Due to the significant levels of proposed growth in this NPA, and limited capacity of nearby WwTW (and limited network capacity in Norwich) wastewater generated at NPA8 will be required to transfer to Whitlingham WwTW making use of the proposed strategic wastewater interceptor sewer.

6.11.3 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA8 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.11.4 There is a strategic sewer linking the NPA to the main Norwich wastewater network, however initial assessment has defined that these sewers are already at capacity and cannot accept any further flow. This assessment would need to be confirmed by AWS via detailed network modelling. For this assessment it is assumed that a new connection is required to the proposed strategic wastewater interceptor sewer which would limit growth until AMP7 (2020) at the earliest. The connections would also have to be requisitioned by the developer and contributions made to the strategic interceptor sewer.

Local Connection

6.11.5 Extensive local connections will be required at developer level for the majority of the NPA other than development in proximity of Hethersett and Little Melton.

Water Resources

Water Supply Infrastructure

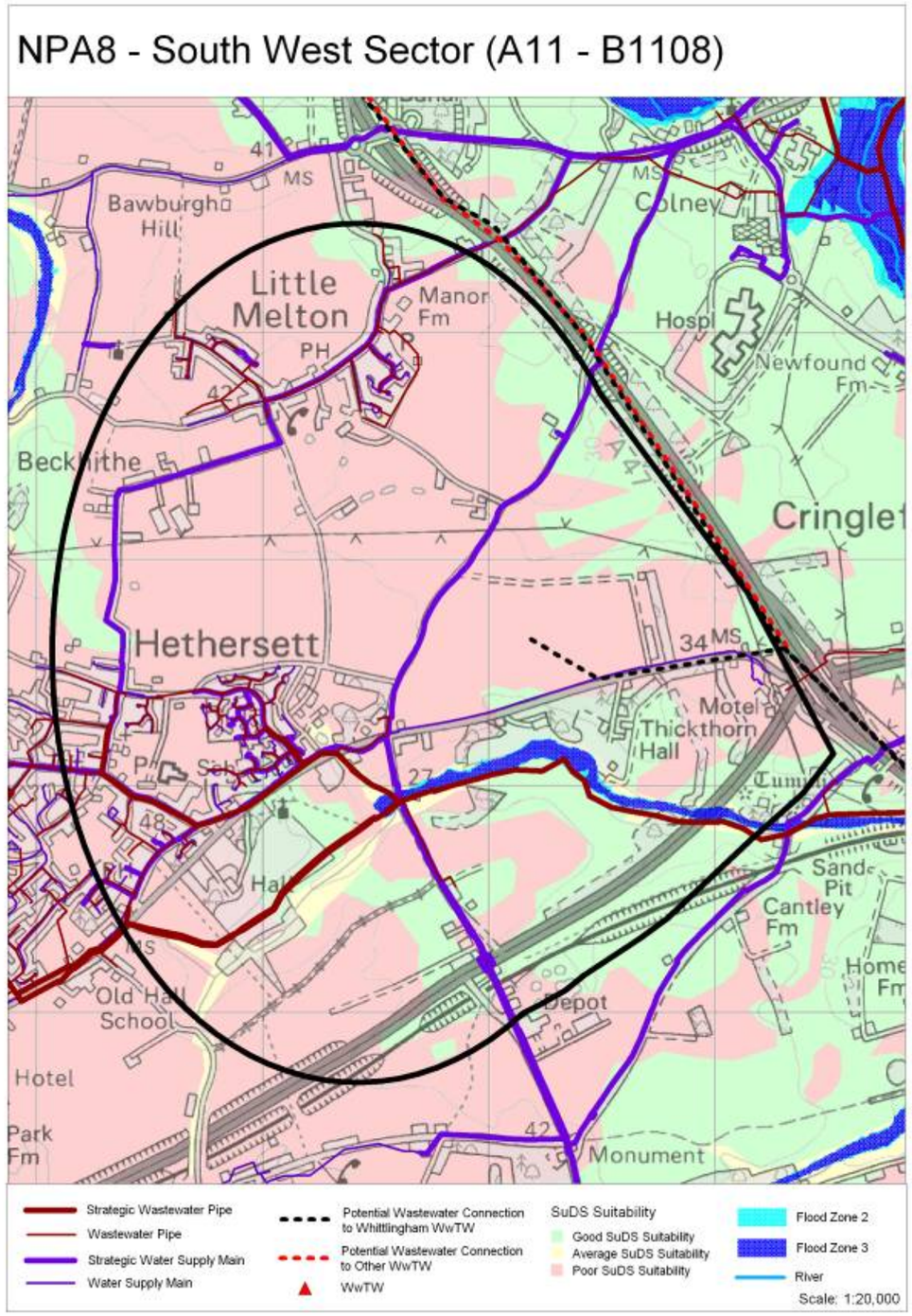
6.11.6 The accompanying figure highlights two strategic mains through the centre of the NPA and towards the western boundary of the NPA which should be sufficient to supply the majority of the development with water supply; however. extensive local connections with will be required

Water Neutrality (WN)

6.11.7 Due to limited existing population in the NPA, WN for NPA8 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.Flood Risk & Management

Flood Risk & the Sequential Test

6.11.8 The extent of Flood Zones 3 and 2 within this NPA is minimal hence development should be able to proceed outside of the floodplain and the NPA will hence be able to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.



SuDS Suitability

6.11.9 Most of the NPA (particularly central) has poor SuDS suitability and is therefore unlikely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy), hence greenfield attenuation requirements will largely have to be met through surface water attenuation features such as detention or balancing ponds.

6.11.10 An SPZ 2 designation to the southeast of the area and the designation of 'total catchment' across most of the NPA may also restrict types of development and certain infiltration types in this location, requiring some form of water quality control such as oil interceptors of runoff (other than clean roof runoff).

6.12 NPA 9 – West Sector

Growth Summary

6.12.1 A total of 3,106 new dwellings are proposed for NPA 9.

Wastewater Treatment

6.12.2 Due to the significant levels of proposed growth in this NPA, and limited capacity of nearby WwTW (and limited network capacity in Norwich) wastewater generated at NPA9 will be required to transfer to Whitlingham WwTW making use of the proposed strategic wastewater interceptor sewer.

6.12.3 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA9 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.12.4 There are two strategic sewers linking the NPA to the main Norwich wastewater network, however initial assessment has defined that sewer running through the centre of the NPA is already at capacity and cannot accept any further flow. This assessment would need to be confirmed by AWS via detailed network modelling.

6.12.5 The sewer to the south of the NPA has potential to take approximately 1,000 new dwellings; however capacity further downstream towards NPA8 has been defined as restricted. To allow this growth to take place, upgrades would be required to the strategic sewer to the east of NPA8 (South of the Wymondham NPA) to allow onward transmittal through existing mains to Whitlingham. The developer(s) could contribute funding towards this upgrade which could be upgraded during AMP6 to allow some early phasing.

6.12.6 For development beyond 1,000 homes, the only option is to provide a new connection to the proposed strategic wastewater interceptor sewer which would limit growth the delivery of this further growth until AMP7 (2020) at the earliest. The connections would also have to be requisitioned by the developer and contributions made to the strategic interceptor sewer.

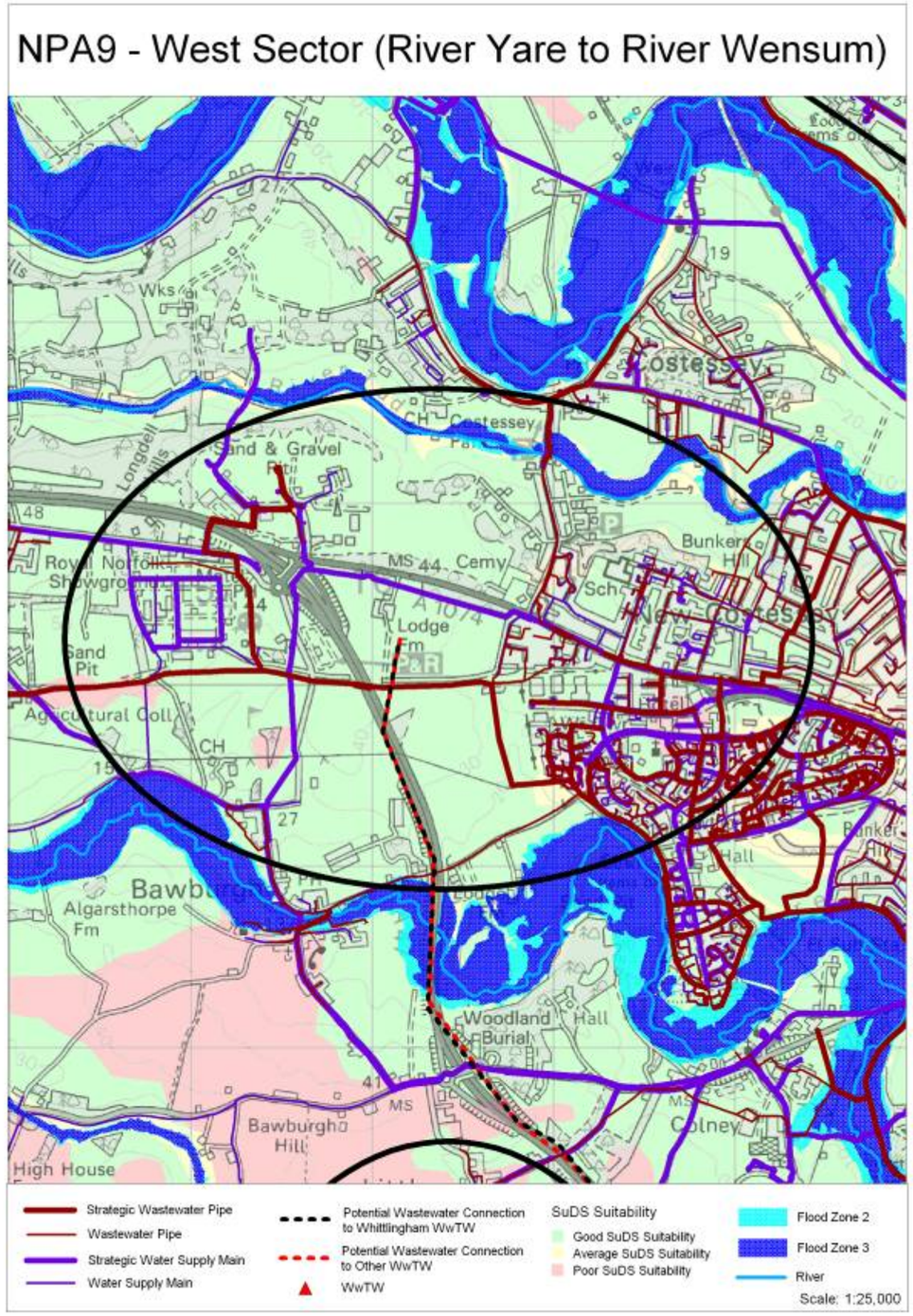
Local Connection

6.12.7 Extensive local connections will be required at developer level for development to the west of the NPA. Development in the east would be able to make use of existing smaller sewer connections.

Water Resources

Water Supply Infrastructure

6.12.8 The accompanying figure highlights that the NPA is well connected with strategic water mains and is close to the main Heigham WTW; therefore there is sufficient infrastructure to supply the development with water supply, although local connections will be required.



Water Neutrality (WN)

6.12.9 WN for NPA9 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.12.10 The extent of Flood Zones 3 and 2 within this NPA is fairly minimal; however development in the northern section of the NPA and at the south eastern tip would need to be carefully planned to enable the NPA to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation.

SuDS Suitability

6.12.11 Nearly all of the NPA has good SuDS suitability and is therefore likely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements can be partly met through infiltration SuDs such as Swales and Soakaways.

6.12.12 Runoff that can be infiltrated will however be slightly restricted in the south eastern section of this NPA due to the presence of SPZ 2 and 'total catchment' area of a source protection zone (Costessey abstraction). Infiltration SuDS here will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed.

6.13 NPA 10 – North West Sector

Growth Summary

6.13.1 A total of 1,486 new dwellings are proposed for NPA 10.

Wastewater Treatment

6.13.2 Dues to the significant levels of proposed growth in this NPA, and limited capacity of nearby WwTW (and limited network capacity in Norwich) wastewater generated at NPA10 will be required to transfer to Whitlingham WwTW making use of the proposed strategic wastewater interceptor sewer.

6.13.3 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA10 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.13.4 There is a strategic sewer linking the south eastern corner of the NPA to the main Norwich wastewater network, however initial assessment has defined that this sewer downstream as it flows through west Norwich is already at capacity and cannot accept any further flow. This assessment would need to be confirmed by AWS via detailed network modelling. For this assessment it is assumed that a new connection is required to the proposed strategic wastewater interceptor sewer (Northern section) which would limit growth until AMP7 (2020) at the earliest. The connections would also have to be requisitioned by the developer and contributions made to the strategic interceptor sewer.

Local Connection

6.13.5 Extensive local connections are unlikely to be required at developer level in the NPA as the developer should be able to make use of existing smaller sewer connections in and around Drayton.

Water Resources

Water Supply Infrastructure

6.13.6 The accompanying figure highlights that the NPA is well connected with strategic mains and is close to the main Heigham WTW; therefore there is sufficient infrastructure to supply the development with water supply, although local connections will be required in some areas.

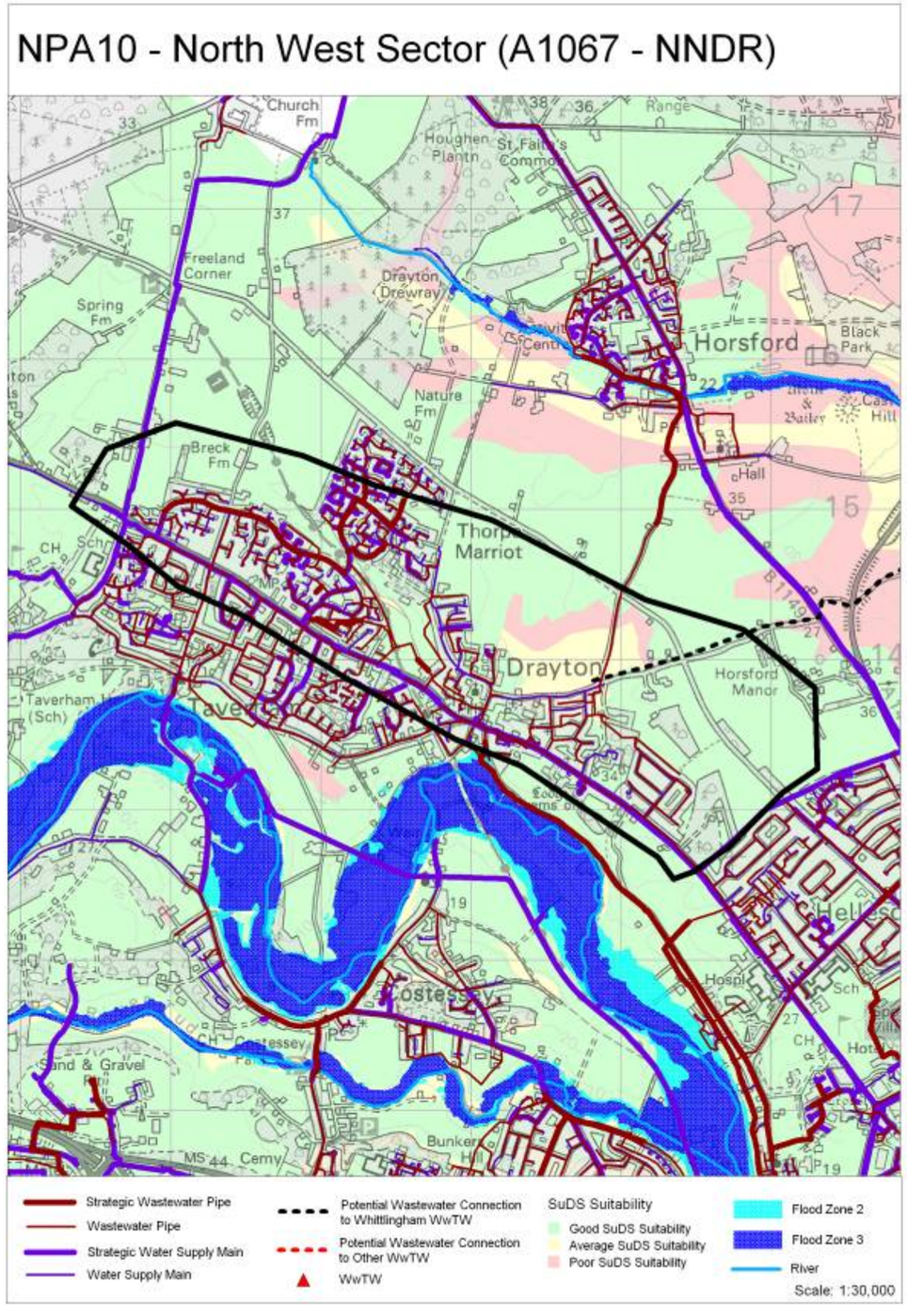
Water Neutrality (WN)

6.13.7 WN for NPA10 is assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.

Flood Risk & Management

Flood Risk & the Sequential Test

6.13.8 There are no designated Flood Zones 3 and 2 within this NPA.



SuDS suitability

6.13.9 Nearly the entire NPA has good SuDS suitability except a very small area to the north of main Drayton. Therefore the NPA is likely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements can be partly met through infiltration SuDs such as Swales and Soakaways.

6.13.10 Runoff that can be infiltrated will however be slightly restricted to the far east and west of the NPA of a 'total catchment' area (and SPZ 2 in the west) of a source protection zone (abstraction to the west of the NPA). Infiltration SuDS here will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed.

6.14 NPA11 – Norwich City Area

Growth Summary

6.14.1 A total of 8,911 new dwellings are proposed for Norwich City area.

Wastewater Treatment

6.14.2 Due to the significant levels of proposed growth in the City, and limited capacity of the city wastewater network, wastewater generated in the city will be required to transfer to Whitlingham WwTW making use of the proposed strategic wastewater interceptor sewer to the south.

6.14.3 Upgrades in terms of additional nitrification capability (ammonia reduction) and reduction of organic load (BOD) will be required at Whitlingham WwTW to treat flow to the required quality under the WFD; however, these improvements can be phased into the works over AMPs 6, 7 and 8 as flow from NPA11 and other NPAs are transferred to the works.

Wastewater Transmission

Strategic Connection

6.14.4 Several strategic sewers are located in the City; but the view of AWS (and one of the key assumptions of this study, endorsed by Scott Wilson independent calculations) is that there is limited capacity in the existing Norwich network and what is available is required to account for the effects of climate change on the system (the majority of which is combined).

6.14.5 For the majority of the proposed development, the only option is to provide a new connection to the proposed strategic wastewater interceptor sewer (South) which would limit significant growth until AMP7 (2020) at the earliest. The connections would also have to be requisitioned by the developer(s) and contributions made to the strategic interceptor sewer.

6.14.6 However, development up to 2020 could be phased in conjunction with AWS by developers commissioning AWS to undertake modelling assessments for various development locations to ascertain of some limited capacity is available in some locations and whether smaller scale reinforcement funded by the developer could allow some degree of early phasing.

Local Connection

6.14.7 Extensive local connections will not be required at developer level due to the well connected nature of the city's sewer network.

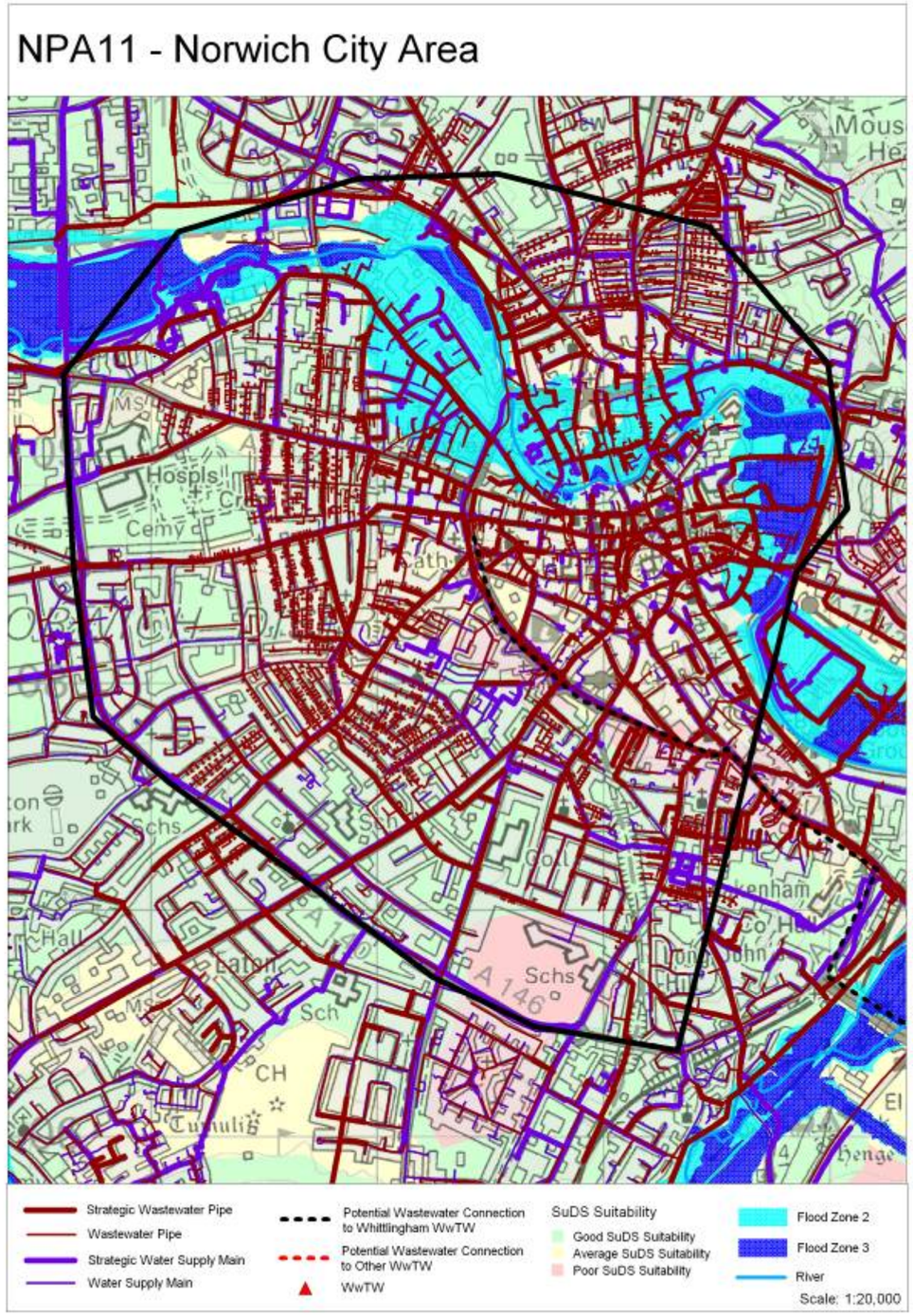
Water Resources

Water Supply Infrastructure

6.14.8 Extensive local connections will not be required at developer level due to the well connected nature of the city's water supply network.

Water Neutrality (WN)

6.14.9 WN for NPA11 is combined with the surrounding NPAs and as assessed as part of Norwich City as a whole. WN is potentially feasible if new homes in this NPA achieve code level 5 or 6 under the CfSH and existing homes within Norwich adopt either low flow toilets or showers, or adopt universal metering combined with a range of low water use fittings.



Flood Risk & Management

Flood Risk & the Sequential Test

6.14.10 The extent of Flood Zones 3 and 2 within this NPA is significant for sections to the north of proposed zone of development; therefore, development here will need to be carefully planned (and utilise the Level 2 SFRA) to enable the NPA to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.14.11 The majority of the NPA has good SuDS suitability and is therefore likely to be suitable for infiltration SuDS (the preferred SuDS option in the hierarchy); hence greenfield attenuation requirements can be partly met through infiltration SuDS such as Swales and Soakaways. However, the NPA is entirely covered by a SPZ, including a large zone of SPZ 1 in the centre which would restrict anything other than clean roof runoff to ground. Infiltration SuDS surrounding the centre will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed. Delivery of SuDS could therefore be problematic given space constraints and careful designing and planning (including tight policy) will be required to ensure no increase in flood risk as a result of development.

6.15 RPA 1 – Reepham

Growth Summary

6.15.1 A total of 283 new dwellings are proposed for Reepham.

Wastewater Treatment

6.15.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in RPA1 will have wastewater treated at the existing WwTW at Reepham. However, significant upgrades to reduce organic load (BOD) and increase nitrification (Ammonia) will be required at Reepham WwTW and this will put the treatment works at the limit of BATNEEC. It is also predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD requirements has suggested that a tighter consent (most likely unachievable) will be needed to achieve immediate downstream compliance with WFD targets. In addition, a revised volumetric consent will have to be negotiated. Significant growth before the end of AMP6 will therefore not be possible until P stripping is introduced and the process capacity of the works is increased. It is therefore recommended that development in Reepham will need to be phased such that the majority of development does not commence until 2020 (AMP7).

Wastewater Transmission

Strategic Connection

6.15.3 The main sewer feeding the WwTW has an estimated capacity of 400 dwellings; sufficient to meet the requirements of proposed growth.

Local Connection

6.15.4 Local connections are likely to be required at a developer level for areas not immediately next to the town. Network modelling may also be required for connecting to smaller connecting sewers in the town.

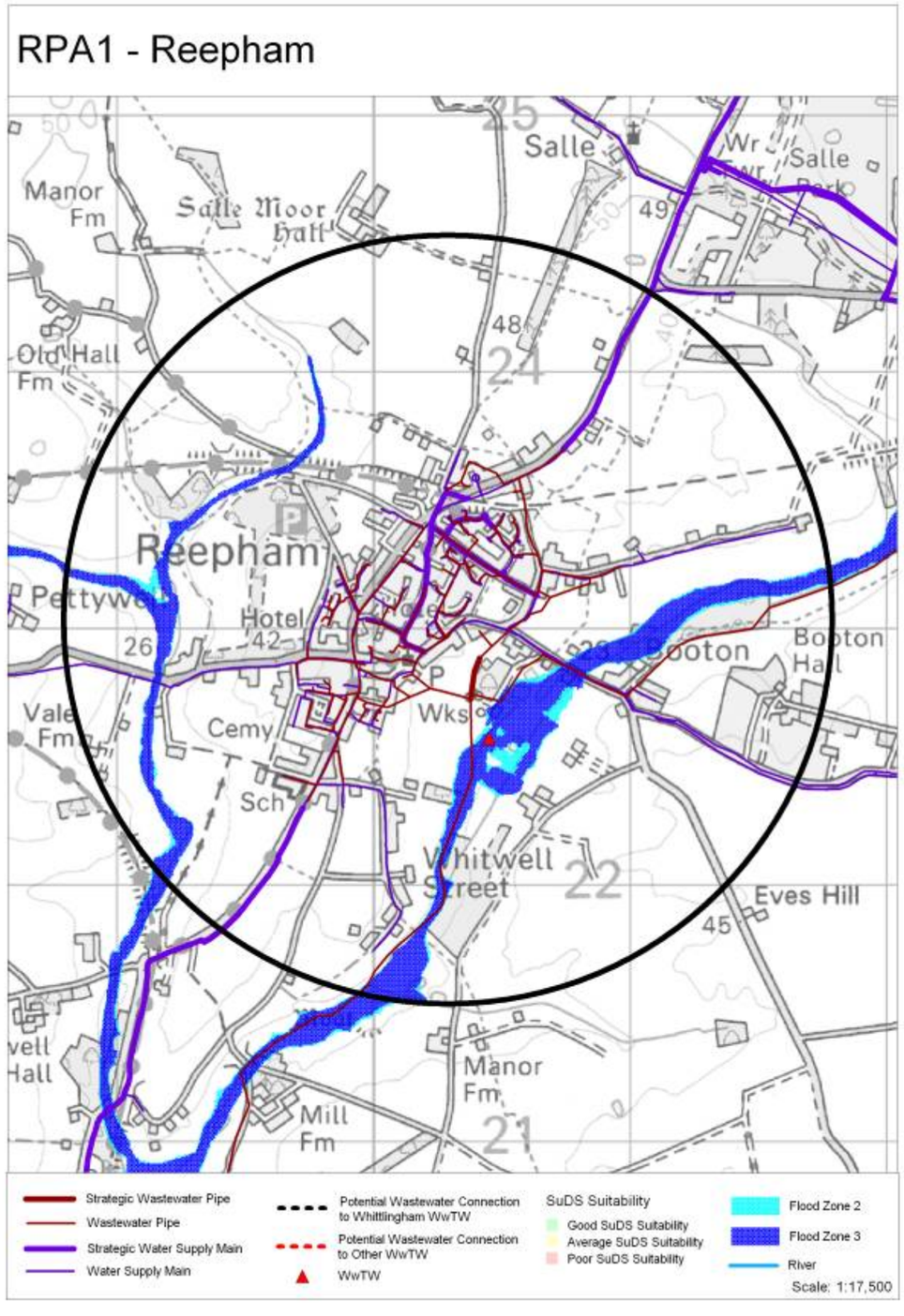
Water Resources

Water Supply Infrastructure

6.15.5 The accompanying figure highlights that there is a single water main servicing the area that should be sufficient to supply water to the proposed development. Local connections will be required with the potential for some small pumping stations.

Water Neutrality (WN)

6.15.6 Reepham has been assessed for WN as a single town. WN is theoretically feasible for the town even with development at codes 1 & 2 on the CfSH, so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving WN for the town as a whole is a definite possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.15.7 The extent of Flood Zones 3 and 2 within this area is fairly minimal; however development to the southeast and west of the town would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.15.8 Reepham is not underlain by any SPZs hence there are unlikely to be any restrictions on development type or infiltration SuDS techniques.

6.16 RPA 2 – Aylsham

Growth Summary

6.16.1 A total of 615 new dwellings are proposed for Aylsham.

Wastewater Treatment

6.16.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in RPA2 will have wastewater treated at the existing WwTW at Aylsham. The WwTW here has indentified process capacity constraints which would require upgrading to meet **existing consents**; however, RQP modelling has demonstrated that (with the exception of P) the quality consents will not need to be increased as a result of growth once upgrades are undertaken to meet current consent requirements. It is predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD requirements has suggested that a tighter consent (most likely unachievable) will be needed to achieve immediate downstream compliance with WFD targets. Significant growth before the end of AMP6 will therefore limited until P stripping is introduced and the process capacity of the works is increased. It is therefore recommended that development in Aylsham will need to be phased such that the majority of development does not commence until the middle of AMP 6 at the earliest (2017 onwards).

Wastewater Transmission

Strategic Connection

6.16.3 Aylsham has a well connected wastewater network system with two main sewers (north and south) feeding the WwTW. Approximate capacity assessments have determined a smaller capacity to the north sewer (419 dwellings) and hence not all the development can be accommodated in this sewer. However, the southern sewer has an estimated capacity of nearly 3,000 dwellings; sufficient to meet the requirements of the proposed growth.

Local Connection

6.16.4 Extensive local connections will not be required at developer level due to the well connected nature of the town's sewer network.

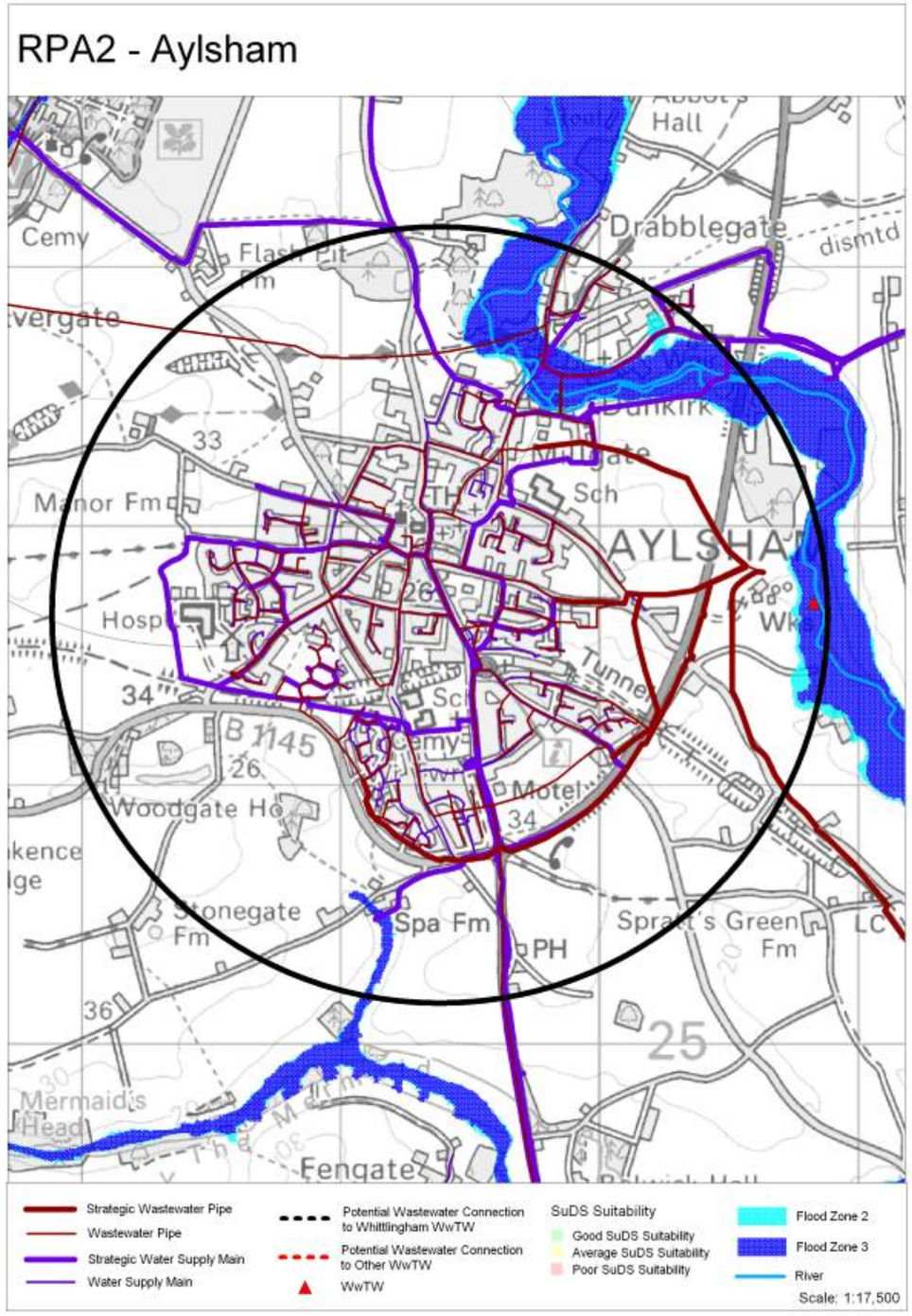
Water Resources

Water Supply Infrastructure

6.16.5 The accompanying figure highlights that there is a single (but well connected) water main servicing the area that should be sufficient to supply water to the proposed development. However, local connections will be required.

Water Neutrality (WN)

6.16.6 Aylsham has been assessed for WN as a single town. WN is theoretically feasible for the town even with development at codes 1 & 2 on the CfSH, so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving WN for the town as a whole is a definite possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.16.7 The extent of Flood Zones 3 and 2 within this area is fairly minimal; however development to the northeast of the town would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.16.8 The town's northern section area is entirely covered by a SP Z, including two zones of SPZ 1 near the town centre which would restrict development types here and will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed. Delivery of SuDS could therefore be problematic given space constraints and careful designing and planning (including policy) will be required to ensure no increase in flood risk as a result of development) in the north of the town.

6.16.9 Restrictions on the type or use of SuDS in the south of the main town are unlikely to be onerous if the area is suitable for infiltration.

6.17 RPA 3 – Wroxham

Growth Summary

6.17.1 A total of 125 new dwellings are proposed for Wroxham.

Wastewater Treatment

6.17.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in RPA3 will have wastewater treated at the existing WwTW at Belaugh.

6.17.3 No upgrades are required to Belaugh WwTW in terms of meeting sanitary determinands; however, it is predicted that a P consent limit of at 1mg/l will be required to meet WFD standards. Significant growth before AMP6 will therefore not be possible until P stripping is introduced at the WwTW.

Wastewater Transmission

Strategic Connection

6.17.4 Wroxham has a reasonably well connected wastewater network system with a main sewer feeding Belaugh WwTW. Approximate capacity assessments have determined sufficient capacity (up to 700 dwellings) to meet the requirements of the proposed growth.

Local Connection

6.17.5 Extensive local connections will only be required at developer level if development is proposed at distance from the existing town

Water Resources

Water Supply Infrastructure

6.17.6 The accompanying figure highlights that there is a single water main servicing the area that should be sufficient to supply water to the proposed development. Local connections will be required with potential for some local pumping.

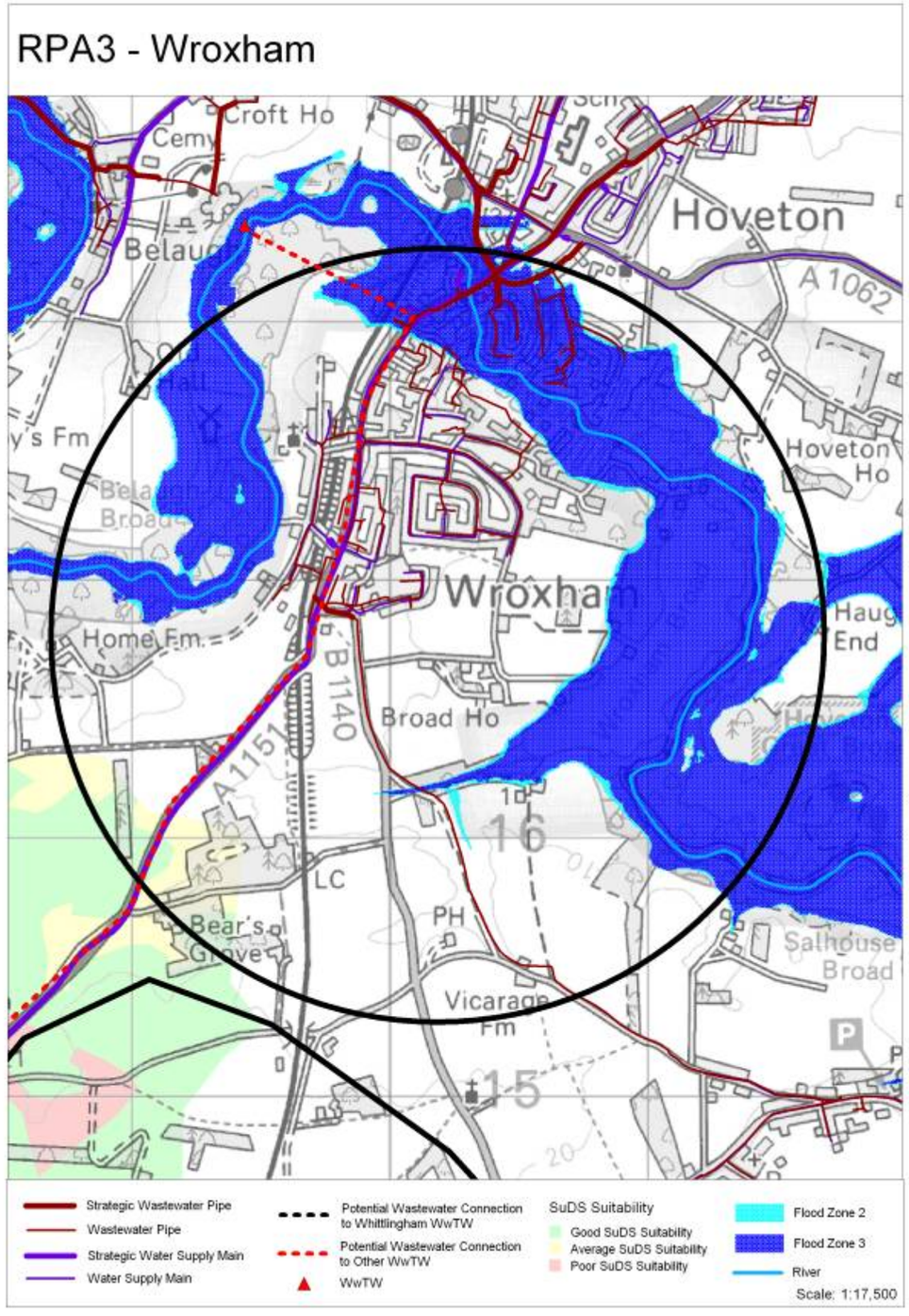
Water Neutrality (WN)

6.17.7 Wroxham has been assessed for WN as a single town. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the town even with development at codes 1 & 2 on the CfSH, so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving WN for the town as a whole is a definite possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.

Flood Risk & Management

Flood Risk & the Sequential Test

6.17.8 The extent of Flood Zones 3 and 2 within this area is fairly extensive. Development in the north and east of the town would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation



SuDS Suitability

6.17.9 The town's western area is covered by a SPZ 2 and 'total catchment', and is close to a SPZ 1 for an abstraction immediately to the west of the town. This would restrict development type to the west of the town and will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed.

6.17.10 Restrictions on the type or use of SuDS in the east of the main town are unlikely to be onerous if the area is suitable for infiltration.

6.18 RPA 4 – Acle

Growth Summary

6.18.1 A total of 173 new dwellings are proposed for Acle.

Wastewater Treatment

6.18.2 To make use of capacity at local WwTW and to reduce pumping and transmission costs, development in RPA4 will have wastewater treated at the existing WwTW at Acle.

6.18.3 Significant upgrades to reduce organic load (BOD) and in particular to increase nitrification (Ammonia) will be required at Acle WwTW. It is predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD requirements has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. The WwTW would also need a negotiation for an increase in flow consent. Significant growth before the end of AMP6 will therefore not be possible until P stripping is introduced and the process capacity of in Acle WwTW is increased.

Wastewater Transmission

Strategic Connection

6.18.4 Acle has a reasonably well connected wastewater network system with two main sewers feeding the WwTW. Both sewers have an approximate capacity sufficient to accept flow from the proposed additional dwellings without the need for strategic upgrades, although this would have to be confirmed on a development by development basis via network modelling checks with AWS.

Local Connection

6.18.5 Extensive local connections will only be required at developer level if development is proposed at distance from the existing town.

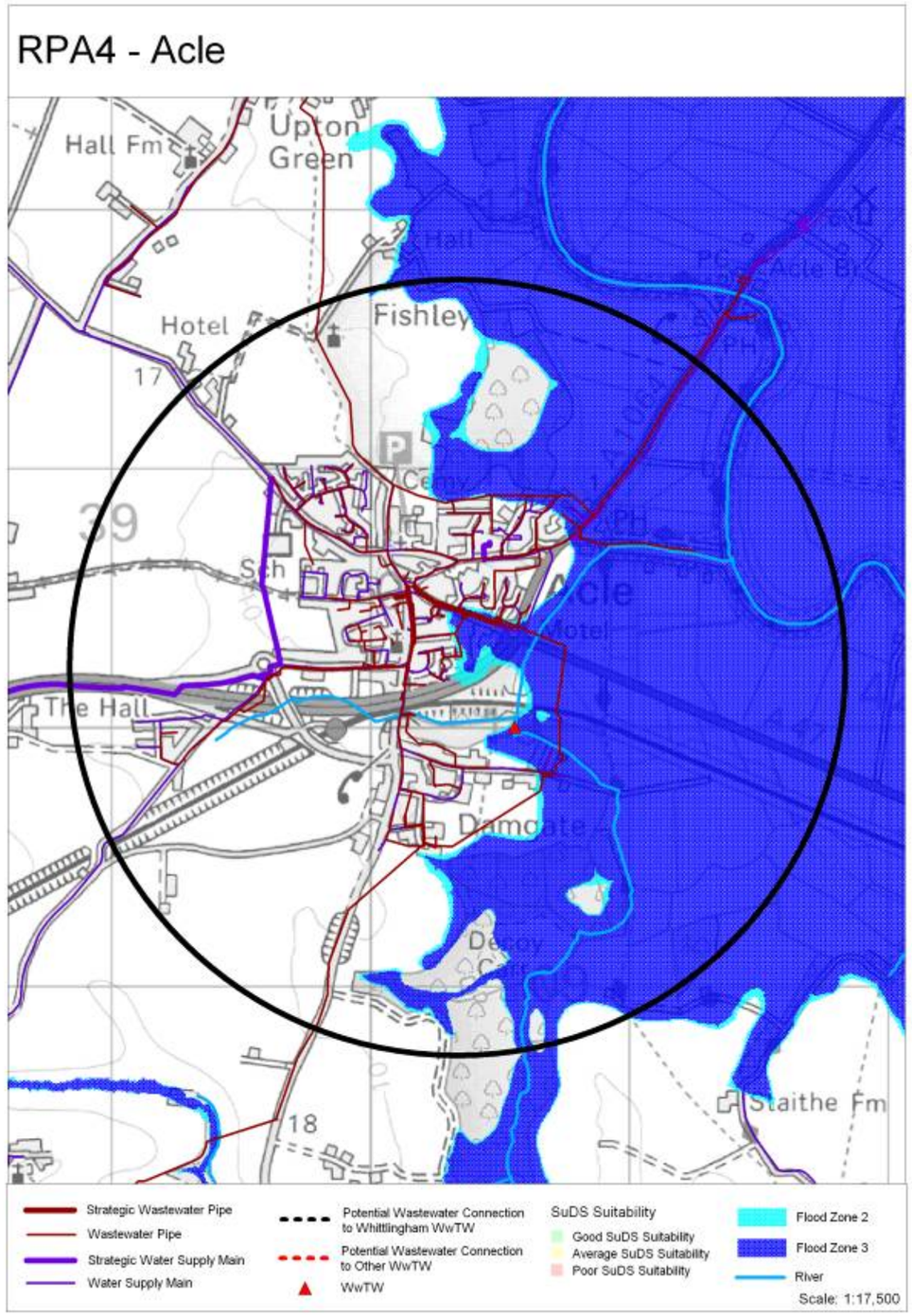
Water Resources

Water Supply Infrastructure

6.18.6 The accompanying figure highlights that there is a single water main servicing the town coming in from the west and this main should be sufficient to supply water to the proposed development. However, local connections will be required.

Water Neutrality (WN)

6.18.7 Acle has been assessed for WN as a single town. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the town even with development at codes 1 & 2 on the CfSH, so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving WN for the town as a whole is a definite possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.18.8 The extent of Flood Zones 3 and 2 within this area is extensive with the eastern section of the proposed development area affected by Flood Zone 3. To meet with the Sequential Test requirements, development in this area will be required to be located to the west of the town. Specific flood mitigation will be required if development areas east of the town are proposed, including finished floor raising and flood compensation.

SuDS Suitability

6.18.9 The town is not located over an SPZ, hence there should be few restrictions on development type or infiltration of runoff (other than clean roof runoff) if infiltration SuDS are feasible.

6.19 RPA 5 – Hingham

Growth Summary

6.19.1 A small total of 48 new dwellings are proposed for Hingham.

Wastewater Treatment

6.19.2 Hingham has no significant WwTW within the village; hence it is proposed to transfer the flow to nearby Wymondham WwTW located to the east of the village which has volumetric capacity in its flow consent to accept the additional flow.

6.19.3 Only relatively small upgrades (in combination with growth in NPA 7) to increase nitrification (Ammonia) and reduce organic load (BOD) will be required at Wymondham WwTW which are within BATNEEC. However, it is predicted that the current P consent limit of 2mg/l would need to be tightened as modelling for WFD requirements has suggested that a tighter consent (most likely unachievable) will be needed to achieve immediate downstream compliance with WFD targets. As P stripping is already in place however, immediate connection of some development is likely to be possible and upgrades to the P stripping process can be phased in over AMPs 6 and 7 if required.

Wastewater Transmission

Strategic Connection

6.19.4 Hingham has a reasonably well connected wastewater network system with a strategic sewer running from the centre of the village to Wymondham WwTW. All sewers connecting to the strategic sewer leaving the town have sufficient capacity to accept flow from the proposed new development and the strategic sewer downstream would appear to have sufficient capacity. Immediate connection and hence phasing is therefore possible in Hingham, although this would have to be confirmed on a development by development basis via network modelling checks with AWS.

Local Connection

6.19.5 Extensive local connections will be required at developer level if development is proposed at distance from the existing village, although development of any of the roads entering and leaving the village will have easier connection points.

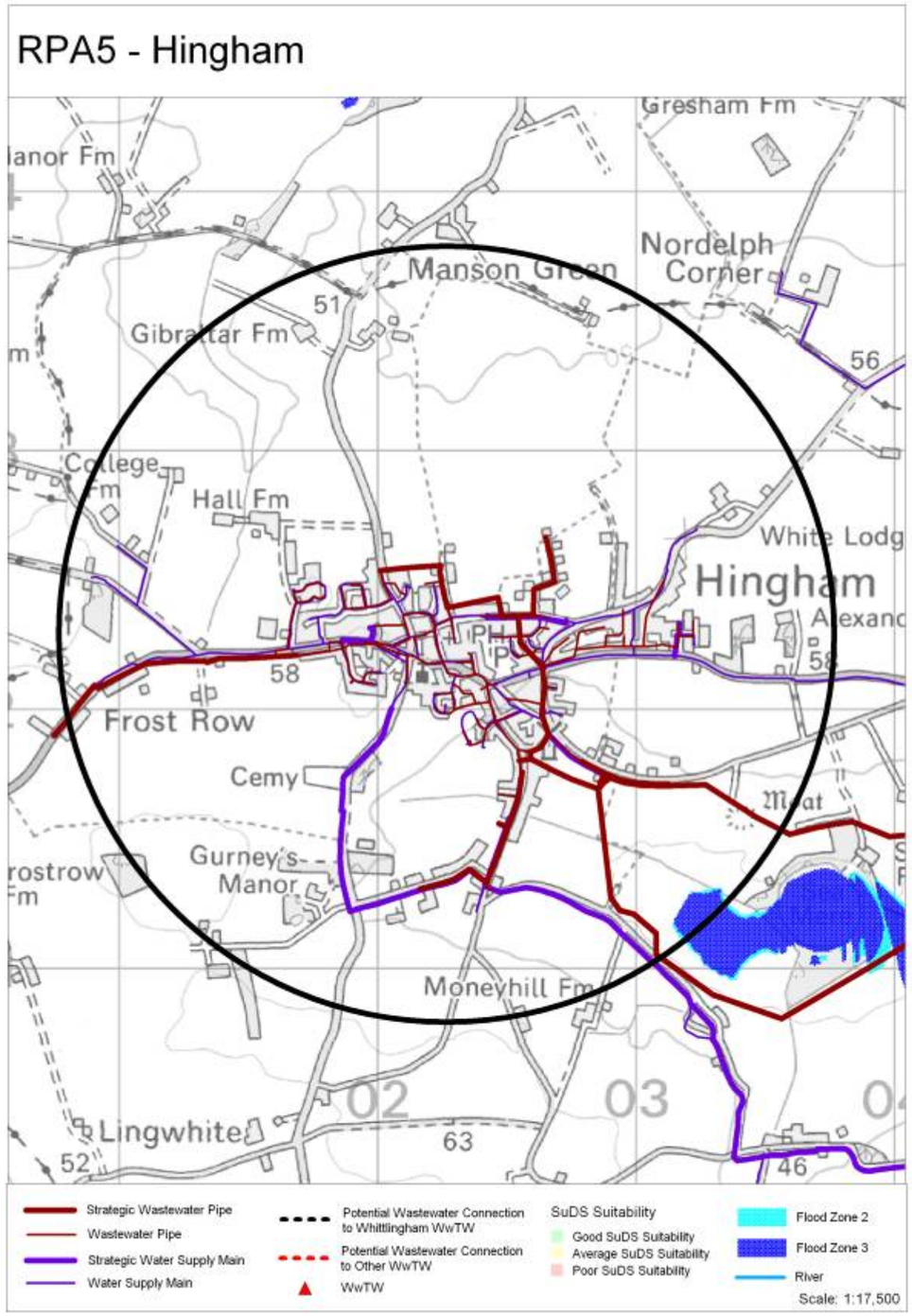
Water Resources

Water Supply Infrastructure

6.19.6 The accompanying figure highlights that there is a single water main servicing the village coming in from the south and this main should be sufficient to supply water to the proposed development. Local connections will be required with the potential for local pumping stations

Water Neutrality (WN)

6.19.7 Hingham has been assessed for WN as a single village. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the village even with new development using similar water demand as current homes so long as metering is introduced across the village for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving less water use overall (than current) for the village (after development) would be a possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.19.8 The extent of Flood Zones 3 and 2 within this area is minimal; however a small section close to Hingham plantation is located within Flood Zones 2 & 3 and hence any development area proposed here would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.19.9 The village is not located over an SPZ, hence there should be few restrictions on development type or infiltration of runoff (other than clean roof runoff) if infiltration SuDS are feasible.

6.20 RPA 6 – Diss

Growth Summary

6.20.1 A total of 237 new dwellings are proposed for Diss.

Wastewater Treatment

6.20.2 To make use of existing capacity at the local WwTW and to reduce pumping and transmission costs, development in RPA6 will have wastewater treated at the existing WwTW in Diss.

6.20.3 Upgrades will be required to increase nitrification (Ammonia) at Diss WwTW which will put the works at BATNEEC. In addition, it is predicted that the current P consent limit of 2mg/l would need to be tightened as modelling for WFD requirements has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. As P stripping is already in place however, immediate connection of some development is likely to be possible and upgrades to the P stripping process and nitrification can be phased in over AMPs 6 and 7 if required.

Wastewater Transmission

Strategic Connection

6.20.4 Diss has a very well connected wastewater network system with two main sewers in the south east of the town feeding the WwTW. The sewer to the east of the town has an approximate capacity of 570 (sufficient to accept all growth) and the strategic main to the south has a very high spare capacity. Development located other than east or south of the town will need to consider network capacity through the town itself on a development by development basis via network modelling checks with AWS.

Local Connection

6.20.5 Extensive local connections will only be required at developer level if development is proposed at distance from the existing town.

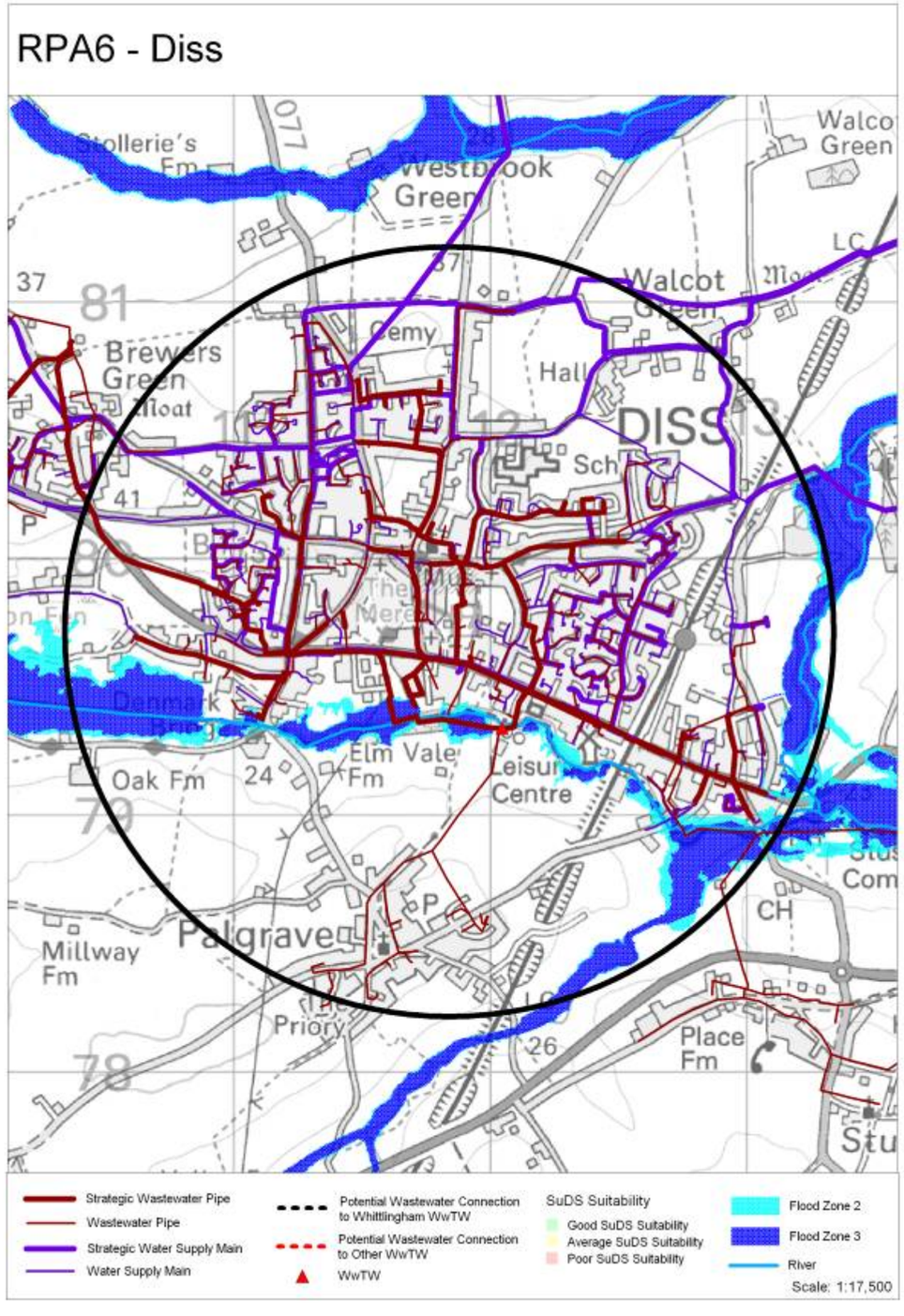
Water Resources

Water Supply Infrastructure

6.20.6 The accompanying figure highlights that there are several water mains servicing Diss largely coming in from the north and northeast. These mains should be sufficient to supply water to the proposed development. Local connections will be required if development is proposed south of the river, otherwise local connections are likely to be sufficient.

Water Neutrality (WN)

6.20.7 Diss has been assessed for WN as a single town. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the town even with new development using similar water demand as current homes so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving less water use overall (than current) for the town (after development) would be a possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.20.8 The extent of Flood Zones 3 and 2 within this area is fairly minimal; however a development immediately to the south of the town and the southeast of the area would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.20.9 Much of the town is covered by a SPZ, including a zone of SPZ 1 to the northwest of the town centre associated with a groundwater abstraction point. SPZ 2 and 'total catchment' areas are therefore located across most of the central, northern and western areas of the town and areas to the north and west of the main town itself. These SPZ designations would restrict development types here and will require some form of water quality control such as oil interceptors if infiltration of runoff (other than clean roof runoff) is proposed. Delivery of SuDS could therefore be problematic given space constraints within the town itself and careful designing and planning (including policy) will be required to ensure no increase in flood risk as a result of development) in the centre, north and west of the town.

6.20.10 Restrictions to the far east of the main town are unlikely to be onerous if suitable for infiltration

6.21 RPA 7 – Harleston

Growth Summary

6.21.1 A total of 479 new dwellings are proposed for Harleston.

Wastewater Treatment

6.21.2 To make use of existing capacity at the local WwTW and to reduce pumping and transmission costs, development in RPA7 will have wastewater treated at the existing WwTW in Harleston.

6.21.3 Some upgrades will be required to increase nitrification (Ammonia) and reduce organic load (BOD) at Harleston WwTW which will put the work close to BATNEEC for Ammonia. However, it is predicted that the current P consent limit of 2mg/l would need to be tightened as modelling for WFD requirements has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. As P stripping is already in place however, immediate connection of some development is likely to be possible and upgrades to the P stripping process can be phased in over AMPs 6 and 7 if required.

Wastewater Transmission

Strategic Connection

6.21.4 Harleston has a very well connected wastewater network system with a strategic sewer running through the centre of the town to the WwTW to the north and two strategic sewers draining the north east and north west fringes of the town. The northwest sewer has capacity for approximately 1,000 dwellings, whereas the northeastern sewer has capacity for approximately 500; therefore, development should be able to be accommodated in these sewers. Development located other than northeast or northwest of the town will need to consider network capacity through the town itself on a development by development basis via network modelling checks with AWS.

Local Connection

6.21.5 Extensive local connections will only be required at developer level if development is proposed at distance from the existing town.

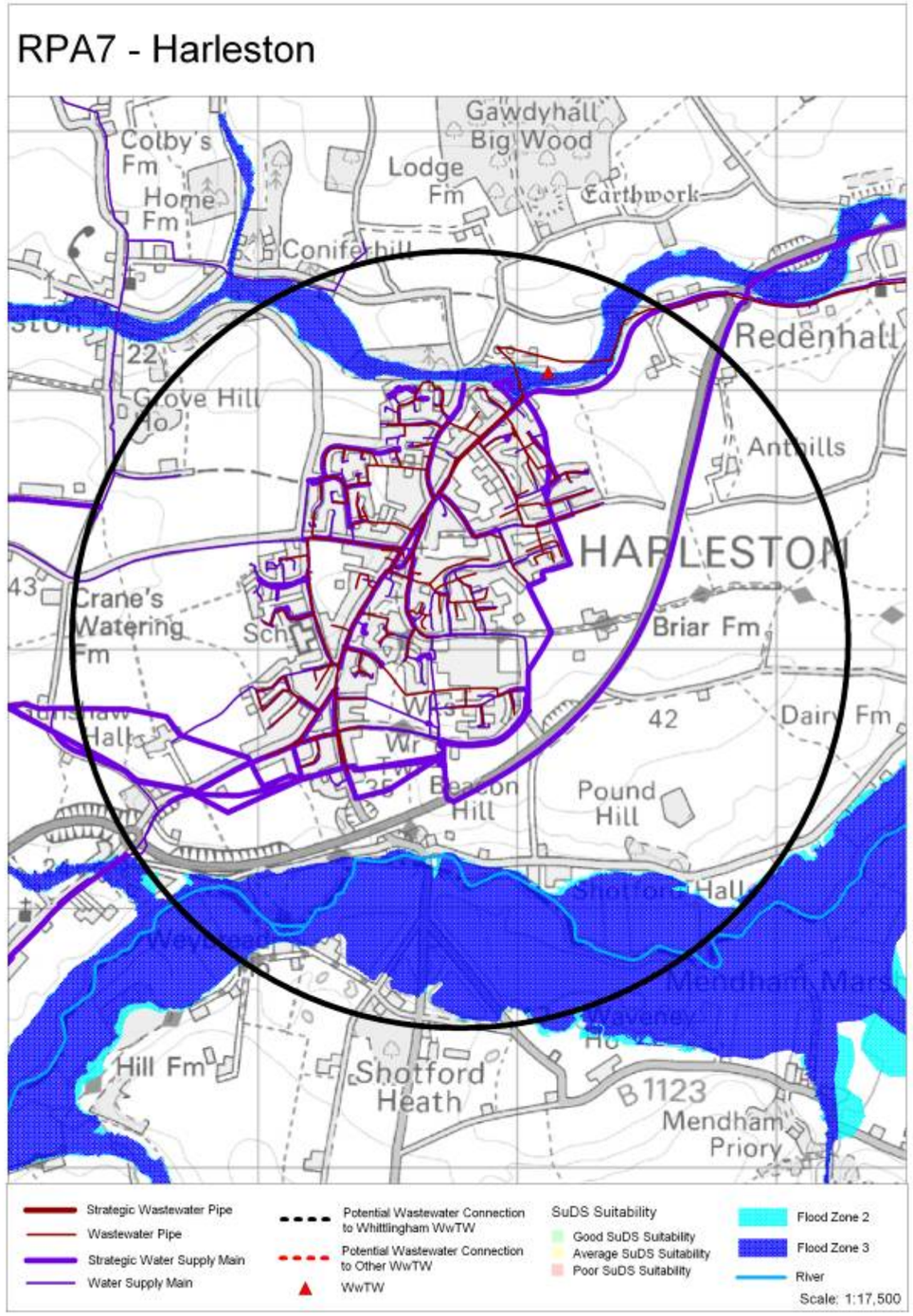
Water Resources

Water Supply Infrastructure

6.21.6 The accompanying figure highlights that there are several water mains servicing Harleston from the northwest and southwest. These mains should be sufficient to supply water to the proposed development. Local connections will only be required at developer level if development is proposed at distance from the existing town.

Water Neutrality (WN)

6.21.7 Harleston has been assessed for WN as a single town. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the town even with development at codes 1 & 2 on the CfSH, so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving WN for the town as a whole is a definite possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.21.8 The extent of Flood Zones 3 and 2 within this area is fairly minimal except for the far south and north of the area. Development to the south of the main town and the A143 would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS Suitability

6.21.9 The town is not located over an SPZ, hence there should be few restrictions on development type or infiltration of runoff (other than clean roof runoff) if infiltration SuDS are feasible.

6.22 RPA 8 – Loddon

Growth Summary

6.22.1 A total of 123 new dwellings are proposed for Loddon.

Wastewater Treatment

6.22.2 There is no significant WwTW serving Loddon, hence wastewater flows from new development would be transferred to Sisland WwTW to the west of the town to make use of existing capacity at the WwTW.

6.22.3 Some upgrades will be required to increase nitrification (Ammonia) and reduce organic load (BOD) at Sisland WwTW but these are well within BATNEEC. It is predicted that a P consent limit of at least 2mg/l will be required and modelling for WFD requirements has suggested that a tighter consent will be needed to achieve immediate downstream compliance with WFD targets. Significant growth before the end of AMP6 will limited until P stripping is introduced. It is therefore recommended that development in Reepham will need to be phased such that the majority of development does not commence until the middle of AMP 6 (2017 onwards).

Wastewater Transmission

Strategic Connection

6.22.4 Loddon has a reasonably well connected wastewater network system with strategic sewers serving the southern and northern sections of the town (north and south of the River Chet). A strategic sewer transfers flows from the town centre west to Sisland WwTW. This sewer has been estimated to have a capacity for over 4,000 dwellings which is more than sufficient to accommodate the proposed growth. Development located other to the south of the town will need to consider network capacity through the town itself on a development by development basis via network modelling checks with AWS.

Local Connection

6.22.5 Extensive local connections will only be required at developer level if development is proposed at distance from the existing town.

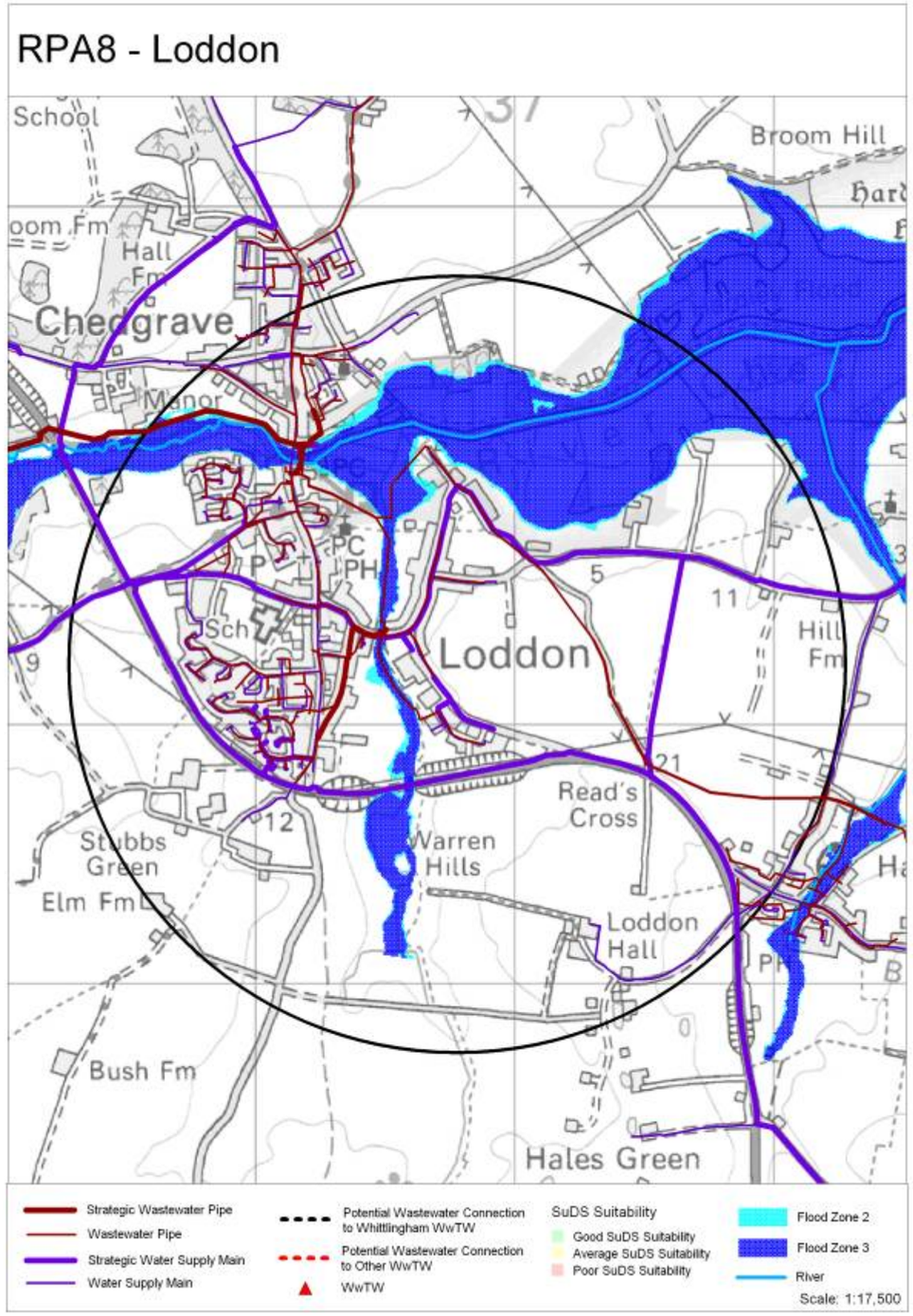
Water Resources

Water Supply Infrastructure

6.22.6 The accompanying figure highlights that there are several water mains servicing the town running from northwest to southeast along the line of the A146. This main and others coming in from the east and west should be sufficient to supply water to the proposed development. Local connections will only be required at developer level if development is proposed at distance from the existing town.

Water Neutrality (WN)

6.22.7 Loddon has been assessed for WN as a single town. As the amount of proposed growth for the town is fairly small, WN is theoretically feasible for the town even with new development using similar water demand as current homes so long as metering is introduced across the town for existing homes and low use fittings (including toilet flushing) are included for existing homes. Achieving less water use overall (than current) for the town (after development) would be a possibility with retrofitting and even higher achievement of codes 5 & 6 under the CfSH for new homes.



Flood Risk & Management

Flood Risk & the Sequential Test

6.22.8 The extent of Flood Zones 3 and 2 within this area is fairly extensive through the town centre, to the north east of the town centre (River Chet) and between the east of the southern section of the town. To meet with the Sequential Test requirements, development in these areas would need to be carefully planned to enable the area to meet the PPS25 Sequential Test and Exception Test and support the proposed development without the need for specific flood risk mitigation

SuDS suitability

6.22.9 The town is not located over an SPZ, hence there should be few restrictions on development type or infiltration SuDS (assuming infiltration is feasible).

7 Infrastructure Funding Options

7.1.1 It is important that the GNWCS considers mechanisms for obtaining and securing funding toward water infrastructure that the developers can contribute to. The following sections describe possible options in relation to limitations placed on developer contribution to water services under the Water Resources Act 1991, which the GNDP should consider as part of producing the Joint Core Strategy and their LDFs.

7.1.2 This GNWCS has highlighted that there is a need for expenditure on new infrastructure in the following areas:

- Water supply and water resources;
- Wastewater treatment and sewerage; and
- Flood risk management (surface water attenuation).

7.1.3 Both water supply (treatment) and wastewater treatment are the responsibility of AWS within the GNDP study area. At present, the Water Industry Act 1991, and agreements between Ofwat and water companies prevent developers contributing towards the provision of water resource schemes, water treatment and wastewater treatment facilities. These elements of the WCS will be funded by customer charges which are set by Ofwat over the 5 year AMP periods through the Periodic Review process (PR process). Customer charges are set across a companies supply area and the same charges apply for all customers equally (i.e. customers in one area will not pay more than in another area even if costs for new infrastructure to service that area are higher). More detail on the AMP and PR process is included in Appendix L: The Periodic Review and AMP process.

7.1.4 Despite this, the provision of strategic level wastewater mains as part of the wastewater strategy has been highlighted as infrastructure that is required specifically to deliver new development, and there are mechanisms that would allow developer contributions to be made towards the funding of water supply and wastewater networks or mains infrastructure on a scale commensurate with the number of housing proposed by each developer. If investment is required to local water or wastewater networks, Ofwat takes the view that water and wastewater companies should seek to finance this work through contributions from developers. This reduces the financing burden on existing customers, who would otherwise have to pay through increases in general charges. Developer contributions can be sought for this infrastructure and the options for it are detailed below.

7.1.5 In addition, flood risk infrastructure required to service a development can be entirely funded from developer contributions. Although the generic nature of the proposed PGAs has meant that it has not been possible to identify specific flood risk infrastructure such as flood defences, it has highlighted that the provision of SuDS and surface water attenuation will be required for development areas to minimise flood risk elsewhere and comply with PPS25. Developer contributions can be sought for this infrastructure and the options for it are detailed below.

7.2 Suggested Developer Contribution Options

S106 Contributions

7.2.1 Under Section 106 of the Town and Country Planning Act 1990, developer contributions, also known as planning obligations may be sought when planning conditions are inappropriate to enhance the quality of development and to enable proposals that might otherwise have been refused to go ahead in a sustainable manner.

7.2.2 Developer contributions are intended to ensure that developers make appropriate provision for any losses or supply additional facilities and services that are required to mitigate the impact of a development. For example affordable housing, school places, roads, pedestrian crossings and other transport facilities, open spaces or equipped playgrounds or new long term maintenance of open space, travel plans, residents parking schemes, public art, libraries and other community buildings.

7.2.3 Government Circular 05/2005 includes a necessity test that ensures that all developer contributions are directly linked to a specific impact of the development and that the funds acquired are to be used for that purpose. The circular states that the obligations will be:

- necessary;
- relevant to planning;
- directly related to the proposed development;
- fairly and reasonably related in scale and kind to the proposed development; and
- reasonable in all other respects.

7.2.4 Planning permission cannot be granted without a completed agreement in place. Developer contributions may be used to:

- restrict development or use of the land in a specified way;
- require specified operations or activities to be carried out on the land;
- require land to be used in any specified way; and
- require a sum or sums to be paid to the authority on a specified date or dates.

7.2.5 Section 106 agreements are very frequently used in the strategic planning process for provision of key infrastructure requirements. However, in general the charge levied is required to be commensurate with the developer's impact.

7.2.6 Therefore, In the case of wastewater network, water supply network and surface water attenuation provision, a single section 106 levy cannot be applied to all new development and a cost apportionment mechanism would have to be derived dependent on the level of impact each development is likely to have and this is not always a straightforward process. For instance, the GNWCS has shown that the provision of SuDS and the relative costs will differ for different PGAs according to the level of infiltration that is possible (according to geology) or acceptable (according to groundwater source protection zones).

Tariff System

7.2.7 Similar to a section 106 agreement and used successfully by the Milton Keynes Partnership, a tariff system charges a single per dwelling fee to a developer to contribute towards the strategic infrastructure required to service it.

7.2.8 Generally, this does not include for water infrastructure but several WCSs are considering this as a potential option for providing a pot of funds to pay for strategic flood risk management infrastructure such as strategic SuDS and greywater recycling systems on a community level.

Planning Gain Supplement

7.2.9 A Planning Gain Supplement (PGS) takes advantage of the increase in land value that accrues when planning permission is granted for development by applying a tax to that increase in value. The revenue generated from the tax can then be used as pot to fund infrastructure requirements.

Unilateral Undertaking

7.2.10 A Unilateral Undertaking is an offer of specific undertaking from a developer. It is usually considered to be quicker, less costly and advantageous to the applicant/owner, as the council does not need to be a party to such a deed. It is preferable to use this rather than Section 106 Agreement when:

- There is a straightforward contribution required;
- There is no requirement for the Council to covenant to do something;
- No payback requirement is necessary;
- No affordable housing is required;

7.2.11 This system could work well for providing developer sums towards strategic wastewater and water supply network infrastructure as the GNDP councils do not necessarily need to covenant to provide the funding mechanism for water company infrastructure.

7.3 Proposed Funding Process

7.3.1 Section 106 or tariff systems are likely to be the best mechanism for providing funding to pay for strategic level flood risk management infrastructure such as SuDS. However, for funding the strategic wastewater mains, the situation is not so straightforward.

7.3.2 Under the Water Industry Act 1991, an Infrastructure charge may be levied on new and existing property connected to the public sewerage system for the first time. In cases where this is required in the GNDP area, this charge will be applied directly by AWS for new development that does not need new offsite infrastructure.

7.3.3 However, if the existing network infrastructure (water supply or wastewater) is not adjacent to a proposed site, the developer will be required to fund or at least contribute to this infrastructure through the requisition process under the Water Industry Act. The formal requisition procedures as set out in the Act (sections 41 and 98) a legal mechanism for developers to provide the necessary infrastructure to service their site.

7.3.4 How this process is ultimately undertaken for the proposed development in the Norwich Study area cannot be decided by this WCS i.e. a decision could be taken that developers pay for new mains through a requisition process directly with AWS i.e. the developer pays for the infrastructure to be built and it is taken on, or requisitioned by AWS. However, because the wastewater main upgrades are strategic in nature, the conclusion of the funding element of this study is that a formal developer contribution mechanism should be set out for development which is dependent on the construction of new strategic wastewater before they can be built and serviced with wastewater collection. The WCS has shown that wastewater treatment requirements of all proposed growth in the GNDP area cannot be met without investment in strategic wastewater mains and as a result, developers should be required to contribute towards the provision of this infrastructure commensurate with the size of the development proposed. Ultimately, the new strategic interceptor wastewater main could be used by AWS to relieve sewer flooding and wastewater capacity issues in Norwich City; hence it is not appropriate for developers to solely fund the interceptor sewer.

7.4 Further Cost Considerations

Minimisation of Cost

7.4.1 Even where direct funding of infrastructure is not an option, developers can at least contribute to minimising the capital cost of water infrastructure and policy can be developed to ensure that this is achieved.

7.4.2 It can be seen from this WCS that a key variable to provision of water services infrastructure is water consumption. To a large extent, developers can be encouraged to reduce this through initiatives such as grey water recycling, having developments with less impermeable surfaces, specifying higher quality materials for pipework etc. By way of example, if the percentage return to sewer can be reduced from 90% to 75%, the number of additional properties that can be accommodated per 1 m3/d headroom at an existing sewage treatment works is 0.8. If reducing the infiltration of ground water into drains supports the reduction in percentage return to drain by using higher quality drain pipes, the number of additional properties that can be supported per 1 m3/d headroom at the same WwTW can be further increased.

Water Resource Provision - Employment

7.4.3 Since December 2005, non-household customers who are likely to be supplied with at least 50 mega litres of water per year at their premises are now able to benefit from a new Water Supply Licensing mechanism. If eligible, they may be able to choose their water supplier from a range of new companies entering the market. The Water Supply Licensing mechanism enables new companies to supply water once Ofwat has granted them a licence. These companies can compete in two ways:

- by developing their own water source and using the supply systems of appointed water companies (such as AWS) to supply water to customers' premises. This would be carried out under the combined water supply licence; or
- by buying water 'wholesale' from appointed water companies (such as AWS) and selling it on to customers. This would be done under a retail water supply licence.

8 Recommendations

8.1.1 Following the completion of the Stage 2b WCS, the following recommendations are made to ensure that the overall water cycle strategy proposed is adhered to (through recommended policy) and that the study findings remain as current as possible based on best available information (through making the WCS a live document that is reviewed upon release of certain key water cycle related documents and information.

8.2 Water Cycle Policy

8.2.1 This section draws on the various assessments undertaken in this Stage 2b study as well as previous WCS stages. It summarises the key issues and suggests direction for policies to be included in the Joint Core Strategy, future Area Action Plans and suggested Supplementary Planning Guidance documents to ensure that the aims of this WCS and a sustainable water environment are achieved.

General

Policy Recommendation 1: Development Phasing

8.2.2 New homes should not be built until agreement has been reached with the water and wastewater provider that sufficient capacity in existing or future water services infrastructure is available in accordance with the GNWCS.

8.2.3 *Reason: The WCS has demonstrated some capacity within existing infrastructure; however this capacity is limited and upgrades (or new) infrastructure is required to deliver full housing requirements up to 2026. Development must not be permitted to develop until the water services infrastructure is in place to service it*

8.2.4 Policy Recommendation 2: Developer Contribution

8.2.5 As well as connection fees required under the Water Industry Act, developers will be required to contribute to strategic wastewater network infrastructure required specifically to service new development areas proposed in the GNDP Joint Core Strategy.

8.2.6 *Reason: The WCS has shown that in general, contributions directly to treatment and water supply infrastructure is not possible under the Water Resources Act 1991. However, AWS are able to requisition or adopt infrastructure funded by developers which is required solely for new development. This position is encouraged by Ofwat and hence developer contribution will be required towards the proposed interceptor sewer wastewater strategy solution for the GNDP study area.*

Wastewater treatment and transmission

Policy Recommendation 3: Strategic Wastewater Network

8.2.7 Recognition is made that the provision of a new strategic wastewater interceptor main will be required around the north and south of Norwich to connect new development areas and transfer much of the wastewater generated to Whitlingham WwTW for treatment.

8.2.8 *Reason: The WCS has demonstrated that sufficient wastewater treatment capacity exists within the combined WwTW capacity in the study area; however, in order to utilise all the spare capacity without building more costly extension, the wastewater network needs to be flexibly designed to ensure that the existing capacity can be utilised. The WCS has shown that the best means of achieving this is to build an interceptor wastewater main which transfers much of the wastewater flow to Whitlingham. The Joint Core Strategy needs to ensure that the provision of this wastewater interceptor main is fully supported.*

Policy Recommendation 3: Strategic Wastewater Treatment

8.2.9 Recognition is made that the provision of upgrades to wastewater treatment facilities within the study area is required in order for demands of future growth to be met without causing a failure in statutory WFD or standards or HD standards. Expansion of some works may be required.

8.2.10 *Reason: The WCS has demonstrated that sufficient wastewater treatment capacity exists within the combined WwTW capacity in the study area as a whole; however, some of the WwTW will need to add process streams or expand the capacity of processes in order to treat to a higher standards to meet current and future water legislation (WFD and HD standards). The Joint Core Strategy needs to ensure that the expansion of some WwTW sites is fully supported.*

Policy Recommendation 4: Protection of Amenity

8.2.11 Development will only be permitted adjacent to WwTW only if the distance between the works is sufficient to allow adequate odour dispersion

8.2.12 *Reason: The WCS has demonstrated that NPAs 5 & 6 currently have WwTW within the generic growth area extent. Therefore, development close to the WwTW in these areas would need to be managed so as to prevent nuisance from odour associated with the treatment process.*

Water Resources & Supply

Policy Recommendation 5: Water Efficiency

8.2.13 All new houses within developments of less than 500 homes should be designed to have a water demand in keeping with levels 3 & 4 in the Code for Sustainable Homes. For developments of greater than 500 homes, houses will be expected to have a water demand in keeping with levels 5 & 6 of the Code for Sustainable Homes

8.2.14 *Reason: The WCS has highlighted that water resources are 'seriously stressed' in the study area and that, although new resources have been planned by AWS, potential sustainability reductions in existing abstraction licences will further exacerbate the lack of available water for supply. New houses and non residential units must minimise water use to ensure that water demand by the end of plan period is as low as possible. The study has also shown that combining investment in measures to reduce water use in existing homes with new homes built to high levels of water efficiency targets under the code for sustainable homes, it is theoretically possible to attain close to water neutrality[24] at the end of the plan period.*

Policy Recommendation 6: Protection of Water Resources

8.2.15 New development will not be permitted in source protection zones unless the Environment Agency is satisfied that the risk is acceptable.

[24] Water neutrality refers total water use of all homes in the study area after new development is complete (2026) is no greater than the base year (2009).

8.2.16 Reason: The WCS has highlighted that water supply in the GNDP study area is highly dependent on groundwater abstraction and as such, it is important to continue to protect the areas that recharge the groundwater through suitable management of surface activities. Several PGAs are over or close to source protection zones around abstraction boreholes and hence Environment Agency agreement will need to be achieved for some development types in these areas.

Flood risk and drainage

Policy Recommendation 7: Site drainage

8.2.17 All new development, including that on brownfield development, should be served by separate surface water and wastewater drainage. No new development will be permitted to discharge runoff to foul drainage connections.

8.2.18 *Reason: The WCS has highlighted that sewer flooding and Combined Sewer Overflows are an existing concern in Norwich and that with climate change, capacity will be limited. Therefore further discharges of surface water to foul or combined drainage should not be permitted to prevent exacerbation of existing problems.*

Policy Recommendation 8: Surface Water Management

8.2.19 All new development, including that on brownfield development, should not be constructed until sufficient surface water management and attenuation has been provided to ensure that flood risk from the development as a result of surface water runoff can be managed in line with PPS25 both during construction and the design life of the development.

8.2.20 *Reason: The WCS has determined that management of surface water is key to preventing downstream flood risk as a result of development. Therefore, design of runoff attenuation (through SuDS design) needs to be built into developments as part of the masterplan and as part of the Environmental Management Plan for construction for major developments. The WCS has provided advice on the size, location and type of SuDS that will be suitable in each PGA.*

8.3 Developer checklist

8.3.1 In addition to the high level policy suggestions included in the previous section, a developer checklist has been provided. The checklist includes for all the necessary steps that a developer would need to take to meet with the key water based legislative and policy requirements.

8.3.2 The overall intention is that all developers would be asked to use the water cycle developer checklist as part of the planning application process and to submit a completed version with their planning applications. The Environment Agency is a statutory consultee with regards to flood risk and the water environment and as such, will need to sign up to the checklist as will the partner authorities, Natural England and the water and wastewater undertaker. The checklist provided in this Stage 2b WCS has been developed from examples used in previous WCS as well as the Environment Agency's national standard checklist available on their website. The checklist refers to different levels of policy to make it clearer to the developer as to which are driven by mandatory national policy, which are driven by Environment Agency requirements and which are driven by local policy.

8.3.3 The Detailed Study checklist has been provided as a 'working document' which should be revised as development scenarios and housing numbers are updated. More relevant site specific details

can then be included to make it a document which can be used as part of the planning process for developers once Area Action Plans or other LDDs are being developed.

8.3.4 The checklist is provided in Appendix C: Developer Checklist.

8.4 Further Work Suggestions

8.4.1 It is recommended that the Stage 2b Water Cycle Study remains a live document and its recommendations and findings are reviewed and reassessed as updates are made to key inputs and legislation such as the WFD, the Habitats Directive RoC process and AWS's final Water Resources Management Plan (WRMP).

8.4.2 A timeline of when the WCS may have to be updated in line with the changes in legislation and drivers is included in Appendix J: Timeline of likely WCS changes.

8.4.3 A more detailed technical SIMCAT (or other catchment model) assessment of the P consent requirements is recommended as a collaboration between the Environment Agency and AWS to determine most suitable limits on P discharge at each WwTWs. This should be aligned with modelling future improvements in catchment (diffuse) sources as a result of implementation of the POMs as to be recommended in the final RBMPs.

9 References

AWS (2005) 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 (2007). Groundwater Protection: Policy and Practice. Part 4: Legislation and policies – pre-consultation draft

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

Environment Agency (2008). Draft 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 2005/06 report.

10 Appendices

Appendix A: Figures

Figure 1: Wastewater Strategy for all PGAs

Figure 2: PGA locations and target Number of dwellings per PGA

Figure 3: WwTW in relation to watercourses and environmental designations

Figure 4: Stage 2b WCS methodology

Figure 5 Source Protection zone map for GNDP Study Area

Appendix B: Wastewater Capacity Calculations

Wastewater Treatment Works capacity calculation assumptions:

- 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[25] 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[26] (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.

[25] 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.
[26] Flow to Full Treatment (FtFT) is the maximum rate of flow that can be treated at a WwTW.

Wastewater Treatment Works capacity calculations:

Appendix C: Developer Checklist

Key	
	Water Cycle Strategy Recommended Policy
	Environment Agency and Natural England Policy and Recommendations
	Local Policy
	National Policy or Legislation

	Flood Risk Assessment requirement checklist		Policy or Legislation
1	Is the Development within Flood Zones 2 or 3 as defined by the flood zone mapping in the SFRA?	Y - go to 5 N - go to 2	PPS25
2	Development is within Flood Zone 1: Site larger than 1 Ha? Site smaller than 1 Ha?	 go to 5 go to 3	
3	Is the development residential with 10 or more dwellings or is the site between 0.5Ha and 1Ha?	Y - go to 6 N - go to 4	
4	Is the development non-residential where new floor space is 1,000m2 or the site is 1 Ha or more	Y - go to 6 N - go to 7	
5	The development constitutes major development and requires a Flood Risk Assessment (in accordance with PPS25 and the relevant SFRA) and the Environment Agency are required to be consulted.	Go to 8	
6	The development constitutes major development and is likely to require a Flood Risk Assessment (in accordance with PPS25 and the relevant SFRA) but the Environment Agency may not be required to be consulted.	Go to 8	
7	An FRA is unlikely to be required for this development, although a check should be made against the SFRA and with the LPA to ensure that there is no requirement for a FRA on the grounds of critical drainage issues. Does the SFRA or does the LPA consider a Flood Risk Assessment (FRA) is required?	Y – go to 8 N – go to 9	
8	Has an FRA been produced in accordance with PPS25 and the relevant SFRA?	Y/N or N/A	
	Surface water runoff		**Policy or Legislation**
9	A) What was the previous use of the site? B) What was the extent of impermeable areas both before and after development?	% before % after	Environment Agency Requirement for FRA.

10	If development is on a Greenfield site, have you provided evidence that post development run-off will not be increased above the Greenfield runoff rates and volumes using SUDS attenuation features where feasible (see also 18 onwards). If development is on a brownfield site, have you provided evidence that the post development run-off rate has not been increased, and as far as practical, will be decreased below existing site runoff rates using SUDS attenuation features where feasible (see also 17 onwards).	Y/N or N/A Y/N or N/A	PPS25
11	Is the discharged water only surface water (e.g. not foul or from highways)? If no, has a discharge consent been applied for?	Y/N Y/N	Water Resources Act 1991
12	A) Does your site increase run-off to other sites? B) Which method to calculate run-off have you used?	Y/N	PPS 25
12	Have you confirmed that any surface water storage measures are designed for varying rainfall events, up to and including, a 1 in 100 year + climate change event (see PPS25 Annex B, table B.2)?	Y/N	PPS25
13	For rainfall events greater than the 1 in 100 year + climate change, have you considered the layout of the development to ensure that there are suitable routes for conveyance of surface flows that exceed the drainage design?	Y/N	PPS25 Guidance Notes
14	Have you provided layout plans, cross section details and long section drawings of attenuation measures, where applicable?	Y/N	
15	If you are proposing to work within 8 m of a watercourse have you applied, and received Flood Defence Consent from the Environment Agency?	Y/N or N/A	Water Resources Act 1991 Land Drainage Act 1991
16	The number of outfalls from the site should be minimised. Any new or replacement outfall designs should adhere to standard guidance form SD13, available from the local area Environment Agency office. Has the guidance been followed?	Y/N	Guidance Driven by the Water Resources Act 1991
	Sustainable Drainage Systems (SUDS)		**Policy or Legislation**
17	A) Has the SUDS hierarchy been considered during the design of the attenuation and site drainage? Provide evidence for reasons why SUDS near the top of the hierarchy have been disregarded. B) Have you provided detail of any SUDS proposed with supporting information, for example, calculations for sizing of features, ground investigation results and soakage tests? See CIRIA guidance for more information. http://www.ciria.org.uk/suds/697.htm	Y/N	PPS25 Guidance
18	A) Are Infiltration SUDS to be promoted as part of the development? If Yes, the base of the system should be set at least 1m above the groundwater level and the depth of the unsaturated soil zones between the base of the SUDS and the groundwater should be maximised. B) If Yes – has Infiltration testing been undertaken to confirm the effective drainage rate of the SUDS?	Y/N Y/N	
19	A) Are there proposals to discharge clean roof water direct to ground (aquifer strata)? B) If Yes, have all water down-pipes been sealed against pollutants entering the system form surface runoff or other forms of discharge?	Y/N Y/N	

20	Is the development area above a Source Protection Zone (SPZ)?	If Y go to 22 If N go to 23	Groundwater Regulations 1998
21	A) Is the development area above an inner zone (SPZ1)? B) If yes, discharge of Infiltration of runoff from car parks, roads and public amenity areas is likely to be restricted – has there been discussion with the Environment Agency as to suitability of proposed infiltration SUDS?	Y/N Y/N	Groundwater Regulations 1998
22	A) For infill development, has the previous use of the land been considered? B) Is there the possibility of contamination? C) If yes, infiltration SUDS may not be appropriate and remediation required to be undertaken. A groundwater Risk Assessment is likely to be required (Under PPS23) Has this been undertaken before the drainage design is considered in detail?	Y/N Y/N Y/N	PPS23
23	Have oil separators been designed into the highway and car parking drainage? PPG23: http://publications.environment-agency.gov.uk/pdf/PMHO0406BIYL-e-e.pdf	Y/N	PPG23
24	Have you confirmed whether the proposed SUDS are to be adopted as part of public open space, or by a wastewater undertaker and provide supporting evidence? Alternatively, have you provide details of the maintenance contributions to be provided over the life of the development.	Y/N Y/N	
25	Have you provided details of any proposed measures to encourage public awareness of SUDS and increase community participation?	Y/N	
	Water Consumption		**Policy or Legislation**
26	A) Have you provided the expected level of water consumption and hence the level to be attained in the Code for Sustainable Homes http://www.planningportal.gov.uk/england/professionals/en/1115314116927.html B) Have you considered whether the development can achieve a water consumption lower than 120 l/h/d (105 l/h/d for Levels 3 & 4 in the Code for Sustainable Homes, 80l/h/d as required for Levels 5 & 6)	Y/N	
27	Is the proposed development likely to achieve a water consumption of between 120 l/h/d and 135 l/h/d as consistent with the latest Defra strategy? http://www.defra.gov.uk/environment/water/strategy/pdf/future-water.pdf	Y/N	
28	Have you Provided details of water efficiency methods to be installed in houses?	Y/N	
29	Have you confirmed whether the development will utilise rainwater harvesting (minimum tank size 2.5m3 per house, see http://www.environment-agency.gov.uk/subjects/waterres/286587/286911/548861/861599/?lang=_e	Y/N	
30	Has a practicable alternative strategy been included for the supply of water for fire fighting?	Y/N	
31	Have you confirmed whether grey water recycling is to be utilised and provided details?	Y/N	

32	Have you provided details of any proposed measures to increase public awareness and community participation in water efficiency?	Y/N	
	Pollution prevention		**Policy or Legislation**
33	Have you provided details of construction phase works method statement, outlining pollution control and waste management measures? See PPG2, PPG5, PPG6, PPG21(http://www.environment-agency.gov.uk/business/444251/444731/ppg/?version=1&lang=_e) and DTI Site Waste Management Plan, (SWMP, http://www.constructingexcellence.org.uk/resources/publications/view.jsp?id=2568)	Y/N	PPG2, PPG5, PPG6, PPG21
34	A) Have you provided details of pollution prevention measures for the life of the development, such as oil and silt interceptors? B) Have you considered whether permeable pavement areas are protected from siltation? C) Have you provided details of maintenance – as with the SUDS?	Y/N Y/N Y/N	
	Water Supply and Sewage Treatment		**Policy or Legislation**
35	Have you provided evidence to confirm that water supply capacity is available, and that demand can be met in accordance with the Greater Norwich Water Cycle Strategy?	Y/N	
36	Have you provided evidence to confirm that sewerage and wastewater treatment capacity is available, and that demand can be met in accordance with the Greater Norwich Water Cycle Strategy?	Y/N	
	Conservation / Enhancement of Ecological Interest		**Policy or Legislation**
37	Have you confirmed that any green infrastructure, such as the surface water system, links to the neighbouring green infrastructure (River Corridors) to assist the creation and maintenance of green corridors?	Y/N	Green Infrastructure Study
38	Have you confirmed that at least 25% of flood attenuation ponds/wetlands will be designed for multifunctional uses, such as providing access, footpaths, cycleways, recreational uses, and submit outline details as suggested under Natural England guidelines?	Y/N	
39	A) Have you shown the impacts your development may have on the water environment? B) Is there the potential for beneficial impacts?	Y/N Y/N	Town and Country Planning Regulations 1999
40	Have you confirmed all ponds within 500m of the site boundary have been surveyed for presence of great-crested newt populations?	Y/N	Habitats Directive

Further information can be found in the Environment Agency's guide for developers:
http://www.environment-agency.gov.uk/business/444304/502508/1506471

Appendix D: Stage 3 RoC Detailed Findings

Water Quality Sensitivities - Wensum

10.1.1 further information as on water quality sensitivities have been obtained regarding the interest features of the SAC and have been listed in Appendix

Bullhead[27]

10.1.2 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[28]

10.1.3 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

10.1.4 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).

10.1.5 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.

10.1.6 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

10.1.7 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

[27] Ecology of the Bullhead Conserving Natura 2000 Rivers Ecology Series No. 4 Mark L Tomlinson and Martin R Perrow
[28] 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

10.1.8 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

10.1.9 No specific additional data

Watercourses characterised by Ranunculion fluitantis and Callitricho-Batrachion

10.1.10 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.

10.1.11 No specific additional water quality data is available

River Wensum SAC – Stage 3 summary

10.1.12 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.

10.1.13 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.

10.1.14 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

10.1.15 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 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 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 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.

10.1.16 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

10.1.17 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

10.1.18 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.

10.1.19 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

10.1.20 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.

10.1.21 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 D: Stage 3 RoC Detailed Findings..

River Wensum Summary

10.1.22 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

10.1.23 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)

10.1.24 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

10.1.25 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

10.1.26 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.

10.1.27 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.

10.1.28 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%.

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

10.1.30 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

10.1.31 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

10.1.32 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.

10.1.33 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.

10.1.34 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

10.1.35 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

10.1.36 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.

10.1.37 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*.

10.1.38 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'

10.1.39 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.

10.1.40 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

10.1.41 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.

10.1.42 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').

10.1.43 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.

10.1.44 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.

10.1.45 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

10.1.46 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

10.1.47 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.

10.1.48 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

10.1.49 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[29]. *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

10.1.50 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[30].

Bullhead[31]

10.1.51 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}).

10.1.52 Gubbels (1997)[32] 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)[33] recorded individuals in flow >40 cm s^{-1}, whereas Strevens (unpubl. Data as

[29] 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
[30] Holdich D (2003). Ecology of the White-clawed Crayfish. Conserving Natura 2000 Rivers Ecology Series No. 1. English Nature, Peterborough
[31] Tomlinson ML & Perrow MR (2003). Ecology of the Bullhead. Conserving Natura 2000 Rivers Ecology Series No. 4. English Nature, Peterborough
[32] Gubbels REMB (1997). Preferred hiding places of the bullhead (*Cottus gobio* L., 1758) in the Zieversbeek brook. Natuurhistorisch Maandblad 86, 201–206.
[33] 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}.

10.1.53 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[34]

10.1.54 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

10.1.55 Schroll (1959)[35] 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)[36], which agrees with Hjulstrom (1935)[37], who found that the deposition of sand and silt occurs only at velocities less than 7 cm s^{-1}.

Adults

10.1.56 At two spawning sites in Czechoslovakia, Lohnisky (1966)[38] 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)[39] note velocities of 30–50 cm s^{-1}.

10.1.57 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

10.1.58 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

[34] Maitland PS (2003). Ecology of the River, Brook and Sea Lamprey. Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough
[35] Schroll F (1959). Zur Ernahrungsbiologie der steirischen Ammocoten Lampetra planeri (Bloch) und Eudontomyzon danfordi (Regan). Int. Rev. ges. Hydrobiol. Hydrogr. 44, 395–429
[36] Hardisty MW (1986). Petromyzontiforma. In: Holcik J (ed). The freshwater fishes of Europe. Aula-Verlag,Wiesbaden
[37] 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
[38] Lohnisky K (1966).The spawning behaviour of the brook lamprey, *Lampetra planeri* (Bloch, 1784). Vestnik Ceskoslovenske Spolecnosti Zoologiocke 4, 289–307.
[39] 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.

10.1.59 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)[40].

10.1.60 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[41].

10.1.61 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

[40] 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.
[41] Killeen IJ (2003). Ecology of Desmoulin's Whorl Snail. Conserving Natura 2000 Rivers Ecology Series No. 6. English Nature, Peterborough

Appendix E: SUDS Types

Soakaways

10.1.62 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). Their use is generally subject to full infiltration testing.

10.1.63 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.

Swales

10.1.64 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.

10.1.65 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

10.1.66 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 the sewer system at an agreed restricted rate, using a hydrobrake or similar.

10.1.67 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.

10.1.68 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

10.1.69 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.

10.1.70 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

10.1.71 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.

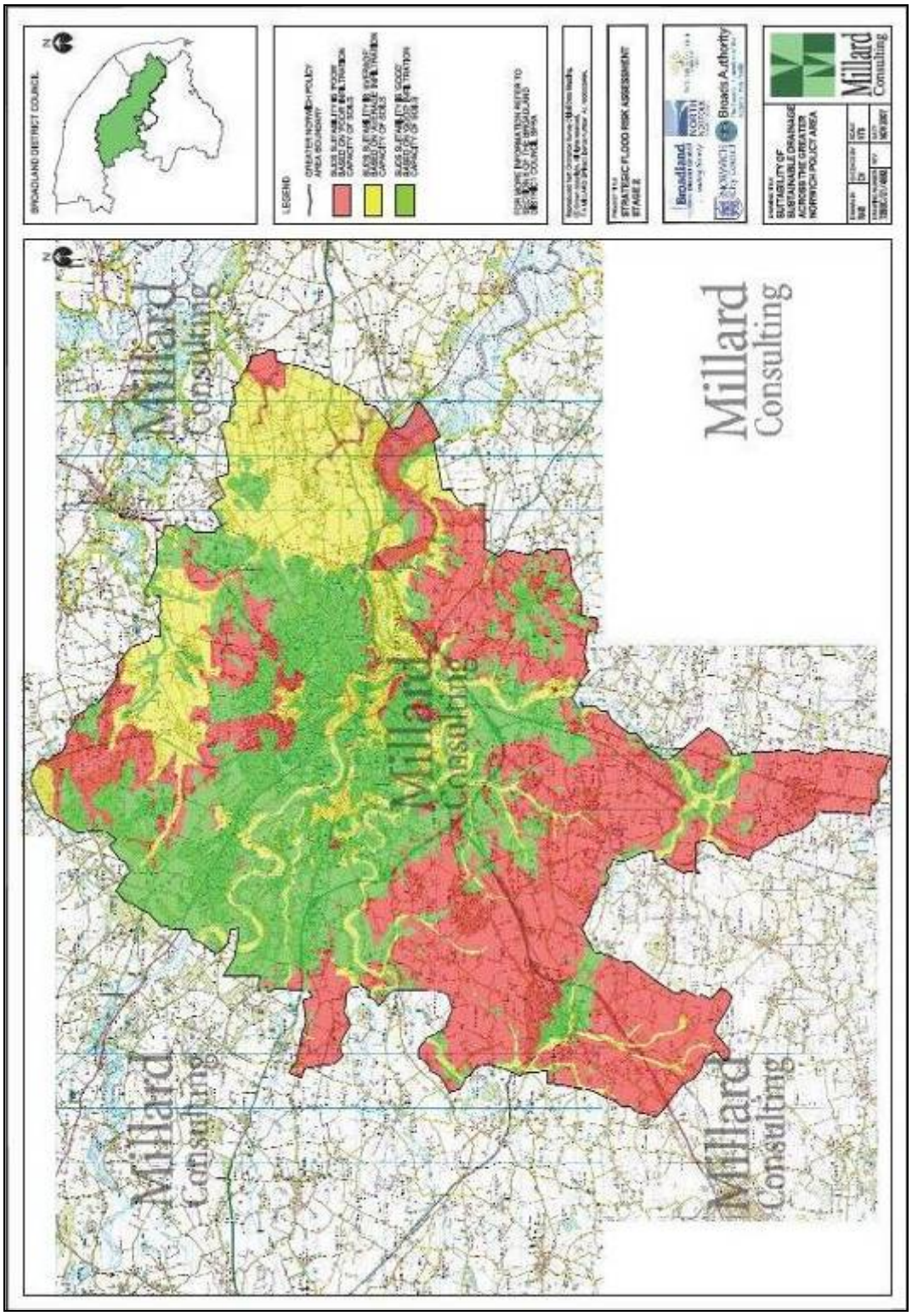
10.1.72 Rainwater harvesting systems can be installed in both new and existing buildings, and the harvested water used for purposes that do not require drinking water quality. Rainwater harvesting has the potential to save a large volume of mains water and therefore help reduce the pressure on water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

Other Methods

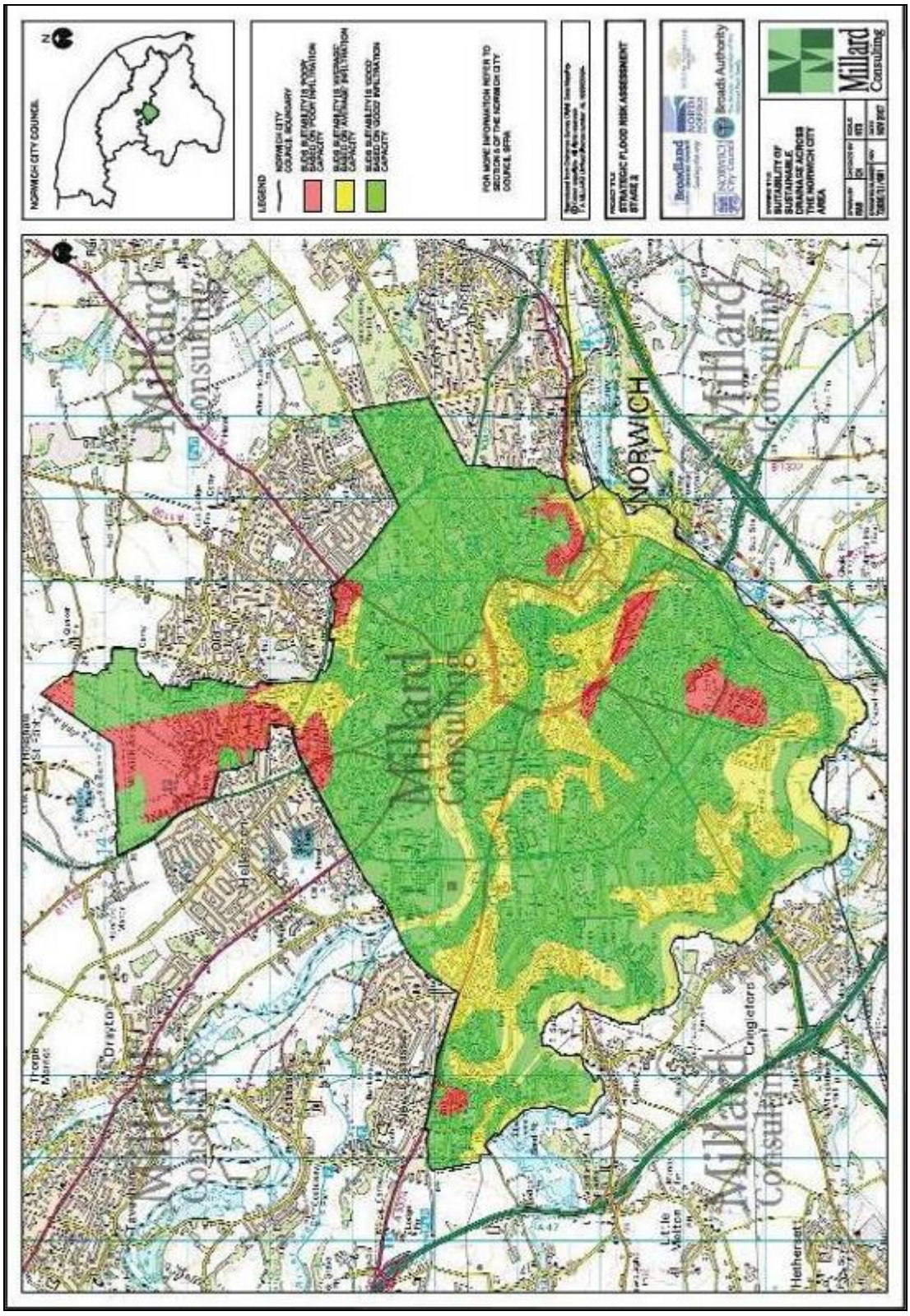
10.1.73 Other typical SUDS methods include techniques such as Greenroofs, wetlands, filter drains and filter strips. They are potentially viable options for the proposed site and can have wider sustainability benefits. However they do not generally constitute a significant volumetric input into attenuation

Appendix F: Suitability of SUDS (from Level 1 SFRA)

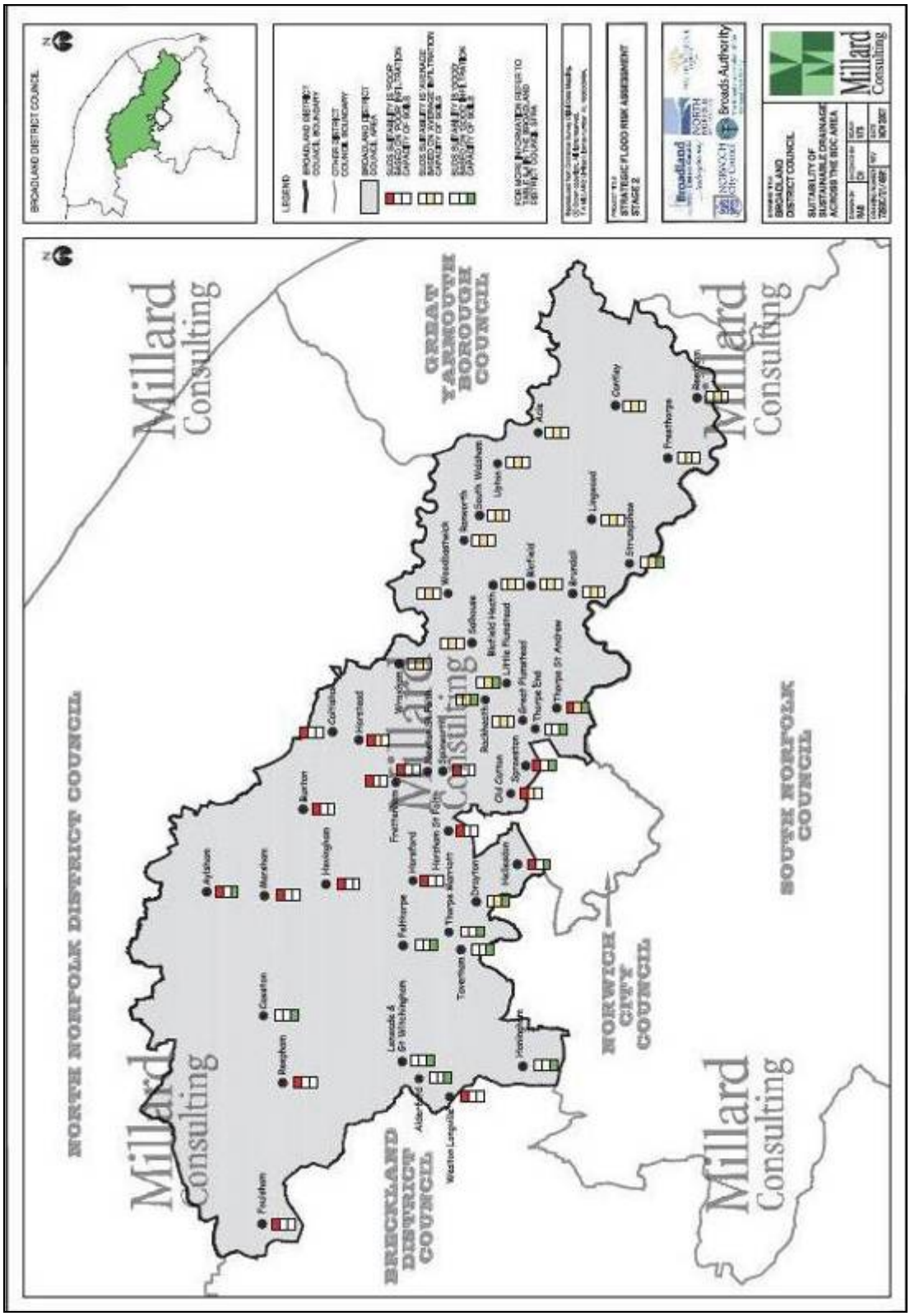
Greater Norwich



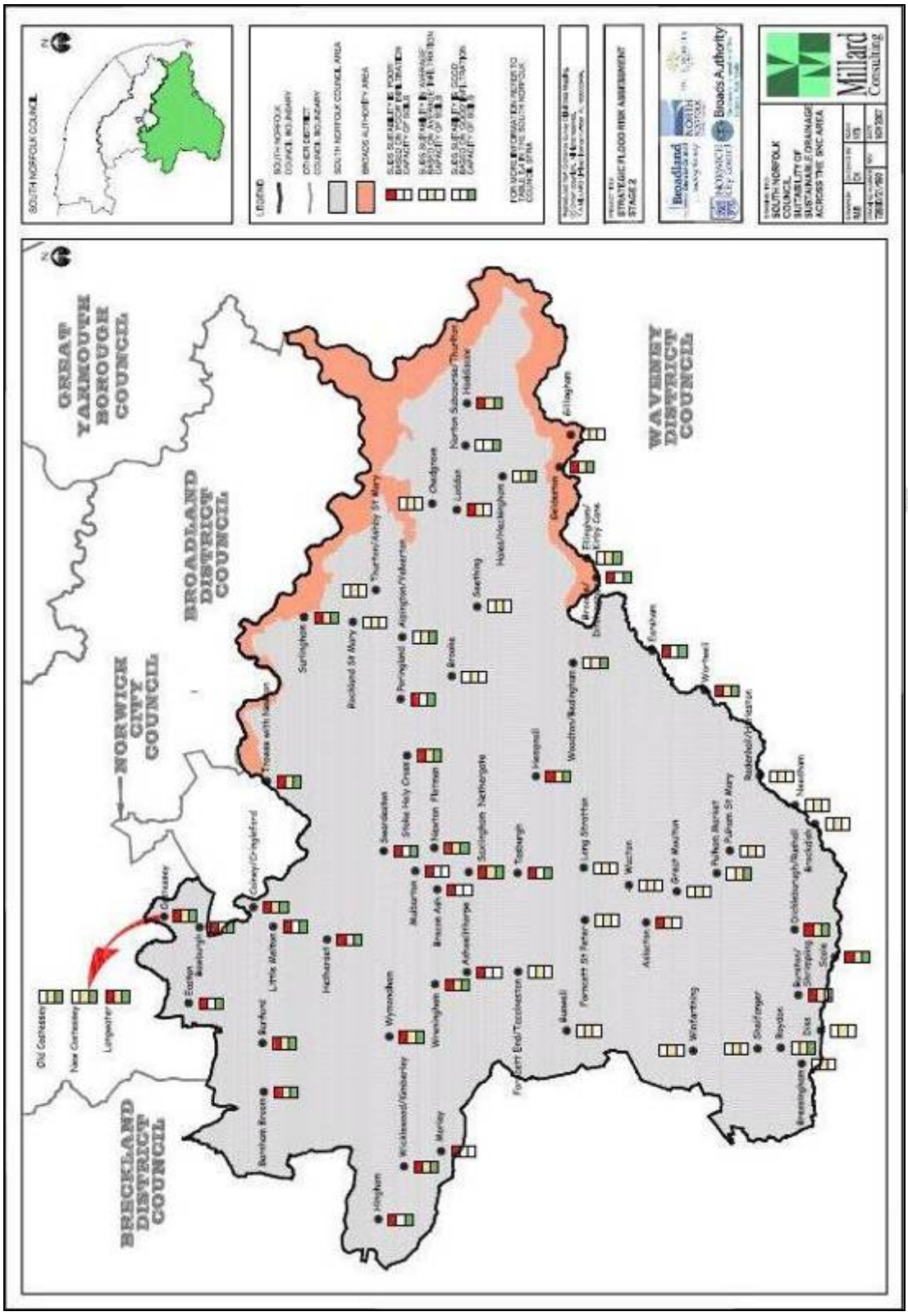
Norwich City Council



Broadlands District Council



South Norfolk Council



Appendix G: Water Framework Directive Detail

WFD - Introduction

10.1.74 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.

10.1.75 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.

10.1.76 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.

10.1.77 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.

10.1.78 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

10.1.79 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)

10.1.80 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.

10.1.81 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.

10.1.82 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%.

10.1.83 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

10.1.84 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.

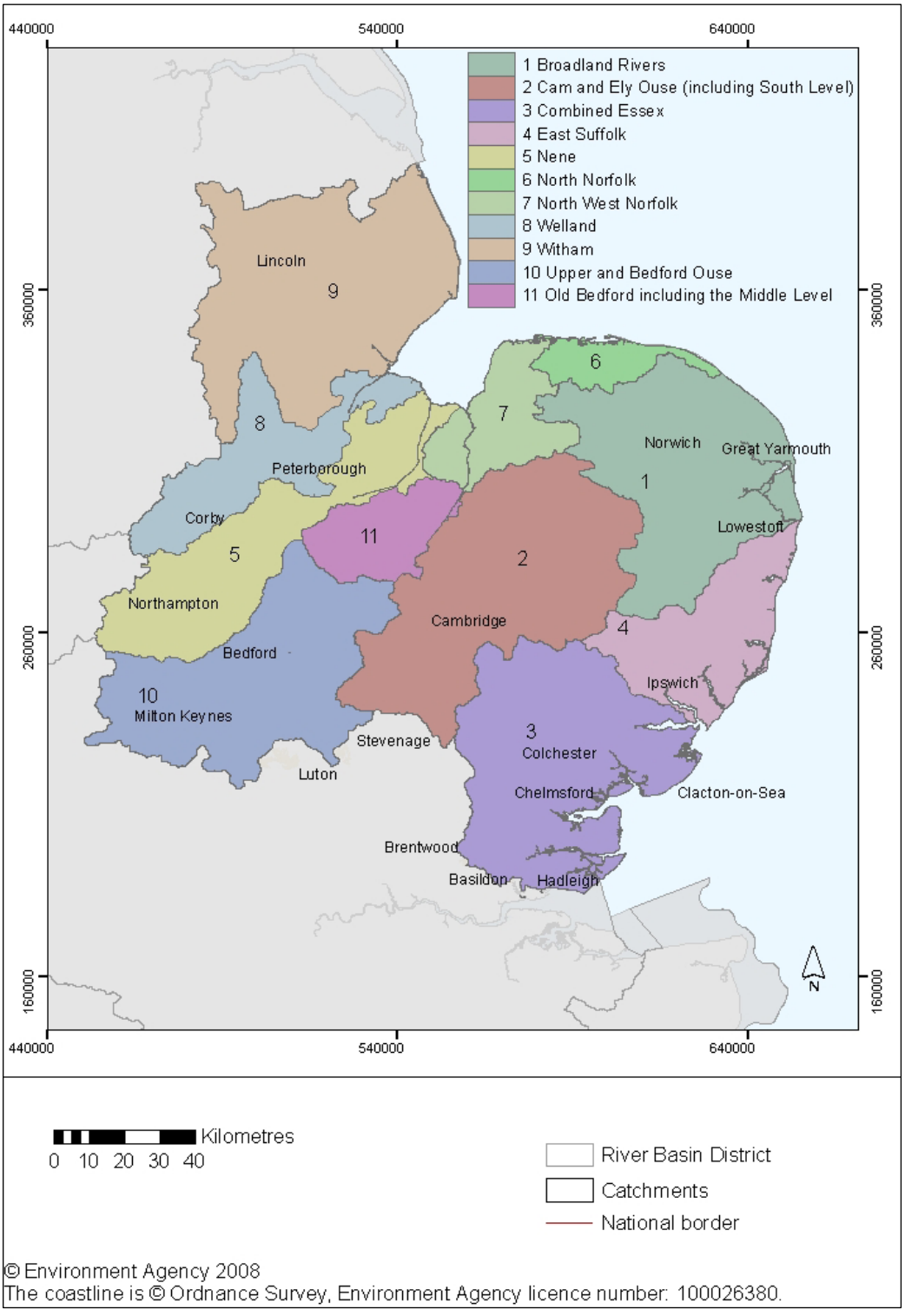
10.1.85 The River Basin District is the richest region in the UK for wetland wildlife. There are several protected areas within the Anglian River Basin District which have been established under European legislation and include the Broadlands Executive Area and several other Areas of Conservation (SAC) 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.

10.1.86 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.

10.1.87 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.

10.1.88 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



10.1.89 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.

10.1.90 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.

10.1.91 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

10.1.92 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.

10.1.93 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 alkalinity42	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

10.1.94 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.

10.1.95 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

10.1.96 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

[42] 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[43] (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

10.1.97 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.

10.1.98 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.

10.1.99 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%.

10.1.100 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.

[43] 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

10.1.101 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

10.1.102 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.

10.1.103 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).

10.1.104 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 H: WwTW Quality Consent Calculations

RQP Modelling Parameters

Cells highlighted where no upstream monitoring information was provided and/or current upstream quality is poor and therefore either high (coloured blue) or good (coloured green) midclass estimates based on the proposed WFD standards have been used.

WwTW	Receiving Watercourse	Upstream River Flow		Upstream Water Quality				WwTW Future Flow		Current WwTW Consent		Downstream Water Quality Objective		Future WwTW Consent (mg/l)
		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	
ACLE-DAMGATE LANE	RIVER BURE	8.8	3.2	BOD	1.79	1.08	3.10	1.046	0.314	29	95	4	90	13.5
				Ammonia	0.07	0.04	0.13			13	95	0.3	90	1.7
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.4
AYLSHAM	RIVER BURE	110.4	51.1	BOD	1.33	0.60	1.85	1.714	0.514	40	95	4	90	134
				Ammonia	0.041	0.019	0.058			5	95	0.3	90	14.3
				P	0.047	0.023	-			-	Mean	0.05	Mean	0.2
BELAUGH	RIVER BURE	228.2	96.9	BOD	1.20	0.28	1.60	2.816	0.845	30	95	4	90	185
				Ammonia	0.045	0.021	0.073			10	95	0.3	90	17
				P	0.034	0.014	-			-	Mean	0.05	Mean	1.2
DISS	RIVER WAVENEY	19.1	3.1	BOD	1.12	0.29	1.31	2.204	0.661	12	95	4	90	15
				Ammonia	0.132	0.062	0.206			5	95	0.3	90	0.9
				P	0.032	0.022	0.032			2	Mean	0.12	Mean	0.6
HARLESTON	RIVER WAVENEY	19.5	2.8	BOD	1.88	1.42	3.25	1.150	0.345	17	95	4	90	10.5
				Ammonia	0.102	0.131	0.167			5	95	0.3	90	1.1
				P	0.085	0.085	-			2	Mean	0.12	Mean	0.4
LONG STRATTON	HEMPNALL BECK	2.6	0.5	BOD	1.26	0.42	1.50	1.724	0.517	20	95	4	90	7
				Ammonia	0.055	0.042	0.081			16	95	0.3	90	0.6

				P	0.085	0.085	-			-	Mean	0.12	Mean	0.15
PORINGLAND	RIVER CHET	3.6	0.8	BOD	1.79	1.08	3.10	1.145	0.344	18	95	4	90	7.5
				Ammonia	0.25	0.15	0.43			-	95	0.6	90	1.2
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2
RACKHEATH	Deployable OutputBBS BECK, TRIB OF RIVER BURE	12.4	4.3	BOD	1.79	1.08	3.10	0.370	0.111	11	95	4	90	37.1
				Ammonia	0.25	0.15	0.43			3	95	0.6	90	6.5
				P	0.085	0.085	-			-	Mean	0.12	Mean	1.0
REEPHAM	BLACKWATER DRAIN, TRIB OF RIVER WENSUM	0.5	0.1	BOD	1.79	1.08	3.10	1.230	0.369	30	95	4	90	5.1
				Ammonia	0.25	0.15	0.43			10	95	0.6	90	0.8
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.1
SISLAND	TRIB OF RIVER CHET	16.0	3.4	BOD	2.21	0.23	2.85	1.340	0.402	20	95	4	90	15.5
				Ammonia	0.246	0.028	0.48			5	95	0.6	90	2.9
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.4
STOKE HOLY CROSS	RIVER TAS	83.8	15.7	BOD	1.32	0.60	1.51	0.581	0.174	50	95	4	90	160.5
				Ammonia	0.093	0.056	0.161			-	95	0.3	90	11.8
				P	0.085	0.085	-			-	Mean	0.12	Mean	3
SWARDESTON-COMMON	INTWOOD STREAM, TRIB OF RIVER YARE	4.4	0.8	BOD	1.79	1.08	3.10	1.344	0.403	15	95	4	90	7
				Ammonia	0.07	0.04	0.13			5	95	0.3	90	0.7
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2
WHITLINGHAM TROWSE	RIVER YARE	616.6	145.6	BOD	1.73	1.16	2.88	83.271	24.981	20	95	4	90	10.5
				Ammonia	0.120	0.173	0.231			7	95	0.3	90	0.7
				P	0.085	0.085	-			1	Mean	0.12	Mean	0.3
WYMONDHAM	RIVER TIFFEY	26.4	4.4	BOD	1.42	0.83	2.06	4.851	1.455	12	95	4	90	10
				Ammonia	0.073	0.128	0.129			4	95	0.6	90	1.9
				P	0.085	0.085	-			-	Mean	0.12	Mean	0.2

Appendix I: Water Demand Calculations Detail

Residential Water Demands in the GNDP study area[44]

Development Areas	PGA	Authority Control	Granted Permissions	Growth Numbers in 'Favoured' option	Total Nos. dwellings up to 2026	Water Company forecast	Water Company forecast	Code for sustainable homes rating 1/2 120 l/h/d	Code for sustainable homes rating 3/4 105 l/h/d	Code for sustainable homes rating 5/6 80 l/h/d	Range of Estimates Min (Col 11)	Range of Estimates Max (Col 7)	Including an allowance for headroom (Col 11)	Including an allowance for headroom (Col 7)
						Scenario 1a	Scenario 1b	Scenario 2	Scenario 3	Scenario 4	Scenario 4	Scenario 1	Scenario 4	Scenario 1
						(Ml/d)*1	(Ml/d)*2	(Ml/d)*3	(Ml/d)*4	(Ml/d)*5	(Ml/d)	(Ml/d)	(Ml/d)*6	(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

[44] 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 J: Timeline of likely WCS changes

As documented throughout the Stage 2b WCS, several key sources of information from statutory processes have not been made available in time to inform the study within the timeframe permitted by the GNDP Joint Core Strategy publication. Because there are several key water resource elements to the unavailable information the agreement of the GNWCS steering group is therefore that the WCS remains a live document and is reviewed if and when all the information is made available. A best estimate of when the information should be made available and hence used in a review of the GNWCS is presented in table J1 below.

Table J1: Suggested Review dates for the WCS pertaining to key uncompleted inputs

Document	Reason not available	Key relevance to the GNWCS	Likely date of availability
AWS final Water Resources Management Plan	Defra has asked (August 2009) for AWS to submit further information to allow the SoS to agree to finalisation of the plan. It is not known what further information has been requested but it is likely that the potential sustainability reduction at Costessey is one of the key issues	The proposed water resources strategy for supplying additional homes cannot be known until the plan is finalised. The water resources strategy proposed in this Stage 2b report will need to be revisited	October 2009
Stage 4 RoC – Site Action Plans and decision on sustainability reduction	RoC process not due to finish until 2010	Full information on the extent of the sustainability reduction at the Costessey surface water abstraction point is not known. This will alter the current water resource availability in the study area and hence the water resources strategy proposed in this Stage 2b report will need to be revisited	Mid 2010
Final WFD RBMP	The draft RBMPs have been subject to consultation during production of the WCS – draft plans to be altered according to consultation responses and finalised at the end of 2009.	Final classifications of waterbody status, programme of measures and standards will be released. May affect assessment oof impact of wastewater discharges and hence wastewater strategy	January 2010

Appendix K: 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 L: The Periodic Review and AMP process

Water companies currently plan for Asset Management and the financial procurement required for this through the Asset Management Plan (AMP) process which runs in 5 year cycles. The Office of Water Services (Ofwat) is the economic regulator of the water and sewerage industry in England and Wales, and regulates this overall process.

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

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

The outcome is a Business Plan which is produced periodically, every five years, by each Water Company setting out the required asset investment over the next five year period, the justification for it and the price increases required to fund it.

Overall, the determination of how much a Water Company can charge its customers is undertaken by Ofwat. Ofwat will consider the views of the Water Company, the other regulators (Environment Agency, DWI), current strategic government direction and consumer groups such as the Consumer Council for Water when determining the price limits it will allow a water Company to set in order to enable future asset investment. This process is known as the Price Review (PR) and is undertaken in 5 year cycles. When Ofwat make a determination on a Water Company's business plan, the price limits are set for the proceeding five year period allowing the water company to raise the funds required to undertake the necessary investment which will also be undertaken in that 5 year planning period (the AMP period).

At the time of undertaking the Stage 2b GNWCS, Water Companies have submitted their final draft Strategic Business Plans which seek funding for asset investment for the 5 year period covering 2010 – 2015 (known as AMP5). Ofwat have returned their 'draft determination' of price limits to be set allowing each water company to return with a revised bid for further funds prior to 'final determination' at the end of 2009.

Appendix M: Network Assessment Summary

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