Breckland Council

Thetford Water Cycle Study

Stage 1 – Outline study

Final Report
May 2008

Prepared for:

Breckland Council

Revision Schedule

Thetford Water Cycle Study
May 2008

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01	20.02.2008	Draft Interim Report	**Carl Pelling** Senior Consultant - Water		
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Executive Summary

Study Purpose

This Outline, Stage 1 Water Cycle Study has assessed the impact of proposed growth targets for Thetford (as set out in the RSS) on the water cycle infrastructure and water environment of the Thetford study area. This has been undertaken for the approximate total of 6,000 new homes up to 2021 and a projected total target of 9,000 homes by 2031.

It has been developed to inform and provide an evidence base to the initial stages of the production of Breckland Council's Local Development Framework. It is also required to provide:

- justification for the planning of new infrastructure in Anglian Water Service's strategic business planning; and
- to provide the Environment Agency and Natural England with a strategic study that identifies and suggests mitigation for potential water environment impacts (including flood risk) such that sustainable development is proposed in Thetford and that objections to develop in Thetford are minimised.

The Outline Thetford WCS has identified the existing capacity of the current water environment and water cycle infrastructure and has used this assessment to determine where additional investment is required to supply new infrastructure or to protect the water environment. Where new infrastructure is required, this has been identified with a recommendation for phasing and timing of investment.

Wastewater Discharge Capacity

Development to 2021

It is considered that there is sufficient water quality capacity in the receiving watercourse for additional wastewater discharge for development up to 2021 and hence, Thetford will not require significant investment in treatment processes at the existing Sewage Treatment Works (STW) for growth in this period (subject to verification in Stage 2).

Development to 2031

Beyond 2021, the majority of the projected growth up to 2031 will require investment in process capacity at the STW such that the additional wastewater discharge is treated to a better quality, particularly in respect to ammoniacal Nitrogen both for current statutory water quality standards, but also for future proposed Water Framework Directive (WFD) standards. It is considered that the improvements required are not beyond the capability of Best Available Technology (BAT) such that water quality capacity of the receiving watercourse (in terms of existing standards and legislation) is sufficient for growth up to 2031.

With respect to the WFD, there is likely to be a requirement to reduce Phosphorus (P) concentrations discharged from Thetford STW for the additional wastewater, but also from the existing discharge. This will require a catchment focused study on how to reduce in-stream P concentrations in the Little Ouse which are already failing expected P standards under the WFD.

The assessment of hydraulic capacity has shown that there will be a negligible impact on peak flood flows from the discharge of additional wastewater, and that for the bankfull limit flow, the increase in water level

is likely to have a negligible impact on flood levels. It is considered that there is sufficient hydraulic capacity in the Little Ouse to accept the increase in flow from Thetford STW.

Ecology and Water Environment

The Habitats Regulation assessment has not identified any hydrologically linked conservation sites as being adversely affected by the proposed development in Thetford due to the likely increase in P load and discharge volumes. However, there is a potential for impact to the Thetford Golf Course SSSI and a component part of the Breckland SAC as a result of abstraction from Two Mile Bottom PWS and hence, this will need to be further investigated in Stage 2.

Wastewater Treatment and Wastewater Network Capacity

Development to 2021

There is generally sufficient capacity to accommodate growth up to 2021 in terms of wastewater treatment.

Some strategic scale investment will be required from 2010 onwards in terms of wastewater network infrastructure in order to service the new development, but there is capacity in the existing wastewater network to allow development to occur with site specific connections up to approximately a 1000 homes (estimated to take place between 2008 and 2010).

Development to 2031

Development for the projected development up to 2031 will require additional wastewater treatment and the outline study has identified an upgrade to the existing Thetford STW as the most likely option for delivery of the additional treatment capacity.

Waster Resources and Supply Capacity

Development to 2021

It is concluded that there is sufficient capacity in the existing abstraction licences feeding Thetford to accommodate growth in the short to medium term up to 2021. In addition, development in this period is unlikely to require strategic level investment in the water supply network and it should be able to connect to all proposed development areas via the existing strategic mains; site specific connections will still be required

Development to 2031

Growth up to 2031 will require investment in potential groundwater recharge schemes supplemented with cross-catchment transfer of raw water in the longer term. Sensitivity testing has shown that aspirations to meet lower water consumption targets for new homes could reduce the demand for water and hence reduce reliance on transfer of raw water into the area from cross-catchment in the longer term.

There is likely to be the requirement to undertake reinforcement and upgrades of the strategic mains in order to facilitate development up to 2031.

Development Scenario Options

A comparative assessment has been undertaken of the five potential development scenarios to demonstrate how development could take place within the potential growth areas. In general, there is little difference between the five scenarios assessed; however it is possible to make some broad statements on preferences between the scenarios. It is generally considered that Scenario B "Key Site North developed to maximum (2010 to 2021) before development of Key Site South East commences (2021 – 2031)" is the best option in terms of the water cycle. However, for the three key scenarios, the wastewater treatment capacity, water supply, water resources and water environment considerations are similar and hence in phasing terms, there is no significant difference.

Glossary

Abbreviation	Description
AMP	Asset Management Plan
AWS	Anglian Water Services
BAT	Best Available Technology
BC	Barnham Cross (abstraction point)
BDC	Breckland Council
BOD	Biochemical Oxygen Demand
CAMS	Catchment Abstraction Management Strategy
CAPEX	Capital Expenditure
CFMP	Catchment Flood Management Plan
CLG	(Department for) Communities and Local Government
CSH	Code for Sustainable Homes
CSO	Combined Sewer Overflow
CWC	Cambridge Water Company
DEFRA	Department for Environment, Food and Rural Affairs
DO	Dissolved Oxygen
DWF	Dry Weather Flow
DWI	Drinking Water Inspectorate
EA	Environment Agency
FEH	Flood Estimation Handbook
FtFT	Flow to Full Treatment
TGFIS	Thetford Growth Framework and Infrastructure Study
GI	(Thetford) Green Infrastructure Study
GQA	General Quality Assessment
GW	Ground Water
HPPE	High Performance Poly Ethylene (pipe)
JCS	Joint Core Strategy
KCDC	Key Centre for Development and Change
l/h/d	Litres/head/day (water consumption measurement)
LDDs	Local Development Documents
LDF	Local Development Framework
LPA	Local Planning Authority
LIDAR	Light Detection and Ranging
MBR	Membrane Bioreactor
Ml	Mega Litre (a million litres)
NGP	New Growth Point
NCC	Norfolk County Council
NE	Natural England
NL	Nunnery Lodge

Abbreviation	Description
NRA	National Rivers Authority
NWA	No Water Available (in relation to CAMS)
NVZ	Nitrate Vulnerable Zone
OBH	Observation Borehole
OFWAT	The Office of Water Services
OPEX	Operating Expenditure
O-L	Over Licensed (in relation to CAMS)
P	Phosphorous
PE	Population Equivalent
PPS	Planning Policy Statement
PWS	Public Water Supply
RBMP	River Basin Management Plan
REV	Rural Enterprise Valley
RSS	Regional Spatial Strategy (East of England Plan)
RQO	River Quality Objective
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPZ	Source Protection Zone
S/D	Supply & Demand (balance)
SS	Suspended Solids
SSSI	Site of Special Scientific Interest
STW	Sewage Treatment Works
SUDS	Sustainable (urban) Drainage Systems
TGFIS	Thetford Growth Framework and Infrastructure Study
TGIS	Thetford Green Infrastructure Study
TMB	Two Mile Bottom (abstraction point)
TSFR	Treated Sewage Flow Recorder (Basically a flow meter)
TSS	Total Suspended Solids (in waste water)
TWCS	Thetford Water Cycle Study
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WRMP	Water Resource Management Plan
WRZ	Water Resource Zone
WTW	Water Treatment Works

1 Introduction

Thetford has been identified as a Key Centre for Development and Change (KCDC) in the draft East of England Regional Spatial Strategy (RSS). In addition to this KCDC designation, Thetford has also been identified by central government as a New Growth Point (NGP). The town is therefore a key focus for growth. This study is the first stage at assessing the impact of growth on the water infrastructure network.

1.1 Growth in Thetford

Thetford is located in southwest Norfolk, close to the border with Suffolk (see Figure 1). It is Norfolk's fourth largest urban centre and is a significant employment centre for the region with an estimated 17,000 jobs. It is also a significant retail, service and administrative centre for the sub region. The town is centred around the confluence of two rivers: the River Thet and The Little Ouse, and is surrounded by several environmentally and ecologically important designated sites. The largest of these is the Breckland Special Area of Conservation (SAC), located immediately to the west of the town. The Breckland Special Protection Areas are also located within the vicinity of Thetford.

The housing growth targets for Thetford up to 2021 are set out in the draft RSS which also requires that the growth figures up to this date should be extrapolated up to 2031 to give a maximum housing target for this timeline. The targets for both housing and employment are outlined in Table 1.1-1.

Table 1.1-1: Growth Development Targets – 2001 – 2031[1]

Growth Period	2001-2021	2021-2031	Total for 2001-2031
Homes	6,000	3000	9,000
Employment	5,000	N/A	5,000

The figures in Table 1.1-1 however need bringing up to date. First, 904 houses have been developed between 2001 and 2007. Secondly, EDAW in their 'Thetford Growth Framework and Infrastructure Study' concluded that the overall residential capacity for Thetford is likely to be in the order of 8,370 dwellings between 2001 and 2031. However, Breckland Council's most up to date trajectories suggest that, due to EDAW underestimating the capacity within the town to take growth, EDAW's overall residential capacity recommended figure would rise to about 8,647 dwellings.

As such, this report, in assessing water related issues uses three housing growth figures:

- Growth 2007 to 2021 – (RSS) – 5,096 dwellings
- Growth 2007 to 2031 (RSS extrapolated as per Table 1.1-1) – 8,096 dwellings
- Growth 2007 to 2031 (using EDAW's estimated residential capacity for Thetford) – 7,743 dwellings

The growth of Thetford and the challenges this poses should not be underestimated. Thetford's population alone will almost double between 2001 and 2031.

[1] Target housing growth figures up to 2021 are taken from the draft RSS and then extrapolated at the same annual rate to 2031.

Due to the scale of development proposed for Thetford, it is considered that a WCS is required to ensure that the proposed growth targets can be met in the town without adversely impacting on the water environment and that required infrastructure can be planned for and brought online alongside new development, as stated in the draft RSS policy WAT2 (Water Resource and Waste Water Infrastructure Development).

1.2 Development & the Water Cycle

1.2.1 What is the 'Water Cycle'?

In its simplest form, the Water Cycle can be defined as 'the process by which water is continually recycling between the earth's surface and the atmosphere'. Without considering anthropogenic influences, it is simply the process by which rain falls, and either flows over the earth's surface or is stored (as groundwater, ice or lakes) and is then returned to the atmosphere (via evaporation from the sea, the soil, surface water or animal and plant life) ready for the whole process to repeat again.

In the context of this study, the 'water cycle' has a broader definition than the simple water or 'hydrological cycle'. The human influence on the water cycle introduces many new factors into the cycle through the need to abstract water from the natural environment, use it for numerous purposes and then return to the natural system. The development and introduction of technology such as pipes, pumps, drains, and chemical treatment processes has meant that human development has been able to manipulate the natural water cycle to suit its needs and to facilitate growth and development. 'Water Cycle' in this context is therefore defined as both the natural water related environment (such as rivers, wetland ecosystems, aquifers etc), and the water infrastructure (hard engineering focused elements such as: water treatment works, supply pipelines and pumping stations) which are used by human activity to manipulate the system.

1.2.2 The Problem

In directly manipulating elements of the water cycle, man affects many changes to the natural water cycle which can often be negative. To facilitate growth and development, there is a requirement for clean water supply which is taken from natural sources (often depleting groundwater stores or surface systems); the treatment of waste water which has to be returned to the system (affecting the quality of receiving waters); and the alteration and management of natural surface water flow paths which has implications for flood risk. These impacts can indirectly affect ecology which can be dependent on the natural features of a water cycle for example wading birds and wetland habitat, or brown trout breeding in a chalk stream which derives much of its flow from groundwater sources.

1.2.3 Implications for Development: the Solution

In many parts of the UK, some elements of the natural water cycle are considered to be at, or close to their limit in terms of how much more they can be manipulated. This is especially relevant for the east of England where rainfall and hence available water for supply is the lowest in the UK. Further development will lead to an increase in demand for water supply and a commensurate increase in the requirement for waste water treatment; in addition, flood risk may increase if development is not planned for in a strategic manner. The sustainability of the natural elements of the water cycle is therefore at risk.

A WCS is an ideal solution to address this problem. It will ensure that the sustainability of new development is considered with respect to the water cycle, and that new water infrastructure introduced to facilitate growth is planned for in a strategic manner; in so doing, the WCS can ensure that provision of water infrastructure is sufficient such that it maintains a sustainable level of manipulation of the natural water cycle.

1.3 Thetford WCS and the Planning Process

As part of the LDF process, LPAs are required to produce evidence based studies which support the selection processes used in deciding on final growth targets and areas to be promoted for growth. The WCS is one such example of an evidence-based study which specifically addresses the impact of proposed growth on the 'water cycle' and as such, will form an important component of Breckland's emerging LDF. Specifically the Thetford WCS will sit alongside the Sustainability Appraisal, Strategic Environmental Assessment and Appropriate Assessment forming a key part of the 'Thetford Area Action Plan' which itself is a key component of Breckland's overall LDF. The WCS will also inform the emerging Breckland Core Strategy Development Plan Document, another key element of Breckland's LDF.

Water Cycle Studies are a relatively new approach to assessing the impact of new development with respect to the water cycle; however, the Thetford WCS must be sufficiently robust such that it can form part of the evidence base for Breckland's emerging LDF.

1.3.1 WCS Links with Other LDF Studies

There are several other studies which have been, or are in the process of being produced on behalf of Breckland Council to act as evidence bases to the developing LDF. Those most relevant to the WCS are listed below and the WCS has been informed by these studies:

- Thetford Growth Framework and Infrastructure Study (TGFIS) (EDAW 2007 – Reference 12)
- Thetford Green Infrastructure Study (Thetford GI Study) (LUC 2007 – Reference 14)
- Breckland Level 1 Strategic Flood Risk Assessment (SFRA) (Mott Macdonald 2008 – Reference 10)

TGFIS

The TGFIS's overall aim was to identify options for, and make a recommendation on, the optimal directions for strategic growth, determine the implications of that growth in relation to infrastructure both physical and social, and identify mechanisms and ways to deliver, manage and monitor that change (Reference 17). The study has been used specifically to define the potential development area options to be assessed in the WCS and to consider the natural limit on the number of homes and levels of employment to be considered in the WCS.

Thetford GI Study

The Thetford GI study has been used to consider the potential for the water cycle elements of the proposed development areas to be linked to Thetford's green corridors and infrastructure. The key aim of the Thetford GI Study was to make recommendations such that the future urban extensions are to be developed sustainability, with green space and environmental assets to be protected and planned for from the outset (Reference 17).

SFRA

The Level 1 SFRA undertakes a strategic level assessment of the sources of flood risk in Breckland Council's administrative area and considers implications of flood risk arising from new development. Specifically for Thetford, this allows Breckland Council to undertake the Sequential Test on the town's potential development areas, as required in Planning Policy Statement 25 (PPS25 - Reference 1). The Sequential Test is a method by which development areas are considered and selected on the basis of taking forward the areas with lowest flood risk, unless there are overriding sustainability reasons for considering higher risk options,

The SFRA has been used in the WCS to determine the level of flood risk to potential development sites in Thetford, but also the potential flood risk that might arise as a result of development in Thetford.

1.3.2 Aim of Thetford WCS

In conjunction with the other strategic studies which inform the LDF, a WCS for Thetford is therefore required to:

- Ensure a co-ordinated approach to identify water supply and waste water infrastructure to support development;
- Avoid negative impact on water-dependent European sites of nature conservation (e.g. Breckland SAC) and non European designated sites;
- Provide an evidence base for Local Development Documents to site development so that Breckland Council can:
    - Ensure delivery of new development in Thetford in the most sustainable way with respect to the water cycle environment
    - Maximise potential of existing water cycle infrastructure ;
    - Minimise need for new infrastructure.

The purpose of this report is to summarise the outputs of the Stage 1 Water Cycle Study.

2 Thetford Water Cycle Study

2.1 Approach to the Water Cycle Study

The Thetford Water Cycle Study intends to test the suitability of the proposed development area options and development scenarios for Thetford taking into account existing and new water infrastructure, whilst considering the impacts of proposed growth to the receiving water cycle environment.

2.1.1 Stages of Thetford Water Cycle Study

In general, there are three main stages in undertaking and producing a WCS, The Scoping Study, the Outline Study and the Detailed Study.; however, the Thetford Water WCS process will be undertaken as a 2 stage process. This report represents the Stage 1 Thetford WCS and consists of the Scoping and Outline Study combined and will assess and identify:

- what development is proposed and in which development areas;
- what elements of the water cycle may be affected by the scale of the development; and
- identify where there are likely to be key constraints affecting potential development areas
- any absolute water cycle environmental capacity constraints to development;
- any water cycle infrastructure constraints to development;
- whether any new water cycle infrastructure is required and hence must be planned for to facilitate new development and which strategic level options are available for delivering new infrastructure required; and
- the most suitable (and sustainable) development areas and/or development scenarios with respect to the water cycle.

The second Stage of the Thetford WCS is the '**Detailed Water Cycle Study'** which will work alongside the latter stages of the LDF process, taking into account other planning considerations as part of this process. The overall aim is to lead to a Water Cycle Study for Thetford which:

- identifies what water cycle infrastructure is required for Thetford and where it is needed;
- identifies who is responsible for providing the infrastructure and when it has to be provided by; and
- provides guidance for Breckland Council and potential developers on site specific infrastructure requirements (e.g. Sustainable Drainage Systems).

Following completion of the Stage 1 study, the Stage 2 detailed WCS for Thetford will be undertaken alongside the preparation of the Thetford Area Action Plan.

2.1.2 Development Definition

In the context of this Outline Study WCS report, areas within Thetford which have been identified as potential areas for re-development or for new development are termed 'development areas'. It is these development areas which are identified for constraints and risk with respect to the water cycle environment and water cycle infrastructure, as well as the requirement for new infrastructure required to facilitate development.

However, it is recognised that development can be brought forward within the identified development areas in a number of ways according to their associated constraints and risks. It is also recognised that these constraints and risks also apply to other planning aspects of future development being considered by Breckland Council i.e. transport links, hospitals and health care and schools. As such, when considering the water cycle and water environment in isolation through this study, there is a requirement to consider a range of options for the housing numbers and the type of employment that can be provided in each development area. This WCS achieves this by identifying a range of potential development scenarios and assesses the subsequent sustainability of each of these scenarios with respect to the water cycle. In so doing, this WCS allows Breckland Council to consider the relative importance of water cycle issues alongside other planning considerations when making final decisions on allocations and development promoted in the Thetford Area Action Plan (TAAP).

The range of options assessed are termed 'development scenarios' and it is these scenarios which are assessed in terms of any absolute constraints, utilising existing infrastructure and identifying the requirement for new infrastructure in order to facilitate growth.

2.1.3 Thetford WCS Study Area

The development areas identified for Thetford are within the immediate vicinity of the existing urban extent; however, the impact of the additional water infrastructure required for growth has the potential to impact on a wider area associated with the protected areas of high ecological value and biodiversity; hence, the water environment has been considered in terms of additional abstraction from groundwater and from discharge of waste water downstream of Thetford.

2.2 WCS Stakeholders

The WCS is being undertaken on behalf of Breckland Council. The Stage 1 Outline Study has been overseen by a Project Steering Group chaired by Breckland Council, and made up of representatives other organisations, all of which have a vested interest in future development in Thetford and/or its impact on water cycle infrastructure and environment. The following parties made up the immediate Project Steering Group:

- Breckland Council (BDC)
- Environment Agency (EA);
- Anglian Water Services (AWS);
- Natural England (NE); and
- Norfolk County Council (NCC).

2.2.1 Wider Stakeholder Strategy

In addition to the Project Steering Group, a wider stakeholder strategy was developed during the WCS in order to ensure that all the stakeholders are kept abreast of project progress, but also crucially, to ensure that the requirements of all stakeholders helps to shape the requirements of the Thetford WCS and its recommendations. As well as being contacted for data (where necessary), the following wider stakeholder group were consulted in a staged process:

- Cambridge Water Company
- Essex & Suffolk Water

- Suffolk County Council
- Highways Agency
- Key Landowners around Thetford.

The EA confirmed at the inception meeting that there are no Internal Drainage Boards (IDB) covering the Thetford area, and that all drainage issues fall under the jurisdiction of the EA. It was also confirmed that the above stakeholder list includes the key contacts for the Moving Thetford Forward Officer Group.

Initial contact was via release of progress reports, where stakeholders were invited to comment on the issues covered and raised; the comments received and the response given is included in Appendix B – Stakeholder Consultation. A further round of consultation will be undertaken as part of the release of this final Stage 1 WCS report, where the key findings of the Stage 1 study will be provided to the wider stakeholder group for their comment before agreeing the scope of the more detailed Stage 2 WCS Study. This will allow the requirements and inputs from the wider stakeholder group to input to final assessments of the study.

2.2.2 Integration with the Planning System

It is important at this stage to consider the planning timelines, both for Breckland Council in terms of the LDF but also AWS in terms of the funding mechanisms for new water supply and water treatment infrastructure.

2.2.2.1 Local Authority Planning

The LDF process involves an extensive process of consultation. This overall planning process supports a two stage strategy for the water cycle study so that important considerations are not overlooked in-between the production of an outline WCS which informs the draft TAAP and the detailed study which will ensure that the final TAAP has sufficient detail to ensure delivery of the WCS requirements. The WCS will also make recommendations on phasing for development.

Further, a key aim of the WCS is to derive water cycle based. The recommendations for policy are included in detail in section 12: Policy, Developer Guidance and Funding Mechanisms.

2.2.2.2 Water Company Planning

There are two elements of Water Company planning that are pertinent to the Thetford WCS and specifically, with regard to integration with Spatial Planning timelines for Local Planning Authorities and Regional Government.

Financial and Asset Planning

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 EA 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 EA 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 by each Water Company setting out the required asset investment over the next 5 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 (EA, DWI) 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 Thetford WCS, Water Companies are preparing for Price Review 2009 (PR09), whereby they are currently drafting their Strategic Business Plans which seek funding for asset investment for the 5 year period covering 2010 – 2015 (known as AMP5).

It therefore follows that any new asset (or infrastructure) investment required to meet the requirements of the WCS needs to feed into the drafting of the Strategic Business Plan for PR09. OFWAT will determine the final price limits from this process in November 2009. This ultimately means that there will be no funding available to undertake significant water cycle infrastructure upgrades until 2010 at the earliest. It can also be seen that, if significant water cycle infrastructure requirements are not included in this current price review (PR09), the funding cannot be sought for it until the next Price Review towards the end of AMP5 (PR14) which would result in funding not being available until AMP6 running from 2015 -2020.

The WCS is therefore essential for several reasons: It allows the discrepancies in the planning timeframes of AWS and Breckland Council to be reconciled through strategic planning as well as providing sufficient evidence base for Breckland Council's statutory LDF process and robust evidence and justification for AWS Strategic Business Plans for investment required in AMP5 (2010-2015) and beyond.

Water Resource Planning

Water companies are now required to produce Water Resource Management Plans (WRMP) on a statutory basis covering 25 year planning horizons. Previously, WRMP were produced on five year cycles and were not a statutory undertaking.

WRMPs set out how a water company plans to provide and invest in existing and new water resource schemes (e.g. reservoirs, desalination) to meet increases in demand for potable supply, as a result of new development, population growth and climate change over the next 25 year period. When complete, the new statutory WRMPs will be updated in 5 yearly cycles to coincide with the Price Review and AMP process.

At the time of undertaking the Stage 1 Thetford WCS, AWS are in the process of drafting and commencing consultation on the WRMP09 and as such were unable to provide detailed information included in the draft Plan and hence the resource schemes being considered. Until such time as consultation is complete and the WRMP09 is approved and published in 2009, it is not possible to state with any certainty as to what

options will be taken forward. However, as explained in section 6, data from the previous WRMP (04) has been made available and AWS have provided updates on the latest results from draft WRMP09.

It can therefore be seen that the WCS is crucial to bridging the gap between the LDF timeframe and the Water Company planning timeframe in terms of strategic planning for new water resources to meet development.

2.2.2.3 Funding Mechanisms

Once the Stage 2 WCS has determined the requirement for new infrastructure it will be necessary for the following key Stakeholders to agree to the WC findings:

- Breckland Council and Moving Thetford Forward as the planning authority and delivery vehicle for growth in Thetford;
- The EA – planning and flood risk consultee as well as regulator for water quality; and
- Anglian Water Services – as provider of wastewater and water supply infrastructure

Having due regard to the planning timeframes set out in sections 2.2.2.1and 2.2.2.2 There will need to be stakeholder agreement on what infrastructure will be required (as recommended by the WCS) as well as when it will be required and how it will be funded. The process and mechanisms for this are discussed in section 12, following assessment of the water cycle baseline and option assessment for Thetford.

2.2.2.4 Water Framework Directive Planning

The WFD was passed into UK law in 2003. The overall requirement of the directive is that all river basins must achieve *"good ecological status"* by 2015 unless there are grounds for derogation. The WFD will, for the first time, combine water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level will be adopted. It will effectively supersede all water related legislation which drives the existing licensing and consenting framework in the UK.

UKTAG[2], the advisory body responsible for the implementation of the WFD in the UK, has proposed water quality, ecology, water abstraction and river flow standards to be adopted in order to ensure that water bodies in the UK (including groundwater) meet the required status. These are currently in draft form and will not be formalised until the final River Basin Management Plans are finalised in December 2009 (prior to EC sign off). For this reason, it has not been possible to undertake a full assessment of the impact of trying to meet the new WFD standards, which in may cases, are likely to be stricter and more onerous to meet than those set by existing statutory targets and legislation. Despite this, the WCS is required to consider the longer term issues with respect to the water cycle and water environment and as such, an assessment of the impact of the interim WFD standards has been undertaken for this Stage 1 study (section 10).

2.3 Data Limitations

Undertaking of the Stage 1 Thetford Water Cycle Study has required a large amount of data collection and analysis, much of which has been reliant on the willingness of third parties to supply in order to allow the study to be progressed. In some cases, the availability of data with respect to water cycle infrastructure

[2] The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK's government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.

and future planning has not been available within the time required to undertake the assessment in Stage 1. In such cases, various assumptions have been used to enable the study to continue. Under each relevant topic, this report identifies what data has been used in each assessment and identifies where assumptions have been adopted and the reasoning behind these assumptions. Recommendations are also made for further, more detailed investigation in the Stage 2 study.

A full list of the data requested and that which was made available to the study is included in Appendix C – Request for Information.

3 Thetford Growth Context

This Chapter describes the growth in Thetford in more detail, specifically within the context of assessing or 'testing' the options for growth in terms of impacts on and the requirements of the water cycle.

As explained, the RSS has set out the growth targets for the Thetford area. The Thetford Growth Framework and Infrastructure Study (TGFIS) has undertaken a broad scale assessment of the various options for potential development areas in Thetford and has made recommendations as to which it sees as the most suitable options.

It is important to note at this stage that the overall WCS is required to address in detail the additional growth targets up to 2021 as set out in the draft RSS, but to also consider the water cycle infrastructure and impacts on the water environment within the context of extrapolated growth up to 2031. This Stage 1 study has therefore considered the development areas and infrastructure required for the 6,000 homes and 5,000 jobs up to 2021, but has also considered the best outline options for providing up to an additional 3,000 homes to 2031.

Growth will be provided for by a combination of limited 'infill' development and new, undeveloped greenfield sites.

3.1 New Residential developments

3.1.1 Completed Development

904 dwellings have already been built within Thetford between 2001 and 2007. It is assumed that the wastewater and water supply requirements for the 904 completed dwellings is already in place and forms part of the assessment baseline for new water cycle infrastructure.

3.1.2 Infill Development

It is envisaged that approximately 1,073 of new housing will be provided in the existing urban area of Thetford and that this will be completed by 2015. For the purposes of this WCS this development is referred to as 'infill development'. Indicative locations of the proposed infill development was taken from information supplied in the Breckland Urban Capacity Study (2007) Reference 20.

3.1.3 Urban Extensions

Initially, two key areas were identified by the TGFIS as having most potential for development. These two areas: Key Site North and Key Site South East, are shown in Figure 3.

Despite the targets set in the RSS, the TGFIS (Reference 12) identified and recommended that for the two key development areas in Thetford, there is a natural environmental growth limit which would restrict development to a total of 8,370 dwellings between 2001 and 2031.

However, Breckland Council's most up to date trajectories suggest that, due to EDAW underestimating the capacity within the town to take growth, EDAW's overall residential capacity recommended figure would rise to about 8,647 dwellings.

When assessing these two key development areas in the WCS, the split assumed in this report is as follows:

- 904 built between 2001 and 2007;
- 1073 infill development by 2015; and
- 6670 on urban extensions by 2031.

3.1.4 Additional Scenarios to Test

Following wider consultation it was agreed that the WCS should also consider development of a further two potential greenfield areas. The TGFIS confirmed that it is unlikely to be possible to meet the extrapolated target of 9,000 within the two key development areas up to 2031. The WCS therefore needed to consider impacts arising from development of other potential areas to ensure a robust evidence base for the LDF.

The two new areas to be considered were: Site E (defined as Area E in the TGFIS) and Site C (defined as Area C in the TGFIS). Development of these additional areas would enable the RSS extrapolated housing target of 9,000 to be reached.

All four potential development areas assessed in the WCS are shown in Figure 3.

3.2 New Employment Areas

There is a target of up to 5,000 jobs to be delivered in Thetford up to 2021 alongside housing growth to maintain the town's self containment in terms of job provision. The preferred option for employment growth identified in the TGFIS (reference 12) suggests:

- Approximately 20% of all jobs delivered in A use class employment (retail and services), i.e. 1,000 jobs (accommodated on vacant sites identified within the BDC, Retail and Town Centre Study); and,
- Approximately 4,000 jobs delivered on new Greenfield sites to 2021, predominantly office based (2,800 jobs), with a smaller number of industrial jobs (600 in Industry and 600 in Warehouse and distribution)

Location scenarios for employment are described in section 3.3.2.

3.3 Development Scenarios – Housing

3.3.1 Housing

In undertaking the Thetford WCS, it would be possible to assess the potential development area options individually; however, it is important to consider that there are numerous ways in which the development can be brought forward in each area both in terms of numbers of housing, but also phasing of housing development. This gives rise to potential development 'scenarios'. The TGFIS has already identified that the growth up to 2031 cannot be provided in any of the proposed development options in isolation; hence it therefore follows that assessing the development area options in isolation would not give a realistic assessment of the impact of development on the water environment, nor an accurate assessment of the most efficient means of providing the required water infrastructure. The WCS must therefore consider development scenarios when looking at options for new water infrastructure.

Despite this, it is not possible to consider all the permutations for how housing could be brought forward in each of the development areas and test each development scenario for implications to the water cycle within the limitations of this study. In the main, this is due to time constraints (i.e. there are four

development areas, and housing could be considered in blocks of say 2,250; this would give rise to 16 different development scenarios) but also because not all of the theoretical permutations for development would be possible due to other planning or sustainability reasons. The WCS has therefore considered development scenarios based on the limitations for other options as identified in the TGFIS.

Initially, this gave rise to three main key development scenarios based on the two key development sites. All scenarios assume that development in the new areas does not commence until 2010 and are detailed below:

- *Scenario A*: Development of Key Site North (2010 - 2027) five years before Key Site South East (2015 - 2027).
- *Scenario B*: Key Site North developed to maximum (2010 to 2021) before development of Key Site South East commences (2021 – 2031)
- *Scenario C*: Both Sites developed in parallel between 2010 and 2027

The exact phasing and numbers of housing provided in each area for each scenario is shown in detail in Appendix A - Possible Dwelling Scenarios.

To maximise the robustness of this WCS, at the request of landowners, two further areas have been studied in addition to the areas recommended in the TGFIS. These two areas are referred to as 'Site E' (defined as Area E in the TGFIS) and 'Site C' (defined as Area C in the TGFIS). The assumption applied was that the two new areas would be developed after the two key sites had been developed to their maximum, hence development would not commence in either area until 2021. On this basis, the following two additional scenarios have been assessed in the Stage 1 WCS:

- *Scenario D:* development of Key Site North to maximum, followed by development of remaining housing development to meet the 8,096 target in either Site E or C up to 2031. No housing in the South East would occur under this scenario.
- *Scenario E*: development of natural limit in Key Site North and Key Site South East areas up to 2021, with additional homes in either Site E or C up to 2031 to reach the maximum required new homes target of 8,096 (albeit less than would be the case under scenario D).

Table 3.3-1 Summarises how each of the proposed development areas would be developed for each of the scenarios being considered.

Table 3.3-1: Summary of Development scenarios

Scenario	A	B	C	D	E
Key Site North	2010 - 2027	2010 - 2021	2010 - 2027	2010 - 2021	2010 - 2021
Key Site South East	2015 - 2031	2021-2031	2010 - 2027	Not developed	2010 - 2021
Site E	Not developed	Not developed	Not developed	Either Site E or Site C post 2021	Either Site E or Site C post 2021
Site C	Not developed	Not developed	Not developed		

3.3.2 Employment

Using the TGFIS, it has been shown that Key Site North is the most suitable for employment development. The TGFIS also concluded that all employment would be provided by 2021 to meet with the Growth Point targets. Table 3.3-1 above demonstrates that in all scenarios, the development of the Key Site North will

take place up to 2021, so it has been assumed for the Stage 1 WCS that most of the development for employment will take place in this location, regardless of the scenario which is eventually taken forward. This is supported by the location of the existing Fison Way Industrial Estate which is located north west of the rail station and borders the north western section of the Key Site North. This WCS assessment has assumed that the residual employment will be located in either Key Area South East, or Site E or Site C dependent on which scenario is taken forward.

In terms of area put aside for employment growth, The TGFIS concluded that 33 hectares would be required for employment growth in Key Site North with the remaining 5 hectares elsewhere dependent on which development scenario is adopted. The splits in employment type as indicated in 3.2 would be assumed for the development areas.

3.4 Development Scenario Assessment

The scenarios described in the preceding sections have therefore been taken forward into the infrastructure option assessment stages of the WCS as outlined in sections 5 and onwards of this report. The assessment of scenarios has also allowed the Stage 1 report to provide interim advice on preferred phasing of development with respect to the water cycle (see section 13.3) and provided interim outputs for AWS to include in the drafting of their strategic business plan for PR09.

4 Flood Risk: Baseline Constraint Assessment

A review of flood risk in the Water Cycle Study is essential to ensure that:

- The risk of flooding to the potential development areas is quantified and the development is steered away from high risk areas (Flood Zones 2 and 3);
- Any flood mitigation measures are planned in a strategic manner; and
- There is no deterioration to existing communities' standard of protection;

4.1 Flood Risk Identification Methodology

The aim of a identifying the potential sources of flood risk to the potential development areas is to assess the risks of all forms of flooding to and from a development in order to identify any potential development constraints with respect to flood risk. PPS25 (Reference 1) emphasises the need for a risk-based approach to be adopted by planning authorities through the application of the Source-Pathway-Receptor model.

The Source-Pathway-Receptor model firstly identifies the causes or 'sources' of flooding to and from a development. The identification is based on a review of local conditions and consideration of the effects of climate change. The nature and likely extent of flooding arising from any one source is considered, e.g. whether such flooding is likely to be localised or widespread. The presence of a flood source does not always infer a risk. The exposure pathway or 'flooding mechanism' determines the risk to the receptor and the effective consequence of exposure. For example, sewer flooding does not necessarily increase the risk of flooding unless the sewer is local to the site and ground levels encourage surcharged water to accumulate. The varying effect of flooding on the 'receptors' depends largely on the sensitivity of the target. Receptors include any people or buildings within the range of the flood source, which are connected to the source by a pathway.

In order for there to be a flood risk, all the elements of the model must be present. Furthermore effective mitigation can be provided by removing one element of the model, for example by removing the pathway or receptor.

4.2 Available Data & Assumptions

The assessment of flood risk constraints has made use of the Strategic Flood Risk Assessment (SFRA) produced for Breckland Council (Reference 10). The Level 1 SFRA was completed in October 2007 and covers an assessment of strategic flood risk in and around the town of Thetford from all potential sources of flooding, including fluvial, groundwater and overland flow. The Level 1 SFRA has been produced sufficient to allow Breckland Council to undertake the PPS25 Sequential Test of potential Allocation Sites within the developing LDF.

Information on potential SUDS utilisation has made use of Source Protection Zone (SPZ) information produced and published by the EA (Reference 5) and Groundwater Vulnerability Maps produced by the NRA (reference 4). Information from the assessment of surface water runoff attenuation (or storage) has been taken from section 8 of this report: Flood Risk and Sustainable Drainage Systems options; this utilised surface runoff calculations recommended by the EA and the Department for Environment, Food and Rural Affairs (DEFRA) – see Reference 18.

Other Information Sources used include:

- Records of Sewer Incidents received from AWS;
- Geology Maps of Thetford and surrounds (British Geological Survey); and
- Groundwater data from observation borehole (OBH) from the EA.

4.3 Baseline Description

This assessment covers the risk of flooding and hence flood risk constraints posed to the potential development sites. Flood Risk generated as a result of the development (from surface water flooding) is considered in Section 8 as this is considered on a development scenario basis and not as an absolute constraint.

4.3.1 Fluvial systems - Rivers

The River Thet and Little Ouse River are the major water rivers in the locality of Thetford.

The Little Ouse River rises to the east of Thelnetham, and is a tributary of the Great Ouse which it joins to the north of Littleport in Cambridgeshire. The Little Ouse River has a catchment area of approximately 380km² to Thetford and defines the boundary between Norfolk and Suffolk along the majority of its course. The Little Ouse River flows in a northerly direction to the east of Thetford, before flowing in a northwest direction through the town centre. Upon exiting the town in the Redcastle area the Little Ouse River once again flows in a northerly direction.

The River Thet rises in the fens close to Rockland All Saints. The Thet flows in a westerly direction from the east of Thetford to its confluence with the Little Ouse River and has a catchment area of approximately 320km² to this point. From this point onwards the combined rivers are known as the Little Ouse River.

Both the Little Ouse River and River Thet are chalk rivers and are recognised as a priority habitat in the UK Biodiversity Action Plan. Figure 4 shows the location of the two key river systems in Thetford.

4.3.2 Catchment Geology and Groundwater

The geological map for the area (Reference 3) shows that Thetford is underlain by a major chalk aquifer. In addition to the chalk aquifer, the following geology is predominant in the locality of Thetford in relation to the proposed development sites:

- The higher ground to the North of Thetford (underlying key site North and Site C) consist of permeable chalk which is overlain by boulder clay (largely impermeable) which is further overlain by post glacial loam and gravel (largely permeable). The boulder clay is considered to be slowly to non permeable and hence is considered as an non aquifer; it therefore forms an impermeable barrier between the loam and gravel layers nearer the surface and the deeper chalk which is considered a Major Aquifer.
- The Valleys of the River Thet and Little Ouse consist of permeable Sands and Gravel. The extent of the Sands and Gravels covers the majority of Key Site South East. The Sands in the locality of Thetford are up to 10m thick and consist of reworked Brickearth (outwash deposits) and the occasional clay layers (thin); the presence of clay in the Sands and Gravels gives rise to a heterogeneous permeability.
- The development site North East is underlain by permeable Chalk.

4.3.3 Flood Defences

The Environment Agency Flood Map and Level 1 SFRA indicate that there are no flood defences in the locality of Thetford which will provide protection from fluvial flooding (Reference 5).

4.3.4 Tidal Flood Sources

Tidal flood sources include the sea and estuaries. There are no tidal flood sources that pose a risk to Thetford.

4.3.5 Overland Flow

Overland flow is water that fails to infiltrate the surface and travels over the ground surface. Overland flow can occur from significantly large areas of hardstanding (e.g. industrial estates, or airports) or from large areas of impermeable soil and or geology which quickly become saturated during rainfall events. In general, these conditions need to be combined with steep topography which can lead to rapid runoff from saturated (or impermeable) areas and channel high flowing water to developed areas.

A review of the topography of the site, the areas of existing development and geology has concluded that new development areas in Thetford are unlikely to be at risk of flooding from overland flow. The SFRA concurs with this conclusion.

4.4 Flood Risk to the Development: Fluvial

Fluvial flood sources include sections of rivers not affected by the sea. The River Thet and Little Ouse River flow from the east of the Thetford and join in the town centre, from where the River Little Ouse flows east to west through the town centre.

PPS25 (Reference 1) defines three 'flood risk zones' with respect to fluvial flooding. The flood zones are classified in terms of flood risk from rivers based on probability of a flood event occurring. The fluvial flood zones are defined as:

- Zone 1 – Low Probability: land assessed as having a less than 1 in 1000 chance of river flooding occurring in any given year (or a less than 0.1% annual probability).
- Zone 2 – Medium Probability: land assessed as having between 1 in 1000 and 1 in 100 chance of river flooding occurring in any given year (or between 0.1% and 1% annual probability).
- Zone 3a – High Probability: land assessed as having a 1 in 100 or greater chance of river flooding occurring in any given year (or greater than 1% annual probability).
- Zone 3b – Functional Floodplain: land where water has to flow or be stored in times of flood. Generally, this is defined as land having a 1 in 20 or greater chance of flooding occurring in any given year (or greater than 5% annual probability).

The extent of the flood zones are determined by hydraulic modelling. The River Thet and Little Ouse were originally modelled by Royal Haskoning in 2000 on behalf of the Environment Agency. These river systems were then remodelled by Halcrow in 2006 to update the data as part of the Level 1 SFRA (Reference 10). The rivers were modelled using ISIS (a 1 dimensional hydraulic model) and elements of Tuflow (a 2 dimensional hydraulic model). The flood events that have been simulated are the 1 in 5, 10, 25, 50, 75, 100, 200, 1000 year events. The 25yr event has been used to define the functional floodplain (flood zone 3b). These modelling results have been used to define the four flood zones for the town of Thetford and

hence to determine which areas of the town and its surrounds fall into which flood risk zone category. Figure 4 outlines the flood zones and their limits as defined in the Breckland SFRA.

4.4.1 Climate Change

PPS25 requires developments in floodplains to consider the potential impacts of climate change on flood risk for the lifetime of the proposed development.

The Environment Agency has advised that commercial developments should be considered to have a 60 year design life, and residential developments should be considered to have a design life of 100 years. In accordance with Annex B of PPS25, allowances for climate change should be made on fluvial flood sources for a 60 and 100 year design horizon. This requires an assessment of the impact of an increase of 20% on peak river flows for the design event being considered. In this case, the peak river flows predicted during flood event with a return period (or frequency) of 1 in 100 years needs to be increased by 20%. The SFRA includes modelled flood levels for the 1 in 100 year event plus 20% and hence this scenario has been considered in the WCS.

4.4.2 Historical Fluvial Flood Events

The Breckland SFRA has identified that Thetford has historically suffered from fluvial flooding. The following incidents have been recorded; however no severity rating, return period for the flood event or details of antecedent conditions are available for these flood events:

- 9th Aug 1843 – 2ft deep on Bridge Street
- 20th century – town centre suffered serious flooding on several occasions
- 26th August 1912 – parts of the town suffered flooding
- 1939 and 1947 – memorable flooding of Thetford's Rivers
- Sept 1968 – High water levels with out of bank flooding occurring in Bridge Street.

4.4.3 Fluvial Flooding – Development Area Analysis

Figure 4 outlines the extent of the flood zones (mapping undertaken by Halcrow in 2006 on behalf of Breckland Council) for Thetford in relation to the proposed development area.

Key Site North

Flood Mapping indicates that this site is wholly located in flood zone 1 and hence is not considered to be at risk of fluvial flooding.

Key Site South East

Flood Mapping indicates that the northern border of this potential development site is at risk from flooding from the River Thet during the 1 in 1000 year event and 1 in 100 year event. Dependent on how the northern boundary is eventually defined, there is a potential risk that the northern edge of the site could be located in Flood Zones 3 or 2. If this were the case, development in the very northern part of this development site would be restricted if a site-wide application of the Sequential Test (Reference 1) is undertaken. Additionally, an area-wide application of the Sequential Test (i.e. within Breckland LPA's administrative area) may indicate that this site is less preferable and may have to be considered after the sites which are clearly located wholly within Flood Zone 1. If the site encroaches on the 1 in 100 year flood extent (zone 3a) then according to PPS25, the following would apply:

- 'Highly Vulnerable' development such as Police Stations would not be permitted;
- 'More Vulnerable' development such as houses, nursing homes, hospitals and hotels would require the Exception Test to be applied showing that there are overriding sustainability reasons as to why they should be located there; that there is no developable, previously developed land available as an alternative; and that the development can be shown to be safe for its design life time;

To the west of the development areas, there are numerous properties already considered to be at risk of flooding from the River Thet and Little Ouse in this location and consequently the SFRA recommends that no development should take place in the River Thet floodplain.

Other Potential Development Areas

The flood mapping indicates that the southern boundary of Site E may be at risk from fluvial flooding during the 1 in 100 and 1 in 1000 year probability flood event hence locating this section of the site within flood zone 2 or 3. The restrictions on development types as outlined for Key Site South East would also apply to Site E. Site C is shown to be entirely located in Flood Zone 1 and is therefore at low probability of flooding from fluvial sources.

4.5 Flood Risk to the Development: Sewer and Surface Water Drainage Flooding

Flooding from surface water sewers occurs as a result of exceedance of the capacity of the sewer system from heavy rainfall or if the system becomes blocked and will continue to remain flooded until the water drains away. Modern sewer systems are typically designed to accommodate rainstorms with a 30 year return period (Reference 9), whilst older sewer systems were often constructed without consideration of a design standard and may in some areas (served by Victorian sewers) have an effective design standard of less than 30 years. Consequently rainstorm events with a return period greater than 30 years would be expected to result in flooding of some parts of the sewer system.

In addition, as towns and villages expand to accommodate growth, their original sewer systems are rarely upgraded, eventually becoming overloaded and reducing their effective design standard of 30 years. Compounding this problem are the effects of climate change. Climate change is forecast to result in milder, wetter winters and increased rainfall intensity in summer months. This combination will increase the pressure on existing sewer systems effectively reducing their design standard, leading to more frequent flooding.

Flooding from foul sewers occurs as a result of exceedence of capacity due to a combination of increased upstream catchment area/properties, connections of surface water to foul sewers, infiltration, blockages and structural defect reducing effective capacity. Foul sewers are designed for 6 DWF. Schemes to resolve flooding from foul and combined sewers, where there is known to be infiltration and storm flows, are designed to accommodate flows generated by 1 in 30 year storms.

The SFRA notes that internal and external sewer flooding have occurred in:

- Thetford town centre on Bridges Walk in August 2006. This flood event has been assigned a 1 in 20 year occurrence; and
- The north of the town in Fairfields. This flood event has been assigned a 1 in 5 year occurrence.

AWS also supplied data on sewer flooding incidents. As well as the events listed above, sewer blockage incidents have been recorded in higher numbers to the residential area to the north of the railway (outside

of the Industrial Estate; to the area bordering the railway and the A1075 (Norwich Road); and the area in and around the town centre.

Key Site North

The SFRA and additional AWS data has identified the existing development that is located to the south of the site as an area that has a history of sewer flooding incidents occurring. However, the new development area is located to the north of the existing areas and on higher ground, such that existing sewer flooding or surface water flooding problems are unlikely to affect this development area.

Key Site South East

There is no known risk of sewer or surface water flooding to the site and the site is remote from current sewer flooding problems.

Other Development areas

There is no known risk of sewer or surface water flooding to Site C as it is remote from existing development and hence existing surface water and sewerage drainage systems. Site E is located near to the existing residential area between the Norwich Road and the railway were historical blockage incidents have been recorded; however, as with Key Site North, it is located on higher ground and unlikely to be affected by existing sewer flooding incidents.

4.6 Flood Risk to Development: Groundwater

Groundwater flooding can occur when groundwater levels in aquifers rise above ground levels. The groundwater vulnerability map of the area (Reference 4) indicates that the geology beneath the town and surrounding area has been classed as a major-aquifer which means it has significant water bearing potential and will have fluctuating water levels based on the amount of abstraction and recharge of the aquifer system.

Normally, in areas where the site is in close proximity to the river it could be reasonably predicted that the sands and gravels would be in hydraulic connectivity which could result in groundwater flooding during times of high flows in the River Thet and Little Ouse.

Although the town is underlain by a major Chalk Aquifer and areas of shallower aquifer in the sands and gravel, there have been no reported incidents of groundwater flooding from a review of data used as part of the SFRA, or from EA records. Groundwater data supplied by the EA was not available for observation boreholes (OBHs) within the vicinity of the proposed development areas; however, analysis of data from sources up to 5km away suggests that groundwater in the Chalk and gravels have not exceeded groundwater levels.

In the absence of a thorough assessment of groundwater flooding in the SFRA, a generic assessment of groundwater flooding risk is covered in the Stage 1 WCS.

North Sites

It is considered that groundwater flood risk in the development areas to the north, that is Key Site North, Site E and Site C are all considered to be low risk as they are either partly hydraulically disconnected from the Major Chalk by Boulder Clay, or the ground level is likely to be sufficiently high enough from the saturated water table in the aquifer to make the risk of rising groundwater in the Chalk a negligible risk.

Key Site South East

Rising groundwater levels in the Sand and Gravels associated with Key Site South East are a possibility, although there is no data to support this supposition, and no historical record of such flooding. Nonetheless, on a precautionary basis it is considered that the western boundary of the site is at a slightly higher risk of groundwater flooding.

4.7 Flood Risk to Development: Artificial Sources

Artificial flood sources include raised channels such as canals, or storage features such as ponds and reservoirs. The SFRA identified that blocked gullies resulted in flooding of the A11 to the northeast of Thetford in August 2006. This section of the A11 is located close to the northern development site.

Key Site North

The SFRA has identified that blocked gullies on the A11 has resulted in inundation of the northeast of Thetford in August 2006. Consequently there is a potential that this flood source could pose a risk to the potential allocation development.

Key Site South East

There are no recorded incidents of flooding from artificial sources affecting the potential allocation site to the southeast of Thetford.

Other Development areas

The blocked gullies on the A11 which resulted in inundation of the northeast of Thetford in August 2006 may pose a risk to Site C. There are no recorded incidents of flooding affecting Site E.

4.8 Flood Risk Constraint Summary

The assessment of flood risk undertaken for each potential development area as identified in sections 4.4 to 4.7 above have been summarised in Table 4.8-1.

Table 4.8-1: Flood Risk Constraint assessment table – Development Area comparison

Flood Risk Constraints				
Allocation Site	**Fluvial**	**Critical drainage / surface water flooding**	**Groundwater**	**Artificial water sources**
Key Site North				Historical flooding of gullies north of the A11
Key Site South East	Northern part of area potentially in Flood Zones 2 or 3		Low risk of groundwater flooding along eastern boundary of site associated with river terrace deposits	
Site E	South Eastern part of area potentially in Flood Zones 2 or 3			
Site C				Historical flooding of gullies north of the A11

Table 4.8-2: Qualitative description of colouring assigned to flood risk constraint table

No issue / negligible
Minor constraint – some small scale management and mitigation required -
Significant constraint – Feasible, but significant management & mitigation required
Major constraint

It can be summarised that there are no overriding flood risk constraints to any of the development areas that would require significant flood risk management or mitigation. There is little to differentiate between the areas, but the following points can be made:

- The Key Site North has less potential issues than Key Site South with the main consideration being that it is remote from fluvial flooding which is the main potential flood risk in the Thetford area;
- Fluvial flooding is a potential issue in Key Area South, although this is specifically tied to the northern area which could be managed by not developing this section of the development area;
- In terms of flood risk, neither of the additional areas presents a significantly better case than developing either of the Key sites.

The assessment for each development areas has been carried over into the overall development scenario assessment in Section 11, by carrying over the highest flood risk assessment colouring to each scenario dependent on which area is included in the scenario.

5 Wastewater Baseline & Capacity Assessment

The wastewater baseline and capacity assessment addresses two key areas for wastewater.

- the baseline with respect to treatment of wastewater and how much 'spare' capacity is available in existing wastewater treatment facilities; and
- the baseline with respect to wastewater or sewer network and whether there is scope to use the existing network system[3] before upgrades are required.

It is important to establish the baseline and hence spare capacity of wastewater treatment facilities and network because a basic assumption of the WCS is that it is preferential to maximise the use of existing facilities. This is to reduce cost, reduce impact to existing communities and to allow early phasing of some new development which will not have to rely on longer lead in times associated with securing funding for new infrastructure through the statutory water company planning process (see section 2.2.2.2).

An important aspect of the spare capacity of the existing wastewater treatment facilities is the assessment of the environmental capacity of the receiving watercourses. Discharge of additional treated wastewater from new development could have a detrimental impact on:

- the water quality of receiving waters;
- the hydrological/hydraulic regime of receiving water's and associated habitats; and
- flood risk downstream of the discharge

This assessment of environmental capacity with respect to wastewater discharge is included in this section.

5.1 Available Data & Assumptions

5.1.1 Data

Various types of information have been supplied by AWS for the wastewater baseline assessment:

- Sewage Treatment Works (STW) size and location and discharge consent details;
- Consent Compliance data for Thetford STW;
- Dry weather flow (DWF)[4], Flow to Full Treatment (FtFT)[5], and flow calculation assumptions (per capita consumption, occupancy rate) for Thetford STW;
- Location of sewer incidents;
- Coverage of sewer network models (models currently being updated);
- Sewer network records in GIS format. These show the layout of the sewer network and include information such as sewer pipe sizes, sewer type, gradient etc; and
- Information on existing capacity and consents relating to Thetford STW.

[3] the network of pipes and pumping stations which are used to transmit wastewater from buildings to treatment facilities
[4] DWF is the wastewater flow that is generated from a sewage treatment works without the input of surface water runoff from rainfall. It is generally defined as the flow from a STW after 7 days of no rainfall.
[5] FTFT is the maximum rate of flow that can be treated at a STW

5.1.1.1 Wastewater - Water Environment Data

The Water Quality assessment has made use of water quality data collected and supplied by the EA for the River Thet and River Little Ouse classification system, along with information on the legislation which drives the water quality standards required to protect ecological habitat integrity for the river systems.

The hydraulic capacity has utilised:

- cross-section surveys of the Little Ouse (provided by EA);
- flow data and rating curves for the Abbey Heath gauging station located on the Little Ouse just downstream of Thetford STW (provided by EA); and
- manual calculations of the Manning's equation to determine changes in water level with increases in flow generated from additional wastewater discharge.

In terms of the wider water related environment, the Stage 1 WCS has undertaken the initial screening stages of an Appropriate Assessment[6] (AA) to identify whether the water cycle and water infrastructure changes assessed in the WCS are likely to have a detrimental impact on the habitats of European designated sites of nature conservation. This screening study undertook a review of all designated sites (European, national and regional/local) that are hydrologically linked to watercourses or aquifers potentially affected by development in Thetford. This process is reported in detail in section 9: Ecological Constraints and Opportunities.

5.1.2 Assumptions

The following assumptions have been discussed and agreed with AWS based on latest available data and have been applied:

- The per capita consumption (G - water used per head, per day) is taken as 0.146 $m^3h^{-1}d^{-1}$. This figure is based on the AWS regional average between metered houses and unmetered houses. It is also referenced from OFWAT Security of Supply Report for 2006 – 2007 (Reference 22);
- The Domestic Population (P) served by Thetford STW is 22,257[7] people;
- Including Trade Effluent, the Total Population Equivalent (PE) served by Thetford STW is 29,886;
- The average occupancy rate is 2.1 people per household (home);
- The infiltration (I) rate (defined as the amount of water that enters the drainage system from other sources such as saturated ground, illegal connections and unaccounted drains) is 1,032 m^3d^{-1} for the current population equivalent. This has been calculated as 25% of the Thetford population multiplied by the per capita consumption[8] (PG – population times growth) and that for future calculation of I, the additional Infiltration is calculated as 25% of future PG.
- The trade flow (E) from industry currently is 1,405 m^3d^{-1}.
- The sewer network in Thetford is assumed to be a largely separate system i.e. foul water network is separate from surface water drainage network. It is acknowledged that this is a fundamental assumption and AWS have confirmed that the some town centre locations are likely to be combined

[6] The need for Appropriate Assessment is set out within Article 6 of the EC Habitats Directive 1992, and interpreted into British law by Regulation 48 of the Conservation (Natural Habitats &c) Regulations 1994
[7] Figures provided by AWS
[8] based on Office of Water Services (OFWAT) standards

in place; therefore, this assumption will have to revised as part of any modelling undertaken in Stage 2.

- No increase in increase in holiday consumption has been assumed

5.1.2.1 Employment Assumptions

It cannot be stated with any certainty as to how the increase employment is to be defined and hence what effect it will have on increased trade flow. Targets have been taken from the TGFIS, however these targets are aspirational and it cannot be known for certain what the total employment figure or what the proportion of different employment types will be. Nevertheless, the assumptions for employment type as laid out in 3.2 have been used and it has been assumed that the mainly office type, R&D work and light industry and warehousing focus will result in a modest increase in trade flow of 15% above the current total. This has been factored into the wastewater capacity assessment. It is recommended that an update on employment types and water demand and wastewater generation is undertaken during the Stage 2 WCS, including an assessment of use by other institutions (such as hospitals and schools).

5.2 Wastewater Treatment Baseline & Capacity

5.2.1 Existing Sewage Treatment Works

There are three STW serving Thetford and nearby Croxton; these are summarised in Table 5.2-1 and the locations shown in Figure 5. The whole of Thetford is served by Thetford STW, and this STW also serves some 63% of the nearby village of Croxton.

Table 5.2-1: Summary of STW in Study Area

STW	Total PE[9]	Calculated DWF ($m^3 d^{-1}$)	Calculated FtFT ($m^3 d^{-1}$)	Watercourse	Location (Grid reference)
Thetford	29,886	6,565	17,632	Little Ouse (direct)	TL8553083570
Croxton – Church Avenue	55	N/A	N/A	Little Ouse (pumped)	TL8746086740
Croxton – Breckwick House	7	N/A	N/A	Little Ouse (pumped)	TL8705087250

5.2.2 Wastewater Treatment Capacity Assessment

It was agreed by the Project Steering Group that the two smaller STWs at Croxton would not be considered in this assessment on the basis that they are too small to consider for expansion, that they are too far away from Thetford to pump the wastewater flow to them, and that it is preferable to discharge wastewater flows downstream of Thetford to avoid exacerbating flood risk issues in the town centre as identified in the Breckland SFRA (Reference 10). The existing Thetford STW is therefore carried forward in this assessment.

The discharge consent information supplied by AWS indicates that the current consented DWF for Thetford STW is 8,810 $m^3 d^{-1}$ which compared to the current calculated treated flow at Thetford (Table 5.2-1) demonstrates that there is a degree of headroom capacity at Thetford STW. For the purposes of the

[9] PE = Population Equivalent and equates to the approximate number of people served by the STW combined with trade effluent

Stage 1 WCS, AWS did not provide information pertaining to the 'process capacity' at Thetford STW. Process capacity refers to the amount of flow that can be treated to the required quality standards as set under the discharge consent. Therefore, it has been agreed that the headroom capacity at the STW is calculated from the volumetric capacity (i.e. the difference between the maximum dry weather flow that AWS are permitted to discharge under the discharge consent and the current dry weather flow 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.

Whilst this assumption is acceptable for the Stage 1 WCS to determine the outline feasibility of using the volumetric headroom at the STWs, the Stage 2 WCS will need to consider the 'process' capacity at the STW as this could limit the extent to which the volumetric capacity can be utilised in the time before funding is required to upgrade the STW. As discussed in section 2.2.2.2, any new upgrades or infrastructure requires funding to be sought by AWS and as such, there is an associated lead in time for the upgrade works which would limit the amount of development that could take place before the upgrades are in place.

It should also be noted that Thetford STW is a sludge treatment centre, whereby sludge produced by other STWs in the region is transferred to Thetford STW for treatment. It has been agreed with AWS that the volume of sludge liquors produced by the sludge treatment process does not affect the assumptions on the volumetric headroom calculations, but the liquors have high concentrations of potential pollutants which could affect the process capacity of the STW; therefore, this would need to be assessed in the Stage 2 WCS.

5.2.2.1 Treatment Capacity Calculations

Appendix D – STW Headroom Calculations, provides details of the calculations undertaken in order to determine the volumetric treatment capacity at Thetford STW (hereafter referred to as headroom capacity). Headroom is calculated by determining the difference between the consented upper limit on dry weather flow, and the dry weather flow that the STW currently treats.

The calculated dry weather flow for Thetford STW is 6,565 m^3d^{-1} (Appendix D). The consent for Thetford STW shows that the treatment capacity at the STW is 8,810 m^3d^{-1}, giving rise to a headroom capacity of 2,245 m^3d^{-1}. Using the assumptions set out in section 5.1.2, this headroom is sufficient to allow the STW to treat flow from a further 15,373 people which is equivalent to around 7,320 new homes.

Despite this basic headroom calculation, the amount of actual available headroom varies according to the scenario considered and the amount of housing therefore proposed. Chapter 3 established that there are two main development scenarios being assessed: scenarios A to C will develop Key Sites North and South East to an assumed environmental capacity of 7,743 new homes whilst Scenarios D and E consider full development up to 8,096 new homes by assessing two additional development areas. These figures disregard the 904 new homes of the overall target which have already been completed as these will already be treated at the STW. Dependent on the number of new housing being assessed, the spare capacity will vary because infiltration allowance (calculated as 25% of the Thetford population multiplied by the per capita consumption) increases with population increases which further reduces the capacity. This is shown in Table 5.2-2.

Table 5.2-2: Calculation of infiltration and treatment headroom for different housing scenarios

Scenarios	Housing target	Infiltration 25% of future PG (m^3d^{-1})	Calculated new DWF (m^3d^{-1})	Spare capacity (m^3d^{-1})	No of houses requiring new treatment facility
Assessment housing target up to 2021[10]	5,096	1,423	8,729	81	0
Assessment housing target up to 2031 – Scenarios A to C	7,743	1,626	9,744	-934	3,045
Assessment housing target up to 2031 – Scenarios D & E	8,096	1,653	9,879	-1,069	3,486

By undertaking an iterative calculation of the infiltration rates as they vary with the housing targets, it can be shown that there is a volumetric capacity limit at the works of 5,307 new homes before an upgrade or new STW will be required. Based on the growth target figures for Thetford the basic headroom capacity calculation shows that the STW has capacity to treat wastewater flows for the target of up to 5,096 new properties up to 2021, but only a further 211 houses can be accommodated up to 2031. In other words, development post 2021 is dependent on new STW infrastructure.

5.2.2.2 Assumption Sensitivity

The conclusions for the housing that can be accommodated by the existing capacity of the STW are sensitive to assumptions applied to the calculations, and in particular to the assumption applied to the per capita consumption. With the publication of the Code for Sustainable homes (Reference 21) there is a considerable drive to move towards more water efficient developments where water consumption is reduced by a number of measures. A reduction in water usage would significantly reduce the wastewater generated from new properties which could result in more properties being able to be treated at Thetford STW using the existing headroom capacity. However, whilst water efficiency will reduce the volume of sewerage produced from new housing, this will tend to increase the strength of the sewage. Consequently, as the volumetric capacity is increased, the biological capacity is reduced, and therefore the capacity at the works is not necessarily released for more housing as a result of these measures.

An assessment of the sensitivity of water consumption is included in section 11.7.2 of this report.

5.3 Water Environment Baseline Assessment: Wastewater

At this stage in the WCS assessment, a review of water-related environment baseline with respect to wastewater discharges is essential to ensure that:

- the water related environment has the capacity to absorb further discharges to the receiving watercourse;
- there are no absolute constraints in terms of the water environment baseline (i.e. unacceptable increase in flood risk); and
- there is no unacceptable deterioration in the quality of the water related environment;

[10] less completed development (904 homes) but including infill development

The assessment of the water environment baseline has considered the capacity issues associated with the ability of receiving watercourses to accept further discharges of treated wastewater from the new development. This assessment has been undertaken for the impacts locally on the river systems, but also on hydrologically linked sites designated for ecological and conservation reasons.

An assessment of the capacity of water resources for further abstraction has been undertaken separately and described in section 6.

The capacity of the receiving watercourses has been assessed in two ways:

- the water quality capacity i.e. how much more waste products (albeit treated) can be discharged to the receiving watercourse before water quality standards imposed to protect the integrity and ecology of a watercourse are reached; and
- the hydraulic capacity i.e. how much more water can be discharged to a point in the receiving watercourse before water levels and flows are altered to a point which affects the integrity of flow and level dependent habitats or increases flood risk downstream.

5.3.1 Assumptions

A key assumption in the baseline capacity assessment has been that the wastewater generated from new development in Thetford will be collected and treated at the existing Thetford Sewage Treatment Works (discharging on the Little Ouse downstream of Thetford town centre – Figure 5) or at a new facility downstream of Thetford on the Little Ouse.

A further assumption is that, in keeping with the requirements of PPS25 and EA policy, new development areas on existing greenfield sites will be required to provide sustainable drainage measures whereby runoff rates do not exceed the greenfield runoff rates which are currently discharged from the non-developed site areas during the design rainfall event (see section 8 of this report). This means that only the increase in generated wastewater needs to be considered in terms of the impact on hydraulic capacity of the receiving water.

5.3.2 Capacity of Receiving Watercourse

5.3.2.1 Water Quality Baseline & Capacity

River Quality Objectives (RQOs)

River Quality Objectives (RQOs) are planned targets for water quality that the Environment Agency use to help protect and improve the quality of the water in watercourses.

Each river stretch has a group of Uses, and the amalgamation of the standards for all these Uses gives a set of water quality standards for that part of the river. These quality standards may be statutory (as laid down by various European Community Directives) or non-statutory.

The Little Ouse is a designated Cyprinid Fishery under the Freshwater Fish Directive, and this is the primary driver for river quality. The river water quality standards required to support this fishery are shown in Table 5.3-1.

Table 5.3-1: Freshwater Fish Directive Imperative and Guideline Standards for Cyprinid Fisheries

Parameter	Cyprinid Standards		Notes
	Units	Standard	
Imperative Standards			
Temperature	℃	3.0	Increase due to thermal discharge
	℃	28.0	Maximum at monitoring site
	℃	10.0	Maximum for breeding season
Dissolved Oxygen	mg/l	>7	50% of samples must meet this standard. Absolute minimum.
pH	-	6 - 9	*Derogation allowed in naturally acidic areas.*
Non-ionised ammonia	mg/l	0.025	Calculated from temperature, total ammonia and pH
Total ammonium	mg/l	1	Relaxed standard of 3 mg/l can be applied where there is good evidence of healthy fish populations.
Total residual chlorine	mg/l	0.005	
Total zinc (standard is dependent on the average yearly hardness)	mg/l	0.3	Hardness <= 10 mg $CaCO_3$ / litre
	mg/l	0.7	Hardness <= 50 & > 10 mg $CaCO_3$ / litre
	mg/l	1.0	Hardness <= 100 & > 50 mg $CaCO_3$ / litre
	mg/l	2.0	Hardness > 100 mg $CaCO_3$/ litre
Guideline Standards			
Dissolved oxygen	mg/l	>8	50% of samples must meet this standard.
	mg/l	>5	100% of samples must meet this standard.
Suspended solids	mg/l	25	
BOD	mg/l	6	
Nitrites	mg/l	0.03	
Non-ionised ammonia	mg/l	0.005	
Total ammonium	mg/l	0.2	
Dissolved copper (standard is dependent on the average yearly hardness)	mg/l	0.005	Hardness <= 10 mg $CaCO_3$ / litre
	mg/l	0.022	Hardness <= 50 & > 10 mg $CaCO_3$ / litre
	mg/l	0.04	Hardness <= 100 & > 50 mg $CaCO_3$ / litre
	mg/l	0.112	Hardness > 100 mg $CaCO_3$ /litre

The principal non-statutory RQO system is the River Ecosystem (RE) Classification scheme which comprises five hierarchical classes in order of decreasing quality (see Table 5.3-2 and Table 5.3-3). Each stretch of river is given a RE target such that if the river achieves this target it means that the river will be of adequate quality to support the required ecosystem. The River Little Ouse has been assigned a target of RE2, “water of good quality and suitable for all fish species”.

Table 5.3-2: Environment Agency River Ecosystem Classification Summary

Class	Quality	Description
RE1	Very good quality	Suitable for all fish species
RE2	Good quality	Suitable for all fish species
RE3	Fairly good quality	Suitable for high-class coarse fisheries
RE4	Fair quality	Suitable for course fisheries
RE5	Poor quality	Likely to limit fish populations

Table 5.3-3: Environment Agency River Ecosystem Classification

Class	Dissolved Oxygen % saturation 10%ile	BOD (ATU) mg/l 90%ile	Total Ammonia mg N/l 90%ile	Un-ionised Ammonia mg N/l 95%ile	pH lower (limit as 5%ile upper limit as 95%ile)	Hardness mg/l $CaCO_3$	Dissolved Copper µg/l 95%ile	Total Zinc µg/l 95%ile
RE1	80	2.5	0.25	0.021	6.0-9.0	10≤ >10&≤50 >50&≤100 >100	5 22 40 112	30 200 300 500
RE2	70	4	0.6	0.021	6.0-9.0	10≤ >10&≤50 >50&≤100 >100	5 22 40 112	30 200 300 500
RE3	60	6	1.3	0.021	6.0-9.0	10≤ >10&≤50 >50&≤100 >100	5 22 40 112	300 700 1000 2000
RE4	50	8	2.5	-	6.0-9.0	10≤ >10&≤50 >50&≤100 >100	5 22 40 112	300 700 1000 2000
RE5	20	15	9	-	-	-	-	-

GQA Scheme

Whereas the Environment Agency use RQOs for planning purposes (i.e. for setting water quality targets and assessing compliance with those targets), the General Quality Assessment (GQA) scheme, is designed to provide an assessment of the general state of water quality and changes in this state over time The GQA scheme looks at a number of separate aspects of water quality:

The chemical grading gives an indication of river water quality with respect to organic pollution. River reaches are sampled a minimum of 12 times a year for the parameters shown in Table 5.3-4, and data collected over three years is used in order to give the required precision in assigning grades.

Table 5.3-4: Environment Agency chemical GQA grades in watercourses

GQA Grade	Dissolved Oxygen (% saturation) 10 percentile	BOD mgL^{-1} 90 percentile	Ammonia $mgNL^{-1}$ 90 percentile
A	80	2.5	0.25
B	70	4	0.6
C	60	6	1.3
D	50	8	2.5
E	20	15	9.0
F	<20	>15	>9.0

River reaches are assessed against all three parameters and a GQA grade is assigned based on the lowest-graded parameter.

The biological grading compares macroinvertebrates in the river with the likely assemblage which would be expected to be found if the river was not impacted. Flow and morphology are taken into account in this assessment.

Table 5.3-5 sets out the grades for chemical and biological quality and provides the context for what the grades relate to in terms of ecological quality and use for other purposes (such as abstraction for potable water).

Table 5.3-5: General Quality Assessment (GQA) classes for chemistry and biology

Chemistry Assessment			Biology Assessment		
Grade	**Quality**	**Likely Uses and Characteristics[11]**	**Grade**	**Quality**	**Description**
A	Very Good	• All abstractions • Very good salmonid fisheries • Salmonid fisheries • Cyprinid fisheries • Natural ecosystems	A	Very Good	• Biology similar to that expected for an unpolluted river
B	Good	• All abstractions • Cyprinid fisheries • Ecosystems at or close to natural	B	Good	• Biology is a little short of an unpolluted river
C	Fairly Good	• Potable supply after advanced treatment • Other abstractions • Good cyprinid fisheries • Natural ecosystems, or those corresponding to good cyprinid • fisheries	C	Fairly Good	• Biology worse than expected for unpolluted river
D	Fair	• Potable supply after advanced treatment • Other abstractions • Fair cyprinid fisheries • Impacted ecosystems	D	Fair	• A range of pollution tolerant species present
E	Poor	• Low grade abstraction for industry • Fish absent or sporadically present, vulnerable to pollution[12] • Impoverished ecosystems[13]	E	Poor	• Biology restricted to pollution tolerant species
F	Bad	• Very polluted rivers which may cause nuisance • Severely restricted ecosystems	F	Bad	• Biology limited to a small number of species very tolerant of pollution

As well as the chemical and biological quality, river systems are also monitored for their nutrient quality which is used to indicate the level of 'eutrophication' of the river reach. Eutrophication is the process by which a water body is saturated by nutrients (generally from anthropogenic sources such as fertiliser runoff or treated wastewater discharges) which has the impact of altering the balance of the ecosystem. This alteration occurs because excessive nutrients allow nuisance species such as algae to proliferate at an unnatural rate at the expense of other aquatic life which rely on the system (fish and aquatic plants); the overall effect is to reduce biodiversity. The two most important nutrients in terms of eutrophication, nitrogen (N) and phosphorus (P), and these are each assessed using a separate GQA grade.

Nutrient levels in rivers naturally exhibit considerable spatial and seasonal variability. A grade from 1 to 6 is allocated for both phosphate and nitrate. There are no set 'good' or 'bad' concentrations for nutrients in rivers in the way that is used to describe chemical and biological quality. Rivers in different parts of the country have naturally different concentrations of nutrients. 'Very low' nutrient concentrations, for example, are not necessarily good or bad; the classifications merely state that concentrations in this river are very low relative to other rivers. Table 5.3-6 shows the GQA classification systems used for nutrients.

[11] Provided other standards are met
[12] Where the grade is caused by discharges of organic pollution
[13] As footnote 5

Table 5.3-6: General Quality Assessment (GQA) classes for nutrients

Nitrate Grades	Description	Phosphate Grades	Description
1	Very Low	1	Very Low
2	Low	2	Low
3	Moderately Low	3	Moderate
4	Moderate	4	High
5	High	5	Very High
6	Very High	6	Excessively High

Water Quality Baseline

Figure 5 shows the sampling locations around Thetford. Recent RE compliance information and GQA grades for each of the river reaches within the study area are reported in Table 5.3-7. For RE compliance, three chemical measures have been selected for trend monitoring – Biological Oxygen Demand (BOD), Dissolved Oxygen (DO) and ammonia.

Table 5.3-7: Water Quality Assessment for River Thet and Little Ouse in the Study Area

Name of River Stretch	Sampling Location Code	Location	River Quality Objective			General Quality Assessment							
				Compliance		Chemistry		Biology		Nitrate		Phosphate	
			Target	2003-2005	2004-2006	2003-2005	2004-2006	2002	2005	2003-2005	2004-2006	2003-2005	2004-2006
River Little Ouse (Black Bourne to River Thet)	**WQ43M02**	**Upstream of Thetford**	2	Pass	Marginal Pass	B	C	A	A	5	5	4	5
River Thet (Brettenham Road Bridge to Little Ouse)	**WQ44M08**	**Upstream of Thetford**	3	Pass	Pass	B	B	A	A	5	5	4	4
River Little Ouse (Thet to Santon Downham)	**WQ45M02**	**Downstream of Thetford STW**	2	Pass	Pass	B	B	A (2003)	A (2006)	5	5	5	5

As indicated in Table 5.3-7, RQO targets within the study area range from RE2 to RE3, and all three stretches of river have consistently achieved the required target. The marginal pass recorded in the Little Ouse downstream of Thetford in 2006 was due to lower than normal dissolved oxygen levels.

The GQA grades confirm that chemical quality in each river stretch is "good", but indicate that biological quality is "very good". This is in keeping with many low-lying East Anglian river systems that have a minimal gradient and as a result suffer from low dissolved oxygen levels during the summer months. The fish and invertebrate life in the rivers have adapted to these conditions, and are not affected by the seasonal change. The lower-than-normal dissolved oxygen levels downstream of Thetford were reflected in the drop to chemical Grade C in 2006.

Nutrient levels are either high or very high, but again, this is typical of inland rivers in East Anglia where diffuse inputs from agricultural sources are high. River phosphate levels in the Little Ouse have dropped significantly since the end of 2004 when phosphate-stripping was installed at Thetford STW due to the designations of Sensitive Areas (Eutrophic) under the Urban Wastewater Treatment Directive.

In addition to the RE2 target, the Little Ouse is also designated as a Cyprinid Fishery under the Freshwater Fish Directive. The river stretch downstream of Thetford STW has been fully compliant with all mandatory standards since designation.

The water quality baseline assessment demonstrates that the rivers in the Thetford area are of good quality and are currently achieving all required water quality standards.

Thetford STW performance

Thetford STW is permitted to discharge to the Little Ouse under a Water Resources Act discharge consent issued by the Environment Agency. This discharge consent has several conditions that must be met by the treated effluent discharged by the STW and compliance with the conditions is assessed by taking samples of the treated effluent discharged. In order to comply with the consent, AWS must operate the STW such that following conditions are met:

- Dry Weather Flow (DWF) i.e. the flow that is discharged during dry weather, consisting mostly of wastewater generated from the population and industry etc, must not exceed 8,810 m^3d^{-1};
- Flow to Full Treatment (FtFT) i.e. the flow that is discharged during wet weather (consisting of wastewater and surface water runoff from rainfall), must not exceed 21,960 m^3d^{-1};
- The discharge shall not contain greater than 35 mg l^{-1} of Biochemical Oxygen Demand (BOD) on a 95 percentile basis with an upper limit of 70 mg l^{-1};
- The discharge shall not contain greater than 16 mg l^{-1} of ammoniacal nitrogen (Ammonia) on a 95 percentile basis with an upper limit of 45 mg l^{-1};
- The discharge shall not contain greater than 50 mg l^{-1} of suspended solids (SS); and
- The discharge shall not contain greater than 7 mg l^{-1} of iron (Fe).

In terms of the concentrations set for BOD, SS and ammonia (i.e. the sanitary determinands), liaison with the EA has established that the Little Ouse will meet its water quality requirements as long as all the flow treated up to the consented flow limit (of 8,810 m^3d^{-1}) discharges to these concentration limits.

The consenting process for Thetford STW has been undertaken on a 'river needs' basis, whereby the EA establish the STW consent parameters for treated discharges based on the River Quality Objectives. For the Little Ouse these are:

- The Freshwater Fisheries Directive (Little Ouse being a designated Cyprinid Fishery);
- The Urban Wastewater Treatment Directive (Thetford being an indirect discharge to two Sensitive Areas (Eutrophic) – the Old West River & Ely Ouse and the Cut-Off Channel
- Government targets (RE2 target); and
- EA policy (local RQO targets for spray irrigation and high amenity).

The current performance of Thetford STW is good, with effluent quality consistently within the discharge consent limits. This in turn is enabling the Little Ouse downstream of the discharge to maintain its RQO target of 2 and compliance with the Freshwater Fish Directive standards.

Analysis of compliance data supplied by AWS supports this conclusion as does liaison with the water quality planning team at the Environment Agency.

Water Quality Capacity

In terms of the concentrations set for BOD, SS and ammonia (i.e. the sanitary determinands), liaison with the EA has established that the Little Ouse will meet its water quality requirements as long as all the flow treated at Thetford STW up to the consented DWF limit (of 8,810 m^3d^{-1}) discharges to the existing concentration limits.

If the population increases being assessed in this WCS are such that the STW would need to discharge a dry weather flow greater than the consented limit, the water quality concentration limits on the treated discharges would have to be reduced in order to prevent a failure of the Little Ouse RQO targets.

The baseline assessment for wastewater as described in section 5.2 concluded that the existing works has enough treatment capacity such that it can accommodate the additional increase in housing of up to 5,096 houses without breaching the DWF consent limit of the works. As a result, there would be no requirement to reduce the consented water quality limits applied to the treated effluent up to 2021. However, at some point between 2021, the projected future growth would exceed the consented DWF at the STW and would hence require a reduction in the concentration of parameters in the treated discharge.

The degree to which the consented water quality limits would have to be reduced would be worked out by the Environment Agency using a comprehensive Monte Carlo simulation tool and this would be a key part of the Stage 2 WCS. However, simple mass balance calculations have been undertaken in Stage 1 using the following assumptions:

- It was acceptable to use the 95 percentile concentration from the STW consent for BOD and ammoniacal-N;
- It was acceptable to use the 90 percentile concentration of BOD and ammoniacal-N in the Little Ouse downstream of the STW (using data from the EA's GQA publications on the web);
- A basic assumption of a conservative pollutant[14] for BOD and ammoniacal-N;
- Q95 gauged low flow data from the Little Ouse as provided by the EA;
- Different assumptions on the increases in dry weather flow depending on the scenario being assessed and hence maximum number of new houses; and
- The RE target for the Little Ouse downstream of Thetford STW is RE2.

The mass balance calculations have been undertaken to provide an indication of the degree of change required in consent standards in order to achieve compliance with the current water quality standards and legislation. It should be noted that the actual consent limits required will need to be agreed via EA approved Monte Carlo simulations during the Stage 2 study.

The EA's published data showed that, for the latest monitoring period, the 90 percentile performance of the Little Ouse for BOD and ammoniacal-N was good. For BOD it achieved a 90 percentile concentration of 1.82 mg l^{-1} which is better than the 90 percentile target for RE1 (2.5 mg l^{-1}). For ammoniacal-N, the river achieved a 90 percentile of 0.38 which places it within the RE2 target of 0.6 mg l^{-1}. Initial mass balance calculations suggest that the additional load added by the treated flow over and above the consented flow up to 2031 would not result in the river failing the RE target of 2 for BOD or ammoniacal-N, assuming that the effluent is treated to its consented quality of 35 mg/l (95%ile) and 16 mg/l (95%ile) respectively before discharging into the Little Ouse. These estimates will have to be verified, using Monte Carlo modelling, in the Stage 2 WCS once the preferred option for providing the additional treatment is agreed.

[14] Conservative in this context means it does not degrade over time but remains in the river as load once it is discharged

In terms of nutrient loads, although nitrates are considered high in the Little Ouse, phosphorous (P) is considered to be the limiting nutrient with respect to eutrophication in freshwater river systems. Because the Little Ouse is connected to two Sensitive Areas (eutrophic) under the Urban Waste Water Treatment Directive (UWWTD) and because Thetford STW treats a population equivalent of greater than 10,000, the STW is required to limit mean Phosphate concentrations in its treated effluent discharge to 2 mg l^{-1}. This requirement will continue for the additional homes and additional discharge, unless the PE were to exceed 100,000 in which case the mean P concentration would have to reduce to 1 mg l^{-1}.

Despite the limit of 2 mg l^{-1} on the treated effluent, the increase in housing and hence increase in P load discharged to the river is likely to further increase instream P concentrations which may result in decrease in GQA P grading to a more consistent grade 5 (very high) or grade 6 (excessively high). There is currently no statutory legislation that would drive a further reduction in P on the consent and hence, although undesirable, it is accepted that the additional wastewater from the proposed development will not lead to a tighter phosphorous removal limit tighter than the current 2 mg l^{-1}. The Screening stages of the Habitats Directive assessment has also indicated that there is unlikely to be an impact on designated sites as a result of increases in P concentrations. However, the draft Water Framework Directive standards are likely to alter this due to the much tighter standard for concentrations of P in rivers.

Other Water Quality Considerations

Before moving on from the water quality baseline assessment, it should be noted that the assessment outlined above is based on existing legislative and statutory guidance. 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).

The WFD 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 river basins must achieve *"good ecological status"* by 2015 unless there are grounds for derogation. The WFD will, for the first time, combine water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, groundwaters, estuaries and coastal waters at the river basin level will be adopted.

UKTAG[15], the advisory body responsible for the implementation of the WFD in the UK, has proposed water quality standards be adopted. These are currently in draft form and will not be formalised until the final River Basin Management Plans are finalised in December 2009 (prior to EC sign off). For this reason, it has not been possible to undertake a full assessment of the impact of trying to meet the new WFD standards which in may cases are likely to be stricter and more onerous to meet than those set by existing statutory targets and legislation. Despite this, the WCS is required to consider the longer term issues with respect to the water cycle and water environment and as such, an assessment of the impact of the interim WFD standards has been undertaken for this Stage 1 study. Because the WFD sets standards for ecology and quantity issues (i.e. abstracted and flow) as well as water quality, the assessment of the WFD impacts are concluded in a separate section of this report (section 10).

5.3.3 Hydraulic Baseline & Capacity

The Little Ouse is gauged at Abbey Heath, a little over 1km downstream of the Thetford STW. (see Figure 5), and the river has been gauged at this station since 1968. The EA provided daily mean gauged flow data for the river and a rating curve which allows the user to determine the water level which will result for any given flow value at the gauging station, or for a given water level, to determine the flow. The EA also

[15] The UKTAG (UK Technical Advisory Group) is a working group of experts drawn from environment and conservation agencies. It was formed to provide technical advice to the UK's government administrations and its own member agencies. The UKTAG also includes representatives from the Republic of Ireland.

confirmed that at Abbey Heath, the river comes out of bank when flows are greater than the Qmed peak flood flow. The Qmed peak flood flow is defined as the 1 in 2 year flood flow, or the maximum flood flow that has a 50% chance of occurring in any given year. The EA estimate the Qmed flow to be approximately 15.2 $m^3 s^{-1}$.

To supplement the information provided, a hydrology analysis was undertaken for the gauging station using the statistical methodology set out in the Flood Estimation Handbook (FEH) for determining the return periods and expected frequency of different peak flood flows. Appendix E – FEH calculations, sets out the calculations undertaken and the methodology used; the results are provided in Table 5.3-8.

Table 5.3-8: Estimates of flood flows and return periods for the Little Ouse at Abbey Heath using two FEH methodologies

Event Return Period	Statistical method – peak flow estimation (m3 s-1)
Qmed (1 in 2 year)	17.93
Q5 (1 in 5 year)	23.94
Q10 (1 in 10 year)	27.62
Q20 (1 in 20 year)	31.10
Q50 (1 in 50 year)	35.69
Q100 (1 in 100 year)	39.20
Q100 + cc (1 in 100 year + allowance for climate change	47.04
Q200 (1 in 200 year)	42.81

In order to determine the potential capacity of the receiving watercourse it was necessary to determine whether the additional wastewater discharged from the proposed growth in Thetford was likely to significantly alter water levels, particularly flood levels in the river Ouse downstream of Thetford.

The Wastewater Baseline Assessment has determined the likely increase in wastewater flow from the additional growth proposed in Thetford. The maximum flow that would arise from the increase in population would occur during Flow to Full Treatment (i.e. during a rainfall event - FtFT) has been calculated to be 26,331 m^3d^{-1} (based on max new housing number of 8,096). The FtFT for the existing population has been calculated to be 17,632.04 m^3d^{-1} giving rise to an additional flow of 8,699.4 m^3d^{-1}; this equates to an additional flow of 0.101 m^3s^{-1}. This additional flow figure has been compared to the peak flood flows in the river estimated from the FEH analysis and presented as a percentage of additional flow in the river as shown in Table 5.3-9.

Table 5.3-9: Additional wastewater discharge as a percentage of peak flood flow for a selection flood events with different return periods

Flood flow Return Period	Peak Flood Flow (m^3s^{-1})	Additional flow from increase in FtFT (m^3s^{-1})	Additional flow as a % of river flood flow (%)
Qmed (1 in 2 year)	17.93	0.101	0.56
Q5 (1 in 5 year)	23.94	0.101	0.42
Q10 (1 in 10 year)	27.62	0.101	0.36
Q20 (1 in 20 year)	31.10	0.101	0.32
Q50 (1 in 50 year)	35.69	0.101	0.28
Q100 (1 in 100 year)	39.20	0.101	0.26

Flood flow Return Period	Peak Flood Flow (m^3s^{-1})	Additional flow from increase in FtFT (m^3s^{-1})	Additional flow as a % of river flood flow (%)
Q100 + cc[16] (1 in 100 year + allowance for climate change	47.04	0.101	0.21
Q200 (1 in 200 year)	42.81	0.101	0.24

The results show that even for the lower return period events, the additional flow makes very little difference to the flood flow (less than 0.56%) which is unlikely to have an impact on flood levels and hence frequency of flooding downstream of the STW. The design event recommended by PPS25 is the Q100 plus an allowance for climate change (increase in flow of 20%) and the analysis shows that the additional wastewater will only contribute a 0.21% increase in flood flow which is considered insignificant. For flows in the river less than the Qmed flow, the percentage of the river flow made up by the additional treated wastewater will be higher; however, the EA have confirmed that for flows less the peak Qmed flow, the Little Ouse stays in bank downstream of Thetford STW hence the additional flow form the treated wastewater will not result in a significant change in water level that would result in an out bank flow.

In order to verify this conclusion, a basic assessment was made of the likely change in water level predicted at the Qmed flow using channel cross-section data provided by the EA and Manning's equation for the prediction of water level for different flood flows.

In absence of any available data, a channel slope of 1 in 300 was assumed with a Manning's roughness co-efficient of 0.045 the Manning's value was selected on the basis of a natural watercourse but with weeds and boulders (Chow 1986 –Reference 29); The channel dimensions provided (by the EA) for a single point just downstream of Thetford STW were used and the cross section was simplified into a trapezoidal channel to facilitate the application of the Manning's calculation spreadsheet.

The model calibrated well with observed data in that the predicted water level for the 1 in 2 year flow (the Qmed) was predicted to be at just below bankfull (as suggested by the EA). The results of adding the additional flow of 0.069 m^3s^{-1} showed that there was little discernible change in water level, with an estimated 10cm increase in levels. This is considered to be within the bounds of model error and unlikely to significantly alter the return period for which out of bank flows would be experienced. The results are shown Table 5.3-10.

Table 5.3-10: Tabulated results of levels in the Little Ouse for additional wastewater flow, undertaken using Manning's Calculations.

				Calculation of normal flow in a trapezoidal channel by Manning's equation											
Flood peak (T)	add flow	flood peak (cumecs)	actual water depth	Base width	Water depth	Side slope	Wetted perimeter	Area	Hydraulic radius	Channel slope	n	Velocity	Discharge *	Hydraulic mean depth	Froude Number
2		17.93	7.91	7.500	1.529	0.515	10.939	12.670	1.158	0.0033	0.045	1.415	17.93	1.396	0.382
2 + add flow	0.101	18.03	7.91	7.500	1.534	0.515	10.952	12.720	1.162	0.0033	0.045	1.418	18.03	1.401	0.382
5		23.94	8.21	7.500	1.828	0.515	11.613	15.433	1.329	0.0033	0.045	1.551	23.94	1.645	0.386
10		27.62	8.38	7.500	1.998	0.515	11.994	17.037	1.421	0.0033	0.045	1.621	27.62	1.783	0.388
20		31.10	8.53	7.500	2.150	0.515	12.336	18.502	1.500	0.0033	0.045	1.681	31.10	1.905	0.389
50		35.69	8.72	7.500	2.340	0.515	12.764	20.371	1.596	0.0033	0.045	1.752	35.69	2.056	0.390
100		39.20	8.86	7.500	2.479	0.515	13.076	21.757	1.664	0.0033	0.045	1.801	39.20	2.164	
100+cc		47.04	9.15	7.500	2.773	0.515	13.738	24.759	1.802	0.0033	0.045	1.900	47.04	2.391	0.392
200		42.81	9.00	7.500	2.617	0.515	13.388	23.157	1.730	0.0033	0.045	1.849	42.81	2.272	

5.3.4 Habitats Regulation Assessment

The initial Stages (screening stages) of a Habitats Regulation Assessment as required under the Habitats Directive have been undertaken for the Stage 1 Thetford WCS (see section 9). Until the development areas and development scenarios are agreed in detail following review of all planning considerations, it is

[16] 20% increase in flood flows for the 1 in 100 year event is used to asses the impact of climate change as recommended in PPS25

not possible to complete a full AA on the WCS to determine the full impact on designated European Sites (such as SACs, SPAs or RAMSAR sites). This will be a requirement of the Stage 2 Detailed Study, but a screening study for the AA is suitable for a stage 1 WCS in order to identify if there are any ecological constraints to the outline study. It should be noted that, at the time of writing, the Habitat Regulations Assessment for the East of England RSS has not been agreed.

The AA screening study has confirmed that there are no European sites that are likely to be affected by the increase in treated wastewater (notably P and volume of wastewater) as a result of the increase in development in Thetford. Additionally, the screening assessment has identified that there are no other national, regional or locally designated sites which are likely to be affected by the additional treated wastewater discharge.

5.3.5 Environmental Constraints Assessment Summary

It should be noted that the environmental constraints considered in the WCS relate to development within Thetford as a whole and only differs according to the number of houses or employment areas being considered. Because the discharge point for the wastewater will be the same regardless of the development areas/scenarios taken forward and because the water sourced for the development does not vary according to the development areas taken forward, the environmental constraints are not considered to vary between development scenarios. Assessment of other environmental considerations of each development area and scenario which are not linked to the 'water cycle', are assessed and discussed elsewhere in other studies supporting Breckland's LDF.

Following the constraints assessment undertaken and reported in this section, the constraints in terms the water environment baseline can be summarised as follows and can be considered as common to all development areas and scenarios:

- The assessment of the existing capacity at the works is such that there id lkely to be a requirement to limit average P concentrations such that treated effluent concentrations are no higher than current discharged concentrations (2 mg l^{-1} of P); however, in stream P concentrations are likely to increase and although no current statutory driver exists to limit P, future legislation under the WFD is likely to require future investment in P reduction;
- The existing quality of the Little Ouse under the EA's GQA grading system is good and it complied with its water quality RQO; development up to 2031 should ensure that this remains the case; and
- There is adequate hydraulic capacity in the Little Ouse to accept the additional wastewater flow without increasing downstream flood levels or affecting ecologically sensitive sites

These factors all demonstrate that the Little Ouse has sufficient water quality and hydraulic capacity (under current statutory targets to receive further discharge of treated wastewater without causing detriment to the Little Ouse under current statutory water quality targets and without impacting on European protected sites.

5.4 Wastewater Network – Baseline & Restrictions Assessment

5.4.1 Wastewater Network baseline

AWS is responsible for the operation and maintenance of the existing foul drainage network and sewage treatment facilities, within the Thetford study area. Thetford is currently served by a separate sewerage

system which all drains to Thetford STW located to west of central of the town centre. Figure 2 outlines the current layout of pipe drainage within the town.

In liaison with AWS, the initial starting point for the Stage 1 Thetford WCS was that any spare 'capacity' in the existing wastewater network would be required to cater for the infill development (identified for Thetford as approximately 1,000 new properties) and for increases in storm flows with climate change[17] in order to prevent an increase in sewer flooding within the existing urban extent of Thetford. Applying this assumption would mean that there was no spare capacity in the wastewater network and that all new development in the new development areas would require new wastewater transmission infrastructure. It is important to establish whether there is some additional capacity, otherwise onset of development in the new development areas would be restricted until the point in time at which AWS will have secured funding for new wastewater transmission infrastructure through the statutory Price Review process (likely to be 2010 – see section 2.2.2.2)

Despite this starting point, subsequent liaison with AWS and the Project Group identified that there was the possibility that some of the new development proposed for the new development areas could be connected to the existing system, where there were no overriding restrictions in the existing system. In order to determine potential restrictions, the wastewater network GIS layout has been interrogated, along with records of DG5 register sewer flooding incidents.

Possible drainage paths, within the existing network, for each of the proposed growth area locations were identified. High level preliminary assessments of the capacities of these drainage paths were then undertaken. This was done to provide an indication of whether it is feasible to drain any of the proposed growth locations via the existing network. Figures 6a to 6d show the drainage paths that were assessed for four potential connection areas.

The assessment has shown that development near to Connection Area 1 (area to the north west of Thetford) is the area with the greatest potential for early development without the need for significant sewer network upgrades. Currently, this area is designated as a likely area for employment growth (Enterprise Park); however, this assumption would still apply to housing located in Key Site North to the east if the Area 1. The existing sewer(s) draining from this area may be able to accommodate an additional 1000 houses. It should however be noted that this sewer drains effluent from an industrial estate. Without more detailed investigation, there is considerable uncertainty to the level of the current effluent from this estate and it is recommended that the wastewater modelling is undertaken to verify this ascertain in Stage 2 WCS.

The other three potential connection areas (2, 3 and 4) appear to have very limited spare capacity on the basis that there is a major restriction on a key strategic route draining the southern and eastern sections of Thetford through the town centre and onto Thetford STW. It is therefore recommended that this limited spare capacity be set aside to enable the planned infill development within the existing urban extent.

As more sewer capacity is taken up by base-flow there is an increased risk to the local watercourses as Combined Sewer Outfalls and pumping station overflows spill more frequently and for longer periods. Stage 2 of the WCS will need to include an impact assessment, and options for mitigation, of the risk of environmental impact posed by taking up capacity in the existing sewerage network.

5.4.1.1 Wastewater modelling

Ideally, the assessment of restrictions would have been undertaken using AWS's hydraulic Infoworks model of the Thetford wastewater network; however, this model was going through a process of being

[17] Climate change is predicted to lead to an increase in winter rainfall and an increase in the frequency of storm events with a high intensity of rainfall which will lead to more frequent overloading of sewer systems

updated at the time of the Stage 1 WCS being undertaken and is not due for completion until April 2008. Therefore, it is recommended that the basic restriction calculations undertaken for Stage 1 are revisited and verified during Stage 2 of the WCS.

5.5 Wastewater Assessment - Summary

In summary, the following points can be made about the wastewater baseline and spare capacity:

- All additional wastewater flow will be transferred and treated at Thetford STW
- There is sufficient volumetric headroom treatment capacity to treat the 6,000 homes required up to 2021;
- There is only sufficient capacity to treat a further 5,307 homes between 2021 and 2031 – an upgrade or a new STW facility will be required to treat flows from the remaining target of 211 homes up to 2031 in terms of volumetric capacity;
- Further investment is required in order to treat the additional flow from the additional population projected for between 2021 and 2031 such that the Little Ouse continues to reach its statutory river quality and ecology targets;
- These conclusions need to be verified in Stage 2 WCS following an assessment of the process capacity at the STW, whereby the existing headroom capacity could be calculated to be less;
- Up to 1000 properties can be developed in areas north of the existing urban extent without the need for significant sewer infrastructure upgrade; infill development will utilise any existing capacity within the remaining system; and
- The network conclusions are currently indicative and need to be verified with network modelling of the development scenarios once the revised Infoworks hydraulic model for Thetford is available.

6 Water Resources and Water Supply Baseline Assessment

6.1 Introduction

This assessment covers the existing baseline with respect to available water resources and where the raw water to supply the new development will be sourced. It also considers the requirement for transmission infrastructure for treated water in order to service and supply the new development areas

6.2 Available Data & Assumptions

Water Supply to Thetford is the sole responsibility of AWS who are in the process of producing their statutory Water Resource Management Plan (WRMP) 2009 which sets out how AWS plan to provide the required water resources for the region over the next 25 years. Some outline interim information was made available from the emerging plan in terms of forecasted supply and demand balances to 2021 and beyond. The draft WRMP09 was due for consultation at the time of writing this report. However, the following information was made available:

- AWS have made available their 2004 WRMP which has been used in this assessment;
- Some outline information was made available in terms of supply and demand balance from the draft WRMP09;
- AWS provided outline information on the location of the three existing sources of raw water supply to Thetford, including licensed daily abstraction limits, annual maximum abstraction and approximate locations of abstractions and storage reservoirs;
- AWS provided network layouts including pipe sizes of the water supply network;
- EA Catchment Abstraction Management Plans (CAMS); and
- NE provided information pertaining to the Appropriate Assessment undertaken for one of the abstraction sources relating to a component part of the Breckland SAC/SPA.

6.3 Regional Water Resources: Existing Situation

The Environment Agency (2001) identifies the Anglian Region as being the driest region of England and Wales. On average the region receives just under 600mm of rainfall per annum.

Evaporation from vegetation reduces this amount by approximately 450mm a year, to give only 150mm per annum of 'effective rainfall'[18] to replenish aquifers and to maintain river flows. The recharge of aquifers is an important mechanism for providing feeds to groundwater-fed ecosystems and wetland habitats. This is aligned with the government policy to maximise Sustainable Drainage Systems (SUDS) where possible and practical (see Section 8).

[18] Effective rainfall is defined as the proportion of rainfall that makes up flow river flow or aquifer recharge i.e. that which is not lost to evaporation, uptake by plants or soil storage

In drought years, the rainfall across the Anglian Region can be as low as 450mm, which reduces the amount of 'effective rainfall' to effectively zero. The climate gradient from West to East and from North to South is accentuated across the region.

Regionally, the water supply is resourced from two main sources:

- River abstraction – 60%; and
- Groundwater abstraction – 40%.

6.4 Thetford - Water Resource baseline Assessment

The Environment Agency manages water resources at the local level through the use of Catchment Abstraction Management Plans (CAMS). Thetford lies within the boundary of the Cam and Ely Ouse (including South Level) catchments.

The water supplies around Thetford are all heavily reliant on groundwater. This is the only practical source of supply as the only feasible nearby surface water sources are the River Thet (classed as over licensed [O-L]), Upper River Little Ouse (classed as O-L) and Sapiston Brook (classed as No Water Available [NWA]).

Within the CAMS, the Environment Agency's assessment of the availability of water resources is based on a classification system that gives a resource availability status and indicates;

- The relative balance between the environmental requirements for water and how much is licensed for abstraction;
- Whether water is available for further abstraction;
- Areas where abstraction needs to be reduced.

The categories of resource availability status are shown in Table 6.4-1. The classification is based on an assessment of a river system's ecological sensitivity to abstraction-related flow reduction. This classification can then be used to assess the potential for additional water resource abstractions.

Table 6.4-1: CAMS resource availability status categories

Indicative Resource Availability Status	License Availability
Water Available (WA)	Water is likely to be available at all flows including low flows. Restrictions may apply.
No Water Available (NWA)	No water is available for further licensing at low flows. Water may be available at higher flows with appropriate restrictions.
Over Licensed (O-L)	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. Water may be available at high flows, with appropriate restrictions.
Over Abstracted (A-A)	Existing abstraction is causing unacceptable damage to the environment at low flows. Water may still be available at high flows, with appropriate restrictions.

The classification for each of the surface waters and groundwaters in the Thetford area is summarised in Table 6.4-2 below.

Table 6.4-2: CAMS resource availability classification

River – WRMU G	Surface Water	Groundwater
Lower Little Ouse	O-L	NWA
Upper Little Ouse	O-L	NWA
Thet	O-L	O-L
Sapiston Brook	NWA	NWA
Ely Ouse (South Level)	O-L	N/A

This table shows a majority of the nearby surface water courses to be over-licensed i.e. that there is little water available at low flows. In order to protect these surface waters, the groundwaters feeding the surface waters with baseflow have also been classified as having no water available or in the case of the River Thet to be over-licensed. It is therefore the case that the classifications around Thetford indicate little opportunity for further surface water or groundwater resource development, at least not in the summer months. Because water companies have to plan their water resource development and hence ensure security of supply for the eventuality of dry years as well as normal years, this means that there is little opportunity to provide future security for Thetford by developing new water resources from the surrounding area.

6.4.1 Abstraction Sources

No surface water abstraction for Public Water Supply (PWS) takes place in the vicinity of Thetford: all of Thetford's water supply is sourced from groundwater sources. Three major PWS boreholes are operated by AWS which provide water for Thetford. Two of these boreholes, Barnham Cross and Nunnery Lodge are located to the South of Thetford with Nunnery Lodge being located close by Key Site South East. One other borehole at Two Mile Bottom is located to the north of the Thetford and outside the ring road i.e. beyond the Key Site North area proposed for development. Figure 7 shows the approximate location of the borehole abstractions supplying Thetford.

Cambridge Water Company (CWC) also has a number of PWS boreholes from which water abstracted and transferred out of the area in order to feed the water demand of the City of Cambridge. In general, these boreholes lie further away to the east at Brettenham. A summary of the licensed Public Water Supply (PWS) sources around Thetford is shown in Table 6.5-1.

6.5 Water Supply – Existing Capacity

6.5.1 Growth Forecasts – Increase in Demand

Various estimates can be made of the likely growth in demand expected from the developments around Thetford based on the growth targets for Thetford and the development scenarios as set out in section 3. These are summarised in Table 6.5-2. The highest forecast for the demand from the maximum target of 8,096 new homes is 3.24 Mld^{-1} to be supplied on average by AWS. For the lower limit of 7,743 homes, the highest maximum target is 3.09 Mld^{-1}. Table 6.5-2 sets out how this varies for different development areas from between scenarios and for different assumptions on per head consumption. The demand calculations have allowed for a 30% increase in residential demand on top of that calculated purely by the water consumption and occupancy rates; this is to make an allowance for headroom which AWS need to supply in order to meet security of supply.

Table 6.5-1: Summary of Licensed PWS sources around Thetford

					Licence Quantity (Ml/d)		
Source Name	**Approx location**	**Water Co.**	**Supply Reservoir fed**	**Area of Thetford supplied**	**Annual Average**	**Daily Max**	**Approximate proportion of annual licence used**
Barnham Cross*	Just South West of Thetford	AWS	Barrow Hill	South (plus parts of Brandon to the West of Thetford)	2.7	3.4	Not known
Nunnery Lodge*	Just South East of Thetford	AWS	Barrow Hill	South (plus parts of Brandon to the West of Thetford)	4.3	5.7	Not known
Two Mile Bottom*	Approx 2 km north west of Thetford	AWS	Mundford Rd	North (plus rural zone of East Wretham)	5.1	6.8	Not known
Two Zone 1's W and SE (Nr Brettenham)	Not known	CWC	Not known	For Cambridge	Not known	Combined total 24 Ml/d (CWC), 50% temp. licence	Not known
Fowlmere	Not known	CWC	Not known	For Cambridge	Not known	Not known	Not known

Note: AWS Anglian Water Services CWC Cambridge Water Company
**Main feed to Thetford - all from AWS's groundwater sources. Combined total of 4000Ml (Avg. 11 Ml/d)*

Table 6.5-2: Estimate of additional demand from proposed development

Scenario	Development Area	up to 2021				up to 2031			
		Number of new houses	AW forecast (Ml/d)[*1]	CLG traget rating lower 120 l/h/d (Ml/d)[*2]	CLG target rating higer 135 l/h/d (Ml/d)[*2]	Number of houses	AW forecast (Ml/d)[*1]	CLG traget rating lower 120 l/h/d (Ml/d)[*2]	CLG target rating higer 135 l/h/d (Ml/d)[*2]
Scenario A	Existing urban extent	1073	0.43	0.35	0.4	1073	0.43	0.35	0.4
	Key Site South East	1220	0.49	0.4	0.45	2200	0.88	0.72	0.81
	Key Site North East	2810	1.12	0.92	1.04	4470	1.78	1.46	1.65
TOTAL		**5103**	**2.04**	**1.67**	**1.89**	**7743**	**3.09**	**2.53**	**2.86**
Scenario B	Existing urban extent	1073	0.43	0.35	0.4	1073	0.43	0.35	0.4
	Key Site South East	0	0	0	0	2200	0.88	0.72	0.81
	Key Site North East	4030	1.61	1.32	1.49	4470	1.78	1.46	1.65
TOTAL		**5103**	**2.04**	**1.67**	**1.89**	**7743**	**3.09**	**2.53**	**2.86**
Scenario C	Existing urban extent	1073	0.43	0.35	0.4	1073	0.43	0.35	0.4
	Key Site South East	2200	0.88	0.72	0.81	2200	0.88	0.72	0.81
	Key Site North East	2825	1.13	0.93	1.04	4470	1.78	1.46	1.65
TOTAL		**6098**	**2.44**	**2**	**2.25**	**7743**	**3.09**	**2.53**	**2.86**
Scenario D	Existing urban extent	1073	0.43	0.35	0.4	1073	0.43	0.35	0.4
	Key Site North	4030	1.61	1.32	1.49	4030	1.61	1.32	1.49
	North East (C) or A11 North	0	0	0	0	2993	1.19	0.98	1.1
TOTAL		**5103**	**2.04**	**1.67**	**1.89**	**8096**	**3.23**	**2.65**	**2.99**
Scenario E	Existing urban extent	1073	0.43	0.35	0.4	1073	0.43	0.35	0.4
	Key Site South East	2200	0.88	0.72	0.81	2200	0.88	0.72	0.81
	Key Site North East	2825	1.13	0.93	1.04	2825	1.13	0.93	1.04
	North East (C) or A11 North	0	0	0	0	1998	0.8	0.5	0.74
TOTAL		**6098**	**2.44**	**2**	**2.25**	**8096**	**3.24**	**2.5**	**2.99**

[1] *Assuming 146 l/h/d supplied by(AWS) %)and assuming 2.1 occupancy rate*
[*2] *Target rating of 120-135 l/h/d (Ref. Consultation of water efficiency in new buildings – recommendation for new Building regulation standard, CLG and DEFRA – January 2007) and an assuming occupancy rate of 2.1 (AWS assumption)*

6.5.2 Existing Capacity

As already mentioned, AWS supply for Thetford comes from three groundwater sources - Barnham Cross (BC), Nunnery Lodge (NL) and Two Mile Bottom (TMB). This later borehole (TMB) supplies Mundford Road Reservoir and from there water is pumped to supply the north of Thetford and areas to the east around East Wretham. BC and NL pump water to Barrow Hill Reservoir and from there to the south of Thetford and areas to the west around Brandon. The amount that can be abstracted from these sources is set out in the details of abstraction licences as determined by the EA; the average amount that AWS is able to abstract from each source is shown in Table 6.5-1. Despite the average limits set on the individual licences, there is an overall limit on how much water can be abstracted within a year for all three of the licences combined. This annual maximum figure is 4000 Ml. This licence, granted by the Environment Agency, represents the quantity of abstraction that they currently consider can be abstracted without imposing any adverse impact on Thetford Golf Course and Marshes SSSI.

Of the water transferred out of area by CWC in order to feed Cambridge's demand, it is not clear whether any spare water is available from these sources in order to possibly supply parts of Thetford (subject to legal agreement between the water companies) in the future. However, it is known that a WCS is currently underway for Cambridge and that the option of increasing abstraction from the CWC sources will likely be investigated as part of the Cambridge WCS. This potential option should be investigated in the Stage 2 WCS.

AWS were unable to provide figures on the percentage of the Thetford licences utilised hence it has not been possible to determine exactly the existing capacity in the water resource system. Despite this, interim outputs were provided from the WRMP09 which gave information relating to the difference in water available for supply and the demand for potable water in the Thetford Water Resource Planning Zone (Thetford WRZ). This balance is called the supply and demand balance (S/D balance) and it is calculated for the current baseline and projected forward 30 years such that AWS can determine where future deficits in the balance might occur; this planning is undertaken for a worst case very dry year to ensure that sufficient resources are available for worst case conditions. The projected future demand includes for estimates of increases in population for the Thetford WRZ (AWS confirmed to be taken from the draft EPP) and it includes an allowance for 'headroom' on top of the future predicted demand. The headroom allows for issues such as outage of water supply facilities and an allowance for uncertainty in climate change. The WRMP process then identifies potential water resources that could be developed to bridge the gap in supply and demand.

The latest interim S/D balance provided by AWS indicated that:

- The current predicted demand in Thetford is just over 9 Mld^{-1} (10 Mld^{-1} with an allowance for headroom);
- The demand is projected to increase by a little over 2 Mld^{-1} by 2031 ; the allowance for headroom results in an increase in demand of just over 3 Mld^{-1} by 2031 similar to WCS calculations shown in Table 6.5-2; and
- The Thetford WRZ currently has sufficient Deployable Output (that is, water which is available for supply during dry years) to meet demand up to 2029 (depending on phasing), beyond which further development of new resources is required; it has been assumed that the Deployable Output allows for the development of local resources which would be developed locally in addition to the three existing licensed abstractions.

The interim outputs from WRMP09 demonstrate that with the utilisation of existing licences in the Thetford WRZ, and potential development of small scale and new local sources, that there is sufficient capacity to supply the majority of target growth up to 2031, but that growth in the few years up to 2031 will require a

new resource. It has been assumed that the licences specifically supplying Thetford will be increased to their maximum licensed quantities along with other sources feeding the overall WRZ. The information taken from the draft WRMP09 is only considered as interim and as such, these assumptions would need to be revisited during the Stage 2 WCS once the draft WRPO09 is published for consultation.

6.5.3 Environmental Baseline - Water Supply Assessment

The screening stages of the Appropriate Assessment have not been able to fully assess the impact of the increase in abstraction at the three licensed sources as it is not known what the current abstraction rate is compared to the licensed maximum. Therefore it is not possible to determine whether the abstraction of licensed quantities at Two Mile Bottom, Nunnery Lodge and Barnham Cross will impact on designated sites (see section 9).

Despite this, it is known that abstractions at Two Mile Bottom have the potential to impact on the Thetford Golf Course and Marshes SSSI. The Two Mile Bottom abstraction boreholes are located in close proximity to the SSSI and it is hypothesised that full abstraction at times of lower groundwater levels could have the effect of increasing drawdown in the shallow gravel aquifer. This increases the 'head' difference between the river level in the Little Ouse and the groundwater level which has the impact of increasing the rate of water loss between the river and the gravels through the river bed which in turn results in an increase of poorer quality water entering the aquifer during low flow conditions. Changes in water quality and levels of the groundwater has the potential to impact on the standing water of the SSSI.

It has been determined that it is not possible to rule out a potential impact on the Thetford Golf Course and SSSI until such time as it is possible to define the increase in licensed abstractions at Two Mile Bottom, and hence the mechanism for potential impacts on the SSSI.

In addition, local groundwater abstraction is known to have had a deleterious impact on the natural eutrophic lakes of the Breckland SAC and this may therefore be an issue requiring exploration in the Stage 2 WCS when the abstraction patterns to service the new development at Thetford are determined.

6.5.4 Potential Risks to Supply

In terms of the potential risks to AWS supplies, these may come from ;

- Climate Change – AWS have considered the effects of climate change in its AMP5 WRMP. In general the effects on Deployable Output from groundwater sources is thought to be negligible. Surface waters are likely to be more affected but this will not impact on the supplies to Thetford at least in the short term;
- Review of Consents – Regulation 50 of the Conservation (Natural Habitats &c.) Regulations 1994 states that all competent authorities have to review all the consents and permissions that they have issued prior to the designation of the European sites, in order to affirm, emend or revoke these permissions in light of the impacts on European Sites. The Environment Agency, as the competent authority, are responsible for reviewing existing discharge and abstraction consents, licences, permissions and activities which are likely to be having a significant effect on a European site not only in isolation, but also in combination with other plans or projects. As far as we are aware, none of AWS's Thetford sources are part of this review (tbc); and
- Water Framework Directive – requires all river basins to achieve *"good ecological and good chemical status"* by 2015. Once again, the competent authority is the EA and further details on the Programme of Measures i.e. actions required by others is expected by the end of 2008.

6.5.5 Water Efficiency Strategy

A water efficiency strategy has been published by AWS within the AMP4 period (2005-2010). This strategy summarises the steps being taken by AWS to control the growth in demand. A particular feature of AWS's strategy has been the steps taken to increase the number of metered customers (currently around 60%). These customers are likely to have a high degree of 'water consciousness' thus making an important step in controlling demand. In the case of unmetered customers, there are various ways in which these customers can be encouraged in the area of greater water efficiency. Further details of these measures are included in section 11.7.1.

6.6 Water Supply Network- Baseline

Although it has been shown that there is existing capacity in terms of water resources for supply, it is important to consider how potable water will be supplied to the proposed development areas according to the development scenarios being considered.

AWS provided details on the existing network layout which is shown in Figure 7. This figure also displays where the strategic large mains are located with respect to the three licensed sources at Two Mile Bottom (to the North), Nunnery Lodge (to the south west) and Barnham Cross (near Barrow Hill in the south east) and where the potential development areas are located with respect to these three main water sources.

It is evident from analysis of the network layout that there is a large amount of flexibility in the supply system that allows potable water to be moved around Thetford from either one of the three existing sources. All four potential development areas (accept Area C) are located close to, or alongside a large strategic main (greater than 450mm) which would allow flexibility in supplying houses from existing mains. Area C is located close to a smaller size water main. It has been agreed with AWS that there will be a requirement for reinforcements of existing and new pipelines for potable water supply to service the large number of new homes, industry and commerce planned for Thetford; this is the case regardless of which area or scenarios are considered for development. On this basis, there is little difference between the scenarios in terms of supplying water to the new areas. Although Site C is not located close to a large main, there is a potential advantage to this site on the basis that it is closer to the Two Mile Bottom abstraction and may reduce costs for pumping and have a commensurate reduced requirement for energy; however if water were to be supplied to this area from Barnham Cross or Nunnery Lodge, it would incur significant pumping costs.

It has been agreed that detailed configuration can be tested and hence costed using network models in the Stage 2 WCS but that the water supply network does not represent a major constraint nor a significant differentiator between sites and development scenarios.

As well as considering modelling of the water supply network, the Stage 2 WCS will also need to assess the capacity of the Water Treatment Works (WTW) feeding Thetford. This information was not made available for the Stage 1 WCS.

6.7 Water Resources and Water Supply Summary

- Borehole sources operated by AWS provide the supply to Thetford but CWC also abstract from the groundwater locally - this water is exported out of the area;
- In the short term, the growth in demand will be met by maximising existing groundwater abstraction licences;

- In the medium term, small-scale local groundwater developments may be considered. Although any development will face the challenge from the EA's CAMS and the EA have indicated through consultation that they would be unlikely to support this position. Sufficient water should be available to meet demand up to 2029, hence the majority of new housing can be supplied with potable water; however, it will be a requirement to define how much water is available in the existing licences before it can be known how many new houses and business can be supplied before water from a longer term resources will be required
- In the long term, improved infrastructure networks should enable water to be transferred into the area, in order to meet the projected growth targets up to 2031 (potentially from Stoke Ferry WTW) or from a strategic new resource being considered as part of AWS longer term WRMP process;
- Whilst new water supply infrastructure will be required for all new development, along with reinforcements of existing mains, all of the development areas are in close proximity to a strategic large scale supply main and water supply source such that that the water supply network does not represent a major constraint nor a significant differentiator between sites and hence development scenarios; and
- detailed configuration can be tested and hence costed using network models in Stage 2 WCS

7 Water Cycle Option Development

7.1 Introduction

Chapters 4 to 6 assessed the existing constraints and existing baseline for the current water cycle infrastructure in Thetford. This was undertaken in the context of analysing how much development could be brought forward with existing infrastructure or minimum investment in new infrastructure. This section discusses outline or strategic options for providing new infrastructure which has been identified as required to supply housing up to the projected targets for 2031. This assessment needs to be undertaken before the development scenarios can be tested against the various water cycle assessment criteria.

The previous baseline and constraints assessment has shown that, whilst there is a need for site specific wastewater transmission and potable water supply connections to service new development areas, no new strategic infrastructure is required in Thetford to deliver the housing targets up to 2015 and that only investment in strategic scale wastewater network mains is required to facilitate development of 5,096 new homes up to 2021; the assessment has also shown that there is sufficient hydraulic and water quality capacity in the Little Ouse river system to accept wastewater from the increase in growth and that there are no ecologically sensitive sites potentially affected by the increase in wastewater discharge. The key concerns for growth up to 2021 is how to provide the strategic wastewater mains and the potential impact on increased abstractions from Two Mile Bottom on the Thetford Golf Course and Marshes SSSI.

Growth beyond 2021 up to 2031 will require significant investment in wastewater treatment infrastructure and further investment in water resource development/supply. Options for this as well as the wastewater network investment required between 2015 and 2021 are set out in the proceeding sections.

7.2 Wastewater Option Development

The assessment of the existing baseline for wastewater treatment assessment and treatment capacity indicated that there is only sufficient headroom to supply up to 5,096 new houses; therefore, whilst development up to 2021 can be accommodated, growth projected up to 2031 will require investment in further wastewater treatment infrastructure.

7.2.1 Future Capacity and Upgrade Requirements

AWS would be required to seek funding through the Price Review Process in order to provide the additional treatment required. The options for providing treatment are:

- Expand and upgrade the Existing Thetford STW
- Provide treatment facilities for each individual site development
- Build a new STW downstream of Thetford

It is considered at this stage in the WCS that the most cost efficient and sustainable option will be to expand the existing STW. Treating wastewater generated at the site locations is not considered to be a preferred option on the basis that discharging the treated volumes upstream of the town centre has the potential to increase flood risk. The only viable alternative would be to pump the treated wastewater up and around the developments; however this would not be as cost-efficient as pumping the wastewater and treating it at a large single facility.

There is the option to construct a new STW downstream of the existing site; however, AWS have not indicated that there are any constraining reasons as to why the existing site is not suitable for expansion which would represent a much more cost-efficient strategy. Despite this, AWS have indicated that landowners around the STW should be brought into the consultation of the Stage 2 Study to facilitate discussions around the possible expansion of Thetford STW.

It also needs to be considered that expansion of the existing site footprint has the potential to increase proximity of the site to residential areas (particularly if they expand towards the northern boundary of the existing site). As such, consideration would need to be given to odour control and potential for restrictions.

Ballpark figures have been supplied by AWS for unit cost increases in provision of wastewater. A population equivalent (PE) of 1,500 to 10,000 would incur a unit cost per PE of approximately £1,500. Based on approximately 5,000 new homes for Thetford, this equates to a population of approximately 10,500 giving a broad-brush cost of £15.75 million.

The options will be developed further in the Stage 2 WCS, but for the purposes of this assessment it has been assumed that the preferred option of upgrading the existing works up to 2031 will be taken forward.

7.3 Wastewater Network Option Development

Assuming that the option of upgrading the existing Thetford STW option in the preferred way forward, there are only a limited number of ways in which the wastewater generated can be transferred to the treatment facility.

The existing capacity assessment identified that up to a 1000 new homes could potentially be developed in Key Site North or Site E and connect to the existing system to allow early development to commence before new funding is made available for new infrastructure in AMP5 (2010-2015). The remaining housing targets and employment areas would have to be accommodated with new infrastructure.

It has been assumed that in order to accommodate the additional wastewater transmission, the wholesale upgrading of the existing system within urban Thetford is both undesirable and unsustainable as this would disrupt the existing community. It is therefore assumed that new strategic infrastructure is required in order to supply the development within new greenfield areas. A route for a new trunk sewer to which could serve all four proposed development areas has been suggested. This route is shown in Figure 8.

There are points of note concerning the development and selection of this route as the preferred option for supplying new growth in Thetford:

- New pipework needs to drain to the STW avoiding existing urban areas due to restrictions on the layout of the existing network within and around Thetford town centre.
- The single route was chosen as it would represent a strategic option which allows all new development within greenfield areas to be connected to the same but new system which is separated from the existing network. This would allow potential developer contribution to be developed for the strategic scale rising main.
- Wastewater collected in the system in Key Area South East, Site E and the eastern section of Key Ste North would require pumping to transmit it the length of the pipe route which is routed around the existing urban area up to the point located just before the A134; however, from this point onwards, the topography is such that the wastewater collected in the remaining length of pipe to the STW (approximately 2km) would be gravity drained.

7.3.1 Route Sensitivity

As well as the main route shown in Figure 8, an alternative route has been considered at this stage which drains to the north of the A11 to avoid the archaeologically sensitive Boudicca site. English Heritage is currently considering the extent of the site in terms of potentially scheduling it. At the time of undertaking this Stage 1 WCS, it was not certain as to the geographical extent of the final scheduled site and as such, the alternative route passes under the A11 at the railway crossing, runs parallel with the north of the A11 and passes back under the railway at the second railway crossing before draining down to the STW; this route completely avoids the Boudicca site boundary. There is a commensurate increase in cost associated with accounting for the crossing points for this alternative route and hence, this option would need to be revisited in the Stage 2 WCS once the full extent of the scheduled Boudicca site is known.

Cost estimates for new infrastructure requirements to enable development of the proposed areas have been produced. The estimates are high level and have been based on OFWAT's report on cost base for the PR04 water company submissions. Appropriate inflation and contingencies have been applied to these figures to bring them to 2008 values. It should be noted that at this very early stage, these estimates are high level and are more useful as a comparator between the growth areas being looked at. The cost estimates have only been provided for the trunk sewers from the development areas i.e. the collector system within the development is not included.

Network modelling will be required once the layout of the preferred development sites is known during the Stage 2 WCS. This modelling will allow the strategic mains option to be designed and costed in more detail as well as allowing the design and cost of site specific collector systems. The Stage 2 WCS will also need to take into account the Environment Agency's expectation that there should be no discharges to the environment from the new sewers or pumping stations. The new system will need to have sufficient capacity, and have emergency systems in place, to cope with breakdown of the pumping stations without recourse to overflows into local watercourses.

7.4 Water Resources Option Development

7.4.1 Introduction

At the present time, AWS are in the process of drawing together their new Water Resources Plan (WRP) for AMP5 and beyond. An early indication of their likely strategy to be contained within their WRMP09 is presented in AWS's Strategic Plan document for the next 25-years and which was published in December 2007. As indicated, interim outputs from the S/D balance have also been provided from the draft WRMP09.

It should be noted that the outline strategy proposed in their 25-year plan is significantly different from previous plans published by AWS, such as their AMP4 WRP. The changes in strategy reflect the greater pressure which is being placed on water companies by virtue of the revised growth forecasts, as well the effects from outside pressures such as climate change, the review of consents and the Water Framework Directive amongst others.

7.4.2 Water Supply Strategy

7.4.2.1 Short Term

In the short term, AWS will meet the growth in demand by maximising its existing groundwater abstraction licences.

7.4.2.2 Medium Term

AWS's Strategic Plan document contains reference to a 'managed aquifer recharge and groundwater development within the Thetford area' (see Figure 20 - page 51 of that document). Bearing in mind the over-licensed or no water available status of the groundwater in the Thetford area (see Table 6.4-2), an aquifer recharge scheme is likely to be the only way by which the EA would consent to increased groundwater abstractions. The EA have indicated through consultation that they would be unlikely to be able to support further local source development which would be contrary to the CAMS status of local water resources. The uncertainty over such schemes means that only a relatively small increase in deployable output can be expected, and that therefore reliance on a longer term water resource scheme is likely to be required.

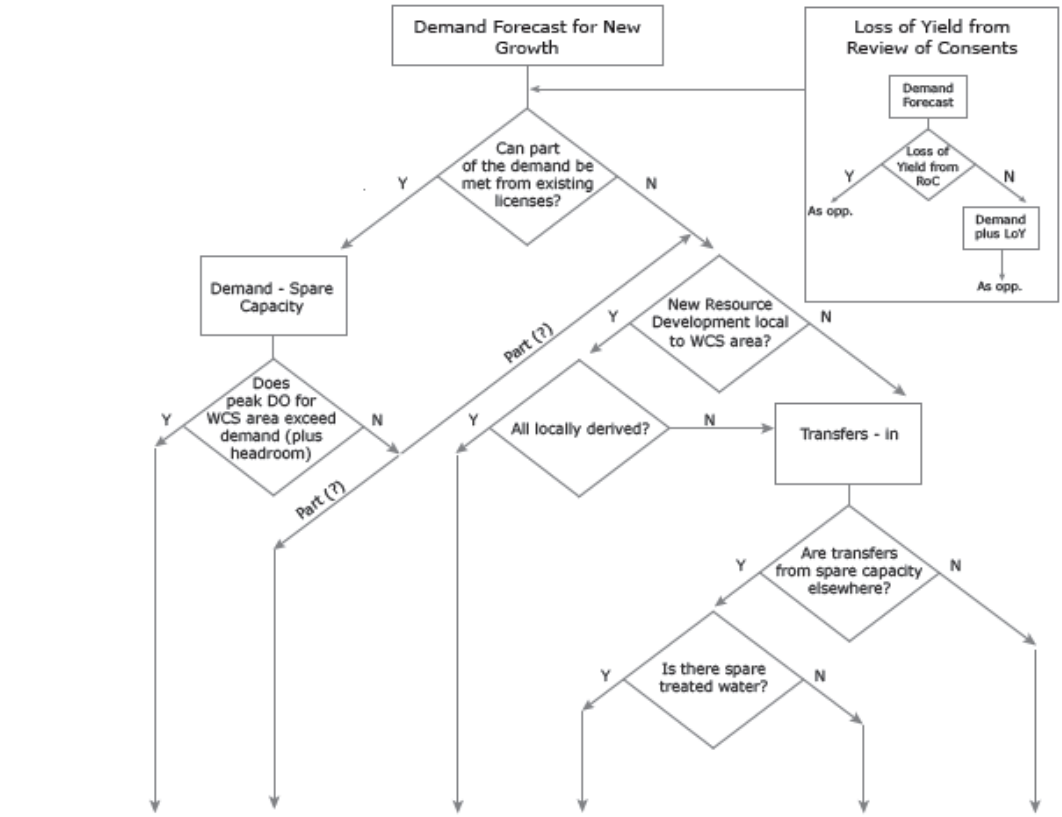
7.4.2.3 Long Term

In the longer term, improvements in AWS's infrastructure network is the only way to secure supply to the Thetford area. At the present time no details are available on options, although bearing in mind the proximity of Stoke Ferry WTW (operated by AWS), this would seem the most likely works to provide back-up for the local groundwater sources

The information provided in this Stage 1 WCS will be used by AWS to determine the percentage of their proposed new water resources which will be required in order to feed development in the Thetford Water planning Zone.

The likely infrastructure requirements needed to supply this water is determined below (Box 7-1) with an indicative outline cost. The methodology used is similar to that used successfully on other WCS and which is outlined in the figure below. At this stage in the WCS process, it is noted that the costs are indicative only and should only be used as a way of determining the potential monetary impacts of providing the required water resource infrastructure for the predicted housing targets up to 2031.

Box 7-1: Indicative costing process for broad scale water resource options for Thetford



Costs	Model A	Model B	Model C	Model D	Model E	Model F
Resource Develop-ment (R)	N	N	Y	N	N	Y
Production (P)	N	Y	Y	N	Y	Y
Distribution (D1) or (D2)	Y	Y	Y	Y	Y	Y
Total (Calculation)	D1 x Vol	(P + D1) x Vol	(R + P + D1) x Vol	(D2) x Vol	(P + D2) x Vol	(R + P + D2) x Vol

KEY:

Calculation Decision / Choice

Assumption

(1) Locally delivered water (D1) should be cheaper than transferred-in water (D2).

(2) Only CAPEX costs considered in this assessment.

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In the case of Thetford;

- Based on AMP4 WRP comparison of deployable output with the Annual Licence Quantity (Cambridge & West Suffolk RZ9 – Table WRP1 [Annex]), approximately 2 Ml/d of spare capacity is estimated to be available from the three Thetford GW licences.
- From the AWS's Strategic Plan document, between 0 and 1 Ml/d of extra GW resource to be derived locally

Referring to Box 7-1, by placing appropriate costs against the Resource Development, Production and Distribution it is possible using the calculations shown in the table at the bottom of this figure to derive rough costs for water resources and water supply for this level of development. For example; 2 Ml/d would come from existing licences requiring no local distribution costs (Model A). Whilst the 1 Ml/d would come from a new locally derived GW source (Model C).

At this stage only very rough estimates can be made regarding what the cost of this development would be, but a figure of around £6 million may be required. Further detailed costings will be considered as part of Stage 2 of the WCS.

8 Generation of Flood Risk - Sustainable Drainage Systems options

8.1 Introduction

Chapter 4 undertook an assessment of potential flood risks and hence constraints posed to the potential development areas. This section considers flood risk generated as a result of the developments which is an important consideration with respect to the assessment of development scenarios and current national planning policy with regards to flood risk management.

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

8.1.1 National Flood Risk Policy: PPS25

PPS25: Development and Flood Risk (Reference 1) requires that all new development should ensure that runoff rates and runoff volumes from new development are not increased above that of the existing land use. Much of the Infill development target of 1073 new homes will be on previously developed (brownfield) land; hence the requirement to reduce runoff rates, as a result of rainfall, will be less onerous for these developments, compared to those on Greenfield sites. For infill development on currently undeveloped land and development of the new areas, there will be a requirement to ensure that runoff rates and volumes are no greater than the greenfield rates for the design event with return period of 1 in 100 years (with an allowance for climate change) and smaller rainfall events up to this level.

8.2 Flood Risk from Development: SUDS utilisation

In order to reduce runoff rates from developed sites to that of existing (and where possible to achieve 'betterment'), PPS25 and its companion guidance (Reference 2) recommend that Sustainable Drainage Systems (or techniques) are used, known collectively as SUDS. Development within the new development areas will need to include for the SUDS both at a site specific level but also a strategic scale level. In general, there are advantages to be gained to developing drainage strategies for site wide developments such that strategic scale options such as balancing ponds can be developed at lower overall cost, but also to:

- maximise green infrastructure linkage,
- maximise ecological enhancement;
- maximise water quality benefits from retention and filter type SUDS; and
- contribute towards the point system for Code for Sustainable Homes grading.

Considering the options now, is a key consideration for this strategic WCS. The following sections outline some of the key outline or strategic considerations for SUDS for the development areas, and it is recommended that the Stage 2 study develops site wide strategic drainage plans for the development scenarios and areas taken forward into the next planning stage.

8.2.1 SUDS Options

A description of the type of SUDS that could be considered for the Thetford development areas dependent on the type of housing and density that is envisaged, is included in Appendix F – SUDS Options Details.

8.2.1.1 The SUDS Hierarchy

The EA and DEFRA currently suggest that the SUDS hierarchy is adopted when considering SUDS techniques to be adopted for new development (see Box 8-1). This lists the order in which different SUDS techniques should be considered for a site in terms of their considered sustainability. SUDs techniques at the top of the hierarchy are preferable for their potential ecological and water quality benefits.

Box 8-1: The SUDS Hierarchy

	SUDS technique	Flood Reduction	Pollution Reduction	Landscape & Wildlife Benefit
Most Sustainable	**Living roofs**	✔	✔	✔
	Basins and ponds - Constructed wetlands - Balancing ponds - Detention basins - Retention ponds	✔	✔	✔
	Filter strips and swales	✔	✔	✔
	Infiltration devices - soakaways - infiltration trenches and basins	✔	✔	✔
	Permeable surfaces and filter drains - gravelled areas - solid paving blocks - porous paviors	✔	✔	
Least Sustainable	**Tanked systems** - over-sized pipes/tanks - storms cells	✔		

Source: SUDS A practical Guide, Environment Agency Thames Region (Reference 23)

8.2.2 Infiltration SUDS

Infiltration is a key factor in reducing runoff rates and volumes, as it reduces the reliance on surface or engineered storage systems such as balancing ponds or storage tanks. Box 8-1 places some surface storage features near to the top of the hierarchy list on the basis of habitat creation and water quality benefits. The benefits of such systems is considered in 8.2.4; however, encouraging natural infiltration by creation of open grassland landscaping (where contamination is not an issue) should be encouraged first for large developments to maximise natural runoff rate reduction and to encourage natural recharge of groundwater systems.

Maximisation of green areas and open space is recommended for large new development areas where the soil and geology is sufficiently permeable to make it a feasible option. Infiltration can also be encouraged via managed SUDS techniques such as soakaways, swales or infiltration trenches. Given that much of the study area is underlain by permeable geology such as Chalk or Sands and Gravels, infiltration is a key consideration for new development in Thetford. Despite this, the Chalk underlying Thetford is considered a Major Aquifer used for public supply (not least for Thetford itself) therefore due regard needs to be paid to protection of groundwater from pollution pathways that can be created by poorly managed or badly located infiltration SUDS and as such, there are restrictions on the types of infiltration SUDS systems permitted within developments.

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

Groundwater Quality - Vulnerability

Groundwater resources are vulnerable to contamination from both direct sources (e.g. into groundwater) or indirect sources (e.g. infiltration of discharges onto land). Groundwater vulnerability within the study area has been determined by the Environment Agency, based on a review of aquifer characteristics, local geology and the leach ability of soils. The vulnerability of the groundwater is important when advising on the suitability of SUDS.

Source Protection Zones

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

SPZs are defined based on the time it takes for pollutants to reach an abstraction point. This transmission time enables the Environment Agency to define 3 zones around a groundwater abstraction point.

- Zone 1 (Inner Protection Zone) – This is defined as ‘any pollution that can travel to the borehole within 50 days from any point within the zone is classified as being inside zone 1’
- Zone 2 (Outer Protection Zone) – This is defined as the area that ‘covers pollution that takes up to 400 days to travel to the borehole, or 25% of the total catchment area – whichever area is the biggest’
- Zone 3 (Total Catchment) - The total catchment is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.
- Zone 4 (Zone of special interest) –This is usually where local conditions mean that industrial sites and other polluters could affect the groundwater source even though they are outside the normal catchment area.

Depending on the nature of the proposed development and the location of the development site with regards to the SPZs, restrictions may be placed on the types of SUDS appropriate to certain areas. Infiltration into SPZ1 is generally only permitted for clean roof runoff. Runoff from roads and car parks is not acceptable in SPZ1 and is only acceptable in SPZ2 if there are sufficient controls of sources of contamination (e.g. oil separators) and that there is sufficient depth between the unsaturated soil into which the water is drained and the saturated water table in the geology below. The SPZ designations for Thetford and surrounds are shown in Figure 9.

From a review of the Environment Agency Website it is noted that there are three Zone 1 SPZs under and around Thetford. The one to the north is associated with the Two Mile Bottom abstraction, to the south west with the Barnham Cross abstraction and the one to the south east with the Nunnery Lodge abstraction. There is a further separate Zone 1 SPZs to the South East of Thetford near Brettenham.

Key Site North

This development site to the North of Thetford is underlain by a Highly Permeable Major Aquifer. This aquifer has two different groundwater vulnerability classifications which include:

- Highly permeable with a soil classification of Urban (high leaching potential). In urban areas, the classifications are based on fewer observations than elsewhere, and thus a worst case vulnerability classification are assumed until proven otherwise; and
- Highly permeable with a soil classification of H2 (high leaching potential) which incorporate soils which have little ability to attenuate diffuse source pollutants or where pollutants have the potential to move rapidly to underlying strata or to shallow groundwater. The soils under this section of the north development site are deep, permeable, coarse textured soils which are able to readily transmit a wide range of pollutants because of their rapid drainage and low attenuation potential.

The far western half of the site is not considered to be in a SPZ, the middle section is underlain by SPZ3 or the 'total catchment', whilst the eastern section is underlain by SPZ2 'outer zone'.

Based on the groundwater vulnerability and SPZ classification, this site is likely to have some limitation on the amount of infiltration that would be permitted in the eastern section although with suitable pollution prevention such as hydrocarbon separators, infiltration SUDS should be acceptable

Key Site South East

The development site to the Southeast of Thetford is underlain by a Highly Permeable Major Aquifer. This aquifer has two different groundwater vulnerability classifications underlying the site which include:

- Highly permeable with a soil classification of H1 (high leaching potential) which incorporate soils which have little ability to attenuate diffuse source pollutants where pollutants have the potential to move rapidly to underlying strata or to shallow groundwater. The soils under this section of the southeast development site are classified as able to readily transmit liquid discharges because they are either shallow, or susceptible to rapid flow directly to rock, gravel or groundwater; and
- Highly permeable with a soil classification of I2 (intermediate leaching potential) which incorporate soils which have a moderate ability to attenuate diffuse source pollutants where pollutants may have the potential to penetrate the soil layer. The soils under this section of the south east development site are classified as being able to possibly transmit non or weakly absorbed pollutants and liquid discharges but are unlikely to transmit absorbed pollutants.

The entire site is underlain by a SPZ1' inner zone'.

Based on the groundwater vulnerability and SPZ classification, this site is likely to have significant restrictions on the type of infiltration SUDS that can be promoted in order to protect the Nunnery Lodge abstraction for PWS borehole. It is likely that only clean roof water runoff will be permitted for discharge to ground and there may also be limitations on the industry and other land uses such as garages and petrol stations to accompany residential development. Surface water runoff reduction will be heavily reliant on surface water attenuation.

Other Development areas

Site C and Site E both have the same groundwater vulnerability classifications as Key Site North. Site E is underlain by a SPZ2 'outer zone', whereas Site C is underlain by SPZ3 'total catchment'.

Site E will have some restrictions on Infiltration Suds, but as with Key Site North, such SUDS techniques should still be possible with suitable pollution prevention. Site C not have any significant restrictions in terms of infiltration.

8.2.3 Surface Water Runoff Attenuation

Once it is known which development scenario is being taken forward and once more is known about the numbers of housing and likely layouts of the sites, it is recommended that the detailed requirements for different types of SUDs as outlined in Appendix F is undertaken in the Stage 2 WCS. In the outline stages however, it can be assumed that only a percentage of the development areas can be set aside as green space and notwithstanding other SUDS techniques such as porous paving, that remaining runoff volumes generated from rainfall events will have to be attenuated or stored in surface water systems such as balancing ponds.

In order to assess the magnitude of surface water mitigation required, it was necessary to undertake broad brush calculations of the likely increases in runoff generated by developing each of the sites. Calculations were undertaken for runoff generated from the existing site (pre development) assuming uniform greenfield conditions and post development conditions assuming 70% of the site is developed as hardstanding; area coverage was taken from the TGFIS.

The calculations were undertaken using the methodology as set out in the joint DEFRA and Environment Agency Flood and Coastal Erosion Risk Management R&D Programme document *"preliminary rainfall runoff management for developments"* (Reference 18 - Revision D). This recommends that for developments between 50 and 200 Hectares the IH124 methodology for calculating greenfield runoff and required attenuation is used; the attenuation design has been undertaken for the 1 in 100 year event plus an allowance for climate change. The calculations were undertaken using Microdrainage software and the results are provided in Table 8.2-1.

Table 8.2-1: Greenfield runoff rate and required attenuation storage calculation

Development Area	Size (hectares)	Approx Greenfield runoff (l/s)[19]	Approx attenuation required (m^3)
Key Site North	200	247.2	96,561
Key Site South East	190	234.8	91,734
Site C	162	200.2	63,252
Site E	131	162	78,223

The approximate storage volumes as set out in Table 8.2-1 will need to be provided dependent on the level of infiltration that can be provided, either via green areas or specific infiltration SUDS. This volume can be provided strategically, in large scale storage features such as retention lakes or in combination with site specific features such as rainwater harvesting or smaller scale balancing ponds.

[19] Run off rates calculated for the 1 in 100 year event + an allowance for climate change. The rate per Hectare was calculated to be 1.236 l/s

8.2.4 Link to Green Infrastructure

Green Infrastructure is a network of protected sites, nature reserves and green spaces that occur at all scales from the urban centre to the rural countryside. The aim of the Thetford Green Infrastructure report (Reference 17) is to identify environmentally sensitive areas and provide a long term strategy for enhancing their ecosystems, recreational and cultural significance. One of the specific objectives is to undertake a sensitivity analysis for the development sites to identify green infrastructure links from and to the rural and urban areas.

The sensitivity analysis on the proposed development sites states that for the northern site (and hence for Site C and Site E) that green roofs could be used to improve the view of the development. In addition, small scale Sustainable Drainage Systems (SUDS) should be incorporated. In addition, the report advocates the protection of existing access routes and the creation of new access routes to the green areas.

For the southern site, the report notes the importance of the river corridors as natural ecological systems. The opportunities in the area have been identified as enhancing the links to and along the River Little Ouse and the River Thet; the incorporation of small scale SUDS and the possibility of strategic SUDS adjacent to the rivers. The creation of linkage with green infrastructure vision is greatest for the Key Site South East area as there is potential for strategic scale SUDS such as balancing lakes to link with the corridor of the Little Ouse and the Thet. This is particularly pertinent given that infiltration is likely to be significantly constraint on the site. However, this points to the area requiring additional land take which could affect the developable viability of the site overall.

8.3 Flood Risk Management Summary

In summary, the following key flood risk management points can be made regarding the site.

- Key Site South East is likely to be significantly limited in terms of opportunities for utilisation of infiltration SUDS as are sections of Site C;
- Key Site North is the least constrained of the sites, followed by Site E reducing reliance on providing large volumes of surface water attenuation in order to limit post development runoff to greenfield rates;
- Potential contamination of the Nunnery Lodge PWS borehole is a risk with development activities associated with developing Key Site South East; and
- Key Site South East represents the best opportunity for linking with green infrastructure opportunities in the town via linked surface water attenuation.

9 Ecological Assessment

9.1 Objectives and Approach

The initial Stages (screening stages) of a Habitats Regulations Assessment have been undertaken for the first stage of the Outline Stage 1 WCS. Until the development areas and development scenarios are agreed in detail following review of all planning considerations, it is not possible to complete a full assessment on the WCS. This will be a requirement of the Stage 2 Detailed strategy, but a screening study for the AA is suitable for a Stage 1 WCS in order to identify if they are any ecological constraints to the outline study.

As well as the European Sites potentially affected, the screening study has considered other nationally, regionally and local designated sites such that a comprehensive assessment of ecological impacts of the WCS is considered.

9.1.1 Scope of Assessment

At this stage, only treated effluent discharge and associated flood risk issues are considered in this screening document, due to the lack of data concerning abstraction associated with the Water Cycle Study. Any new development at Thetford is most likely to discharge treated effluent to the River Little Ouse. The most likely possible effects that require consideration are therefore:

- Increased phosphorus load (and potentially concentration), coupled with an increase in total oxidized nitrogen, potential lowering of dissolved oxygen for a stretch and an increase in biological oxygen demand and nitrogen for a given distance; and
- Potential increase in velocity and levels, notable at lower to normal flows for a distance downstream as a result of the additional wastewater volumes entering the river.

Despite this, it is known that abstractions at Two Mile Bottom have the potential to impact on the Thetford Golf Course and Marshes SSSI. The Two Mile Bottom abstraction boreholes are located in close proximity to the SSSI and it is hypothesised by the Environment Agency and Natural England that full abstraction at times of lower groundwater levels could have the effect of increasing drawdown in the shallow gravel aquifer feeding the marshes which results from the abstraction. This increases the 'head' difference between the river level in the Little Ouse and the groundwater level which has the potential impact of increasing the rate of water loss between the river and the gravels through the river bed which in turn results in an increase of poorer quality water entering the aquifer during low flow conditions.

As well as heathland habitats, in contrast the wet peaty soils of the SSSI support a range of fenland plant communities and a fine example of valley alder woodland. Horse Meadows support a series of fen and wet grassland communities under scattered plantings of poplar. reed canary-grass *Phalaris arundinacea*, purple small-reed *Calamagrostis canescens*, reed sweet-grass *Glyceria maxima*, common reed *Phragmites australis*, greater pond sedge *Carex riparia* and tufted sedge *C. elata* provide the dominant or co-dominant species on the wet fen. Much of the variation in the vegetation is due to the differing degrees of wetness and depth of standing water on the site. Changes in water quality and levels of the groundwater has the potential to impact on the standing water of the SSSI.

It has been determined that it is not possible to rule out a potential impact on the Thetford Golf Course and SSSI until such as time as it is possible to define the increase in licensed abstractions at Two Mile Bottom, and hence the mechanism for potential impacts on the SSSI. This should be further investigated in the Stage 2 WCS. It is noted that although the SSSI forms a component part of the Breckland SAC and SPA,

the wetland areas are not of European importance and hence are not subject to assessment under the Habitats Regulations. The wetland features are however covered by the Wildlife and Countryside Act 1981 (CROW Act) and this issue should therefore be considered as part of Stage 2.

In addition, local groundwater abstraction is known to have had a deleterious impact on the natural eutrophic lakes of the Breckland SAC and this may therefore be an issue requiring exploration in the Stage 2 CWS when the abstraction patterns to service the new homes at Thetford are determined.

9.1.2 Methodology

The need for Appropriate Assessment is set out within Article 6 of the EC Habitats Directive 1992, and interpreted into British law by Regulation 48 of the Conservation (Natural Habitats &c) Regulations 1994 (Box 9-1). The ultimate aim of appropriate assessment is to "maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest" (Habitats Directive, Article 2(2)). This aim relates to habitats and species, not the European sites themselves, although the sites have a significant role in delivering favourable conservation status.

Box 9-1: The legislative basis for "appropriate assessment"

Habitats Directive 1992

Article 6 (3) states that:

"Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."

Conservation (Natural Habitats &c. Regulations) 1994

Regulation 48 states that:

"*A competent authority, before deciding to … give any consent for a plan or project which is likely to have a significant effect on a European site … shall make an appropriate assessment of the implications for the site in view of that sites conservation objectives*".

"… The authority shall agree to the plan or project only after having ascertained that it will not adversely affect the integrity of the European site".

In the past, the term "Appropriate Assessment" has been used to describe both the overall process and a particular stage of that process (see below). Within recent months, the term Habitat Regulations Assessment has come into use in order to refer to the process that leads to an "Appropriate Assessment", thus avoiding confusion. Throughout this report, Habitat Regulations Assessment is used to refer to the overall procedure required by Regulation 48 of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended 2007).

In practice, Habitats Regulations Assessment of projects can be broken down into three discrete stages, each of which effectively culminates in a test. The stages are sequential, and it is only necessary to progress to the following stage if a test is failed. The stages are:

9.1.2.1 Stage 1 – Likely Significant Effect Test

This is essentially a risk assessment, typically utilising existing data, records and specialist knowledge. The purpose of the test is to decide whether 'full' Appropriate Assessment is required. The essential question is:

- "*Is the project, either alone or in combination with other relevant projects and plans, likely to result in a significant adverse effect upon European sites?"*

If it can be demonstrated that significant effects are unlikely, no further assessment is required.

9.1.2.2 Stage 2 – Appropriate Assessment

If it cannot be satisfactorily demonstrated that significant effects are unlikely, a full "Appropriate Assessment" will be required. In many ways this is analogous to an Ecological Impact Assessment, but is focussed entirely upon the designated interest features of the European sites in question. Bespoke survey work and original modelling and data collation are usually required. The essential question here is:

- *"Will the project, either alone or in combination with other relevant projects and plans, actually result in a significant adverse effect upon European sites, without mitigation?"*

If it is concluded that significant adverse effects will occur, measures will be required to either avoid the impact in the first place, or to mitigate the ecological effect to such an extent that it is no longer significant. Note that, unlike standard Ecological Impact Assessment, compensation for significant adverse effects (i.e. creation of alternative habitat) is not permitted at the Appropriate Assessment stage.

9.1.2.3 Stage 3 – Imperative Reasons of Overriding Public Interest (IROPI) Test

If a project will have a significant adverse effect upon a European site, and this effect cannot be either avoided or mitigated, the project cannot proceed unless it passes the IROPI test. In order to pass the test it must be objectively concluded that no alternative solutions exist. The project must be referred to Secretary of State on the grounds that there are Imperative Reasons of Overriding Public Interest as to why the plan should nonetheless proceed. The case will ultimately be decided by the European Commission.

This report deals with the first stage of Habitat Regulations Assessment – the Likely Significant Effect Test.

The assessment has been undertaken at the Local level to Thetford, but also downstream with respect to impacts of discharges and abstractions. At each level, identification and assessment of sites has been addressed for SACs, SPAs and RAMSAR sites in the first instance, followed by SSSIs and 'other non statutory designated sites. The detail and screening opinion for each site is included in Appendix H. The summary of the screening assessment is provided in the proceeding section.

9.2 Overall screening opinion

It can be seen from the screening exercise included in Appendix H, that only one designated site – Thetford Golf Course and Marsh SSSI – a part of both Breckland SAC and Breckland SPA, is incapable of being screened out at this stage as unlikely to suffer significant adverse effects as a result of the potential

for increased abstraction from the Two Mile Bottom groundwater source. As this particular issue relates to this SSSI it therefore requires further investigation.

There are five potential development scenarios proposed at Thetford. On the basis of the information contained within this screening report, none of the scenarios identified above is likely to have a greater or lesser impact, since all will essentially result in the same or similar volumes of treated wastewater being discharged from the same STW outfall.

Despite the assessment linked to discharge of treated wastewater, it has been determined that it is not possible to rule out a potential impact on the Thetford Golf Course and SSSI until such as time as it is possible to define the increase in licensed abstractions at Two Mile Bottom, and hence to better define the mechanism for potential impacts on the SSSI. This will be investigated further in the Stage 2 WCS.

10 Water Framework Directive (WFD) Assessment

10.1 WFD Introduction

The Water Framework Directive (WFD) 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.

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 set by the directive.

All Water bodies in the UK will be designated a status based on their ecological, and chemical quality. The statuses will range from poor through to very good and standards are being developed with which to measure this status covering a range of criteria including water quality, biological quality, and morphology. 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 in conjunction with the WFD UK Technical Advisory Group (UKTAG) is developing a series of River Basin Management Plans RBMPs) for the major River Basins of the UK. The RBMPs will be published in draft in 2008 and as final in 2009 and will contain a Programme of Measures which will set out the changes that need to be implemented in order to bring the water bodies which are currently failing the required standards up to good status. Thetford and its rivers are included in the Anglian River Basin District which covers 27,890 km^2 ranging from Lincolnshire in the north to Essex in the south and Northamptonshire: the extent is shown in Figure 10.

The standards are currently in draft form and will not be finalised until the RBMPs are published in late 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.

Prior to the finalisation of the Anglian RBMP, the EA have undertaken a draft assessment of the characterisation of risk for water bodies in the Anglian River Basin. The summary of the characterisation is shown in Table 10.1-1.

Table 10.1-1: Summary of WFD Risk Characterisation for the Rivers Thet and Little Ouse

Risk factor	River Concerned (Thet or Little Ouse)	Risk Characterisation
Point source acidification	Both	Not at Risk
Diffuse and Point source ammonia	Both	At Risk
Diffuse and Point source BOD	Both	Not at Risk
Diffuse and Point source Oxidised Nitrogen[20]	Both	At Risk
Diffuse and Point source	Both	At Risk

[20] Total Oxidised Nitrogen is the considered as combined Nitrate and Nitrite.

Risk factor	River Concerned (Thet or Little Ouse)	Risk Characterisation
Phosphate		
Diffuse – mines and minewaters	Both	Not at Risk

Whilst the draft risk characterisation is considered as a broad-brush assessment at this stage in the RBMP process, it does given an indication of the pressures on the two key river systems in and around Thetford and this indicates that diffuse and point source nutrient enrichment is the key concern, along with ammonia (as identified in the water quality baseline assessment of the Little Ouse – section 5.3.2.1).

10.2 WFD Standards

In terms of water quality standards, the current River RQO and GQA programme has been very successful, particularly in assessing the impact of point source discharges on watercourses. In conjunction with the Urban Wastewater Treatment Directive (UWTD), investment to the larger STWs has improved discharges considerably. There are still problems however. In particular, rural sources, especially agricultural diffuse pollution (mainly nutrients, sediment, pesticides), smaller STWs, industry, urban areas and roads can cause water quality problems.

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.

The Water Framework Directive (WFD) classifies water in a different way, using new and revised environmental standards to assess whether environmental conditions are good enough to support appropriate aquatic life for the system in question. The Directive requires that all inland and coastal water bodies reach at least "good" status by 2015 – subject to certain exemptions, which allow alternative objectives to be set in cases where it is infeasible or disproportionately expensive to achieve good status.

The WFD came into force on 22nd December 2000 and in accordance with the agreed implementation timetable, monitoring under the Directive commenced on 22nd December 2006. The Directive requires that a draft River Basin Management Plan (RBMP) to maintain or improve the aquatic environment is established by the end of 2008, and updated every six years; the plans will be finalised at the end of 2009 following review by the EU.

It is generally expected that the new classification will reduce the number of water bodies achieving 'good ecological status', since rivers will be graded by the worst parameter of the revised monitoring scheme. The new classification system includes rivers, lakes, estuaries, coastal waters and groundwaters. The WFD requires surface water bodies to be classified into one of five ecological status classes, and one of two chemical status classes. In addition, there are two stages to groundwater classification.

From 2007 to 2009, England and Wales will continue to report results based on the GQA monitoring system, with separate indicators for biology and chemistry. In England, however, a reduced network will be used, so that resources can be re-directed to implementing the WFD monitoring programme. During this time, the existing GQA and WFD approaches will report in parallel. This will enable differences between the two approaches to be distinguished.

The status of each surface water body is judged using separate 'Ecological classification' and 'Chemical classification' systems. The overall status of the water body will be determined by whichever of these is the

poorer. To achieve 'good status' overall, a water body must achieve both good ecological and good chemical status.

10.2.1 Ecological Classification

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.
- Hydromorphological assessment to document water flow and physical habitat.

As of December 2007, UKTAG had derived standards for some of the more important chemical parameters in freshwaters. The standards will differ based on the 'typology' of each water body; rivers, lakes, transitional and coastal waters, groundwater. A summary of initial classification for rivers is presented below, based on UKTAG (2007). In this case, just two parameters (dissolved oxygen and phosphorus) are presented as examples, but it is important that studies on water quality bear the full list of new standards in mind. Although the existing GQA scheme is likely to run until 2009, the new standards are being introduced concurrently, and any differences in water quality as a result of the new standards should be fully explored.

The general typology for rivers is based on alkalinity and altitude, as shown in Table 10.2-1. However, for dissolved oxygen and ammonia, the typology was simplified into just two types, as shown in Table 10.2-2. These typologies should be used to define the dissolved oxygen standard for a particular watercourse typology, as shown in Table 10.2-3. The standards in Table 10.2-3 were developed on the basis of oxygen conditions associated with macroinvertebrates, as these are the most sensitive biota to Dissolved Oxygen (DO).

Table 10.2-1 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 10.2-2. Final typology for oxygen and ammonia for rivers (WFD)

Upland and low alkalinity	Types: (1+2, 4 and 6
Lowland and high alkalinity[21]	Types: 3, 5 and 7

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

Table 10.2-3: Standards for oxygen in rivers (WFD)

Dissolved oxygen (% saturation)				
10-percentile				
Type	High	Good	Moderate	Poor
Upland and low alkalinity	80	75	64	60
Lowland and high alkalinity	70	60	54	45

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.

For revised nutrient standards in rivers, UKTAG (2007) identified that ecological sensitivity could be related to alkalinity and altitude. The resulting river typology can be seen in Table 10.2-4.

When developing the standards for nutrients in rivers, Guthrie *et al* (2006) reported that diatoms showed greater sensitivity to nutrients than macrophytes, and these were subsequently used to develop the standards shown in Table 10.2-5. Also included in Table 10.2-5, are guideline values produced by the Environment Agency which are commonly referred to, as well as values recommended by the Habitats Directive.

UKTAG (2007) 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.

Nitrate is already covered by legislation which proscribes a Statutory Limit of 50 mg NO_3/l (11.3 mg NO_3-N/l) as described previously. However, these limits are largely based on protection of freshwater for the purposes of drinking water. UKTAG (2007) 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.

Table 10.2-4: River typology (WFD)

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

Table 10.2-5: Phosphorus standards in rivers under WFD standards, existing GQA guidelines and habitats directive, for comparison

	SRP[22] (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 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

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 10.2-6, 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%.

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.

Table 10.2-6: 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

10.3 WFD and Thetford

Based on the draft standards and draft risk characterisation, the Environment Agency have provided the most recent determination of the water quality targets that the Little Ouse will be required to achieve under the WFD; these are highlighted in Table 10.3-1.

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

Table 10.3-1: Likely WFD water quality standards for the Little Ouse

Determinand	Little Ouse Target (mgl^{-1})	Compliance Requirement
Biochemical Oxygen Demand (BOD)	5 mgl^{-1}	90 percentile
ammoniacal-N	0.6 mgl^{-1}	90 percentile
Phosphate	0.12 mgl^{-1}	Annual average
Dissolved Oxygen	60% saturation	10 percentile

Analysis with the current water quality targets for the Little Ouse suggest that for the sanitary determinands (BOD and ammoniacal-N) the WFD targets are similar (or not as stringent) as required to attain an RE2 target. An RE2 target requires a 90 percentile of 4 mgl^{-1} of BOD, a 90 percentile of 0.6 mgl^{-1} of ammoniacal-N and a 10 percentile of 70% DO saturation. This indicates that as long as the RE2 target is obtained by the increase in wastewater discharge, the WFD standards for sanitary determinands in the Little Ouse should be achieved. This Stage 1 study has highlighted that to achieve this, the extension to Thetford STW is unlikely to require a tightening of the existing consent limits (see section 5.3.2.1).

The target for P for WFD is the key consideration at this stage and this has been confirmed in liaison with the EA water quality planning team. As described in section 5, whilst P is monitored in rivers and there is a GQA grade for P enrichment in rivers, the only legislative driver that requires reductions in point sources of P is the UWWTD which requires limitations based on whether a STW 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 STW with PE greater than 10,000 (2 mgl^{-1} limit – annual average) or 100,000 (1 mgl^{-1} – annual average).

In the latest round of GQA monitoring (2004 to 2006) the Little Ouse achieved a GQA P grade of 5 (Very High) and had an annual mean concentration of 0.21 mgl^{-1}. This demonstrates that the Little Ouse is already failing the WFD target for good ecological status. A mass balance calculation shows that in order to ensure no further deterioration in P the Little Ouse, the additional wastewater discharged from the increase in development would have to be treated to 0.21 mgl^{-1} or less as an annual average. However, this would only achieve a position of 'no deterioration' and would not assist in reducing P concentrations in the Little Ouse in order for it to attain the required P standard under the WFD. Further investment would be required in the total catchment of the Little Ouse to manage input of P 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 STWs and industrial processes); in all likelihood, there will be a requirement for further P reduction for the STW's current consented discharge, over and above that currently required under the UWWTD.

It is recommended that the Stage 2 WCS considers the overall catchment considerations for reducing P concentrations in the Little Ouse by making use of, or building on previous catchment based modelling (such as SIMCAT or PSYCHIC) and that specifically Thetford STWs significance in the catchment management of P pollution is defined. There are several initiatives being considered and planned as part of the overall WFD research into nutrient enrichment and it is important to consider the recent launch of the Government's water strategy for England, Securing Water for the Future (DEFRA 2008 - Reference 28) which is making recommendations for a consultation on controls of P in domestic laundry and cleaning products and whether voluntary and regulatory control options should be considered. The DEFRA strategy also highlights continued support for farmers on Catchment Sensitive Farming.

10.3.1 WFD and Water Company Planning

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 WFD RBMPs are not due to be finalised until 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.

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).

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. In this respect, the Thetford WCS can highlight and provide justification for further investment for inclusion in AWS's submission for PR09 such that measures can begin to be implemented in AMP5 prior to the 2015 WFD target.

11 Scenario Development Assessment

11.1 Scenario Overview

Following the assessment of each of the water cycle and water environment topic areas in preceding sections, each of the development scenarios describing how the different areas can be brought forward is considered and assessed for suitability. The constraints and options for water cycle elements relating to the development are covered in the assessment tables which give a visual comparison of each scenario based on a colour coding system. In addition, a textual description of the colour assigned to each scenario is given in the table relevant to each scenario.

The assessment has been undertaken for each of the five development scenarios. For clarity, the scenarios are described again below:

- *Scenario A*: Development of Key Site North (2010 - 2027) five years before Key Site South East (2015 - 2027).
- *Scenario B*: Key Site North developed to maximum (2010 to 2021) before development of Key Site South East commences (2021 – 2031)
- *Scenario C*: Both Sites developed in parallel between 2010 and 2027
- *Scenario D:* development of Key Site North to maximum, followed by development of remaining housing development to meet the 8,096 target in either area E or C (as defined in the TGFIS) up to 2031. No housing in the Key Site South East would occur under this scenario.
- *Scenario E*: development of natural limit up in Key Site North and Key Site South East areas up to 2021, with additional homes in either area E or C up to 2031 to reach the maximum required new homes target of 8,096 (albeit less than would be the case under scenario D)

The Assessment tables have considered the development of housing in 5 year blocks to coincide with AWS's statutory planning and funding programme (the AMP process). This will aid in assisting with the development of investment programming for new infrastructure. Additionally, the assessment covers constraints to both the provision of infrastructure and the constraints relating to the water environment. The colour coding system used is explained in Table 11-1

Table 11-1: Explanation of colour coding used in assessment tables

	Spare capacity, minimum investment required
	Site specific mitigation or investment required
	Strategic scale mitigation or water cycle infrastructure will be required
	Major investment required / major limitation

11.2 Scenario A: Development of Key Site North (2010 - 2027) five years before Key Site South East (2015 - 2027)

Table 11.2-1: Assessment summary table for Scenario A:

Years	Housing Numbers in each period	Cumulative housing total as infill	Cumulative housing total in new development areas	Cumulative housing total	Water cycle infrasructure constraints				Water Environment constraints		
					Wastewater treatment	Wastewater Network	Water Resource development	Water supply network	Water Environment	Flood Risk to development	Flood Risk Management
2008 - 2010	440	440	0	440							
2010 - 2015	1763	1073	1130	2203							
2015 - 2020	2400	1073	3530	4603							
2021 - 2025	2500	1073	6030	7103							
2025 - 2031	640	1073	6670	7743							

11.2.1 Infill Assessment

Overall, it can be seen that there is sufficient capacity to proceed with the infill development (2008 to 2010) with a small limitation with respect to flood risk and flood risk management; it is considered that individual housing developments in the urban area need to consider assessment of flood risk and provision of site specific mitigation through SUDS; this should be covered in the production of site specific Flood Risk Assessments (FRA) for the infill development. This assessment of infill development is common to all scenarios and hence is only described here.

11.2.2 Wastewater – New Development Areas

Development of Scenario A would require significant investment by 2021 in order to provide sufficient wastewater treatment. Existing infill development and development of Key Site North up to 2015 has the potential to make use of the existing wastewater network for transmission of wastewater flows to the STW. Once development of the South East area commences in 2015, this would require investment into new strategic scale infrastructure which could serve all of the remaining development but with higher associated pumping costs.

11.2.3 Water Resources and Water Supply – New Development Areas

Significant investment in new water resources is not likely to be required until 2025 which is likely to be in the form of a strategic cross catchment transfer of raw water to the Anglian Region. Capacity in existing licences is likely to be available up until 2015, when strategic investment is likely to be required for development of further sources of which the only likely option is a recharge scheme. The water supply position is sufficient for infill development and it has been assumed that the existing system will be suitable for a limited number of direct connections to the new development

areas up to 2015. Thereafter, there will likely be a need for reinforcement and new dedicated mains which will require strategic investment to supply the new areas; although there is little difference in this position between the two Key Sites being developed in this scenario.

11.2.4 Water Environment and Flood Risk – New Development Areas

It has been considered that use of the existing licence capacity will have limited environmental impact for infill development up to 2010, but that use of the licences up to 2015 has the potential to impact on Thetford Golf Course and Marshes SSSI as well as a component part of the Breckland SAC and will need further investigation. Similarly, the CAMS process has highlighted limited further spare capacity in the existing groundwater and surface water resources which could limit development of local sources further. Additionally, strategic investment may be required in wastewater treatment in order to treat the P discharges from current as well as additional wastewater discharges to meet the proposed WFD standards.

The need to provide site specific mitigation in the form of SUDS (which is common to all development areas and scenarios) has resulted in an assessment of dark green for flood risk. However, there is no other considered flood risk limitation to development up to 2025 on the basis that flood risk can be managed for the known flood sources i.e. A11 gullies to Key Site North and potential groundwater flood risk to Key Site South East. A decision has been taken however, to colour code development between 2025 and 2031 as orange on a precautionary basis. This is to reflect that the northern and western boundaries of Key Site South East are in close proximity to Flood Zone 2 and as such, there could be limitations on the extent of development in this area, or restrictions on the types of development that would be permitted on these fringes. Further, an orange coding has been given to flood risk management for all development involving Key Site South East from 2015 onwards as infiltration SUDS will be restricted owing to the SPZ1 designation; there will therefore be a likely requirement for strategic scale surface water attenuation to be provided if development of this area commences.

11.3 Scenario B: Key Site North developed to maximum (2010 to 2021) before development of Key Site South East commences (2021 – 2031)

Table 11.3-1: Assessment summary table for Scenario B:

Years	Housing Numbers in each period	Cumulative housing total as infill	Cumulative housing total in new development areas	Cumulative housing total	Water cycle infrasructure constraints				Water Environment constraints		
					Wastewater treatment	Wastewater Network	Water Resource development	Water supply network	Water Environment	Flood Risk to development	Flood Risk Management
2008 - 2010	440	440	0	440							
2010 - 2015	1763	1073	1130	2203							
2015 - 2020	2400	1073	3530	4603							
2021 - 2025	1720	1073	6030	7103							
2025 - 2031	1420	1073	6670	7743							

11.3.1 Wastewater – New Development Areas

The summary assessment for development according to scenario B is the same as scenario A for wastewater treatment provision. In terms of wastewater network provision, existing infill development and development of Key Site North up to 2015 has the potential to make use of the existing wastewater network for transmission of wastewater flows to the STW, hence the light green coding. However, the Wastewater network assessment is considered as slightly preferential to scenario A on the basis that development of the South east area will not be required until 2021 and the strategic scale main could be developed solely for the Northern area up until this point; because of the grater length of gravity fed pipes associated with sole development of Key Site North, the strategic infrastructure would have less cost, both from a construction cost (CAPEX) and operating cost (OPEX); therefore, the assessment is considered orange as opposed to red for 2015-2021 for Scenario B. Once development of the South East area commences in 2021, this would require investment into larger scale new strategic scale infrastructure which could serve all of the remaining development but with higher associated pumping costs.

11.3.2 Water Resources and Water Supply - New Development Areas

The water supply and water resource assessment is the same as scenario A. This is on the basis that water sources to supply the future Thetford growth does not vary according the development areas assessed and that each development area is in a similar position with respect to the existing baseline for the water supply network.

11.3.3 Water Environment and Flood Risk - New Development Areas

The water Environment Assessment is the same as Scenario A, as is the flood risk to development. With respect to flood risk management, Scenario B is considered preferential to Scenario A on the basis that development in key Site South East (which is dependent on surface water attenuation) is not required until 2021 onwards.

11.4 Scenario C: Both Key Sites developed in parallel between 2010 and 2027

Table 11.4-1: Assessment summary table for Scenario C:

Years	Housing Numbers in each period	Cumulative housing total as infill	Cumulative housing total in new development areas	Cumulative housing total	Water cycle infrasructure constraints				Water Environment constraints		
					Wastewater treatment	Wastewater Network	Water Resource development	Water supply network	Water Environment	Flood Risk to development	Flood Risk Management
2008 - 2010	440	440	0	440							
2010 - 2015	2763	1073	1130	2203							
2015 - 2020	2500	1073	3530	4603							
2021 - 2025	1515	1073	6030	7103							
2025 - 2031	525	1073	6670	7743							

11.4.1 Wastewater - New Development Areas

The summary assessment for development according to scenario C has shown that it is less preferable to Scenarios A and B in terms of wastewater provision as development of both Key areas starting in 2010 has the potential to result in the volumetric treatment capacity of the STW to be reached by the end of 2021. Although calculations have shown that the predicted development number of 5,703 new homes for Scenario C up to 2021 is more than the calculated headroom, it is only by a small margin and there are several uncertainties in the calculation of headroom to make this a potentially unviable option once more data is available to assess it; in particular the uncertainties around infiltration calculations and the spare process capacity of the works. Development for this scenario between 2015 and 2021 has therefore been given a precautionary orange coding as opposed to a definite red constraint.

In terms of wastewater network provision, existing infill development has the potential to make use of the existing wastewater network for transmission of wastewater flows to the STW, hence the light green coding. However, the Wastewater network assessment is considered as less preferential to scenarios A & B on the basis that development of the South east area from 2010 will require strategic new mains to be in place which would have to routed around the northern or southern extent of the existing urban areas owing to the calculated restrictions in the existing network through the town centre. Strategic scale investment is therefore required as early as 210 for this scenario.

11.4.2 Water Resources and Water Supply - New Development Areas

The water supply and water resource assessment is the same as scenarios A & B. This is on the basis that water sources to supply future Thetford growth does not vary according the development areas assessed and that each development area is in a similar position with respect to the existing baseline for the water supply network.

11.4.3 Water Environment and Flood Risk - New Development Areas

The water Environment Assessment is the same as Scenarios A & B. Flood risk management issues may potentially occur earlier for Scenario C when compared to A and B on the basis that development of the Key Site South East will complete earlier in 2021 and the issues with the fringes of the northern and western boundaries of the development site may restrict development numbers or types. With respect to flood risk management, Scenario C is considered less preferential to Scenarios A and B on the basis that development in key Site South East (which is dependent on surface water attenuation) is required early from 2010 onwards which would likely require early provision of strategic scale surface water attenuation features to comply with PPS25.

11.5 Scenario D: development of Key Site North to maximum, followed by development of remaining housing development to meet the 8,096 target in either area E or C (as defined in the TGFIS) up to 2031. No housing in the South East would occur under this scenario.

Table 11.5-1: Assessment summary table for Scenario D:

Years	Housing Numbers in each period	Cumulative Housing total as infill	Cumulative housing total in new development areas	Cumulative housing total	Water cycle infrasructure constraints				Water Environment constraints				
					Wastewater treatment	Wastewater Network	Water Resource development	Water supply network	Water Environment	Flood Risk to development		Flood Risk Management	
										Site C	Site E	Site C	Site E
2008 - 2010	440	440	0	440									
2010 - 2015	2763	1073	2130	3203									
2015 - 2020	4540	1073	6670	7743									
2021 - 2025	353	1073	7023	8096									
2025 - 2031	0	1073	7023	8096									

Scenarios D & E have not been explicitly developed in terms of housing trajectories; however based on the descriptions provided, the housing number assumptions and timings as developed for scenarios A to C have been used. In addition, it has not been decided by Breckland as to which of the two additional areas (Site C, or Site E) would be developed in each scenario. Despite this, the assessment has shown that the proximity of the new areas, both to each other and to Key Site North, is such that the assessment of water infrastructure is the same regardless of which additional development area is considered; however, there is a variance in the Flood constraint assessment and this is reflected in the split table assessment for flood constraint assessment for scenarios D and E.

11.5.1 Wastewater – New Development Areas

The summary assessment for development according to scenario D has shown that it is considered as less preferential to Scenarios A, B and C in terms of wastewater provision as development of the additional areas would theoretically allow more housing to be built up to the limit of 8096 new houses. This would require additional expansion at Thetford STW over and above that of scenarios A to C.

In terms of wastewater network provision, existing infill development has the potential to make use of the existing wastewater network for transmission of wastewater flows to the STW, hence the light green coding; however, the Wastewater network assessment is considered as slightly preferential to both scenarios A, B and C on the basis that development of both the areas could more easily connect to the strategic main supplied for Key Site North and would have less overall pipe distance and requirement for pumping as would be required to develop Key Site South East. It is considered that this lowers the colour coding from red to orange to reflect the reduced CAPEX and OPEX cost of taking this development option forward.

11.5.2 Water Resources and Water Supply - New Development Areas

The water resource assessment for development according to scenario D has shown that it is considered as less preferential to Scenarios A, B and C as development of the additional areas would theoretically allow more housing to be built up to the limit of 8096 new houses. This would require additional water resources to be found and an increased reliance on transfer from cross catchment according to the long term water resource strategy. The water supply assessment is similar to Scenarios A, B and C on the basis that each development area is in a similar position with respect to the existing baseline for the water supply network.

11.5.3 Water Environment and Flood Risk - New Development Areas

The water environment assessment is considered to be slightly less preferential than that for Scenarios A, B and C. Comparatively, the colour coding used for scenario D is the same as that of A to C; however, additional housing would result in additional requirement for abstraction which could impact on the development of local resources and could also increase the requirement of further P removal from the STW.

Flood risk to development is only considered an issue if Site E is developed on the basis that the southernmost boundary of the site is in close proximity to Flood Zone 2 and as such, there could be limitations on the extent of development in this area, or restrictions on the types of development that would be permitted on the southern fringes. There are not considered to be any major constraints on the provision of flood risk management to Site E as it is outside of a SPZ1. Development of Site C as opposed to Site E would have no strategic limitations in terms of flood risk (A11 gullies risk can be managed). There are not considered to be any major constraints on the provision of flood risk management to Site E or site C as they are outside of a SPZ1.

11.6 Scenario E: development of natural limit in Key Site North and Key Site South East areas up to 2021, with additional homes in either area E or C up to 2031 to reach the maximum required new homes target of 8,096 (albeit less than would be the case under Scenario D).

Table 11.6-1: Assessment summary table for Scenario E:

Years	Housing Numbers in each period	Cumulative Housing total as infill	Cumulative housing total in new development areas	Cumulative housing total	Water cycle infrasructure constraints				Water Environment constraints				
					Wastewater treatment	Wastewater Network	Water Resource development	Water supply network	Water Environment	Flood Risk to development		Flood Risk Management	
										Site C	Site E	Site C	Site E
2008 - 2010	440	440	0	440									
2010 - 2015	2763	1073	2130	3203									
2015 - 2020	4540	1073	6670	7743									
2021 - 2025	353	1073	7023	8096									
2025 - 2031	0	1073	7023	8096									

11.6.1 Wastewater – New Development Areas

The summary assessment for development according to scenario E has shown that it is similar to scenario D in that it is considered as less preferential to Scenarios A, B and C in terms of wastewater provision as development of the additional areas would theoretically allow more housing to be built up to the limit of 8096 new houses. This would require additional expansion at Thetford STW over and above that of scenarios A to C. In addition, Scenario E is less preferential than Scenario D as it would require additional treatment infrastructure by 2015 to accommodate full growth in Key Sites North and South East by the end of 2021.

As with scenario D the wastewater network assessment is considered as slightly preferential to scenarios A, B and C on the basis that development of both areas could more easily connect to the strategic main supplied for Key Site North and would have less overall pipe distance and requirement for pumping as would be required to develop Key Site South East. It is considered that this lowers the colour coding from red to orange to reflect the reduced CAPEX and OPEX cost of taking this development option forward. However, it is not considered as preferential as Scenario D on the basis that the development of additional houses between 2010 and 2015 would require strategic level investment and infrastructure to be developed.

11.6.2 Water Resources and Water Supply - New Development Areas

As with Scenario D, The water resource assessment for development according to scenario E has shown that it is considered as less preferential to Scenarios A, B and C as development of the additional areas would theoretically allow more housing to be built up to the limit of 8096 new houses. This would require additional water resources to be found and an increased reliance on transfer from cross catchment according to the long term

water resource strategy. The water supply assessment is similar to Scenarios A to D on the basis that each development area is in a similar position with respect to the existing baseline for the water supply network.

11.6.3 Water Environment and Flood Risk - New Development Areas

The water Environment Assessment is considered to be slightly less preferential than that for scenarios A, B and C. Comparatively, the colour coding used for scenario E is the same as that of all others; however, as with scenario D, additional housing would result in additional requirement for abstraction which could impact on the development of local resources and could also increase the requirement of further P removal from the STW.

Flood risk to development is only considered an issue if Site E is developed on the basis that the southernmost boundary of the site is in close proximity to Flood Zone 2 and as such, there could be limitations on the extent of development in this area, or restrictions on the types of development that would be permitted on the southern fringes. The development of housing before 2025 means this may be an issue earlier than scenario D and hence is slightly less preferential. There are not considered to be any major constraints on the provision of flood risk management to Site E or site C as they are outside of a SPZ1.

11.7 Scenario Development: Sensitivity Testing

The main assessment in this Stage 1 study has relied on assumptions provided by AWS (146 litres per head per day [l/h/d]) when calculating wastewater generation and water demand from the new development. In undertaking the calculations, it has been shown that the requirement for additional wastewater treatment and water demand are sensitive to the assumptions applied to water consumption.

This report has previously alluded to potential savings on water demand that can be achieved when water efficiency is designed into new homes referencing the design aspirations as set out in the Code for Sustainable Homes (Reference 26), as well as the introduction of metering and tariffs. The DEFRA water strategy (Reference 28) also sets new consumption targets for new homes at 120 l/h/d.

Breckland council have advised that they do not yet have proposed targets for what Sustainable Code level the new homes should achieve; however, it is important to consider potential savings that could be made and several sources on water efficiency such as Waterwise (a UK NGO - Reference 30), The Code for Sustainable Homes, AWS's water efficiency plan, and OFWAT guidance on water efficiency measures (produced in consultation with various water companies - Reference 24).

11.7.1 Water Efficiency

The growth of homes in the Anglian region will place increasing strain on available resources. AWS have already noted this and through existing schemes has already achieved efficiencies through increased metering and reduction of water supply leakage [23]. Meter penetration has reached 57% of AWS's customers [24] and they have managed to reduce its levels of leakage to 19% of the water put into supply (based on 2005/06)[25].

New developments can be built with water efficiency in mind. The CLG (Communities and Local Government) have recently consulted on a water efficiency figure for all new builds of between 120 and 135 l/h/d (litres per head per day).

Approaches to water efficiency differ between the two groups of customers supplied by AWS. The two groups are metered and unmetered customers.

- Metered customers will already be 'water conscious' and a typical AWS metered customer uses around 128 l/h/d[3]. It can be assumed that these customers will have taken easy steps to improve their water efficiency for example, by mending dripping taps, installing water butts and replacing old washing machines with new more water efficient models.

- Unmetered customers in the Anglian region typically use 160 l/h/d [3]. Unmetered households may not be able to afford to switch to a meter (under existing water tariffs) and their options for reducing water usage may be less than for metered customers. Help in the form of a water efficiency audit may be useful step for customers to understand where they might be using most water. The next step may be to provide certain groups of unmetered customers, such as those receiving social security payments with small grants to enable households to convert to more water efficient technologies such as low flow showers and low flush toilets.

[23] Anglian Water's Water efficiency plan
[24] Anglian Water's Drought Plan. AWS, 2006
[25] OFWAT Security of Supply, Leakage and water efficiency 2005/06 report.
[4] Water Resources in the South East Forum

11.7.1.1 New Development – Water Efficiency

New developments can be built with water efficiency in mind and it is recommended in this Stage 1 strategy (through the developer checklist) that new development is built to a high standard of water efficiency to reduce the requirement for new wastewater provision and water resource demand.

The Code for Sustainable homes 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 11.7-1 outlines the water efficiency that needs to be achieved to reach each of the sustainable levels.

Table 11.7-1: 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	

The examples of water efficiency measures include in Table 11.7-1 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 (Reference 24) for water and sewerage companies and it is recommended that these are assessed and considered for inclusion in new development as part of the Stage 2 strategy as the preferred options for development come forward. 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.

New developments offer the opportunity to work towards a much higher level of water efficiency. The eco-towns water cycle worksheet (Reference 27) 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 kind of initiatives could be considered for Thetford 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 Thetford.

11.7.1.2 Current development – reducing exiting baseline

As well as efficiency in new build, Breckland Council have requested that options are sought to reduce the existing water consumption baseline from the current Thetford population, over and above the measures

being implemented by AWS. It is recommended that a detailed water efficiency plan is developed for existing customers in the Stage 2 WCS as an overall plan to reduce the baseline water demand in the town. This outline study has initially identified several ways in which current demand can be reduced in Thetford.

There are possibilities within existing development to achieve significant savings and to improve efficiency and reduce the baseline water consumption. Measures that can be employed are:

- Education about water efficiency, in particular about water efficient fixtures and fittings and appliances;
- Advertisement of products and services that can help people to be more water efficient; promote local plumbers who preferable install water efficient fixtures and fittings (for example, provide grants to cover any additional cost for a 4.5l toilet rather than a 6l toilet). The installation of 6 litre flush toilets can give a saving of 8% and potentially even more savings with 4.5 litre flush toilets. It should be noted that all new homes being built today are fitted with 6 litre flush toilets as a matter of course);
- Promotion of the Waterwise Marque which is given to products that show excellent water efficiency. More information can be found at www.waterwise.org.uk.
- Provision of support for the purchase and installation of water efficient fixtures fittings and appliances such as low flush toilets, efficient dishwashers and washing machines, aerating taps (aerators can be retrofitted on to existing taps), water butts.
- Provide information on lagging pipes to prevent bursts in the winter.
- Provide water audits to show consumers where they use the most water and how they can reduce their water usage.
- Encourage local businesses to promote water efficiency.
- Installing aerators on taps and showers to reduce the amount of water wastes
- Fit flow restrictors on showers, which reduces flow to a maximum of 8 litres per minute.

11.7.2 Water Consumption - Sensitivity Analysis

The Code for Sustainable Homes targets have been used to determine the overall reduction in wastewater generation and water demand that would ensue if these theoretical targets could be guaranteed for new builds. It is noted at this stage that such targets, whilst inspirational and worth pursuing, are theoretical and that AWS will have a statutory obligation to provide an amount of water per new home based on latest requirements of the industry regulator – OFWAT. This is linked to the requirement to provide for 'security of supply' during worst case drought years and as such, there is a regulatory requirement to provide new water resources and wastewater treatment according to industry standard demand calculations; this includes for uncertainties as a result of climate change (e.g. less summer rainfall gives lower river flow and hence less water for abstraction) or leakage (even in new pipe work there is some loss through leakage).

Nevertheless, it is important that water efficiency is considered in future planning and that AWS and Breckland Council are aware of the savings that could be achieved through attainment of theoretical water consumption reduction in new homes. Table 11.7-2 provides estimates of the theoretical savings in the capacity at Thetford STW and water demand if the water efficiency targets could be reached. It should be noted that the calculations have been undertaken by applying the efficiency to the new houses built only (including the infill development, but not those already completed) i.e. assuming that 146 l/h/d is the baseline for the existing population.

Table 11.7-2: Sensitivity testing of the effect of different water efficiency targets on potential savings on water demand and wastewater treatment capacity

Water consumption target (l/h/d)	Sustainable Homes Code	Waste water treatment capacity				Water Demand (Mld^{-1})		
		AWS assumption (m^3d^{-1})	Eco-Homes (m^3d^{-1})	reduction (m3d-1)	No. of homes (extra)	AWS assumption	Eco-Homes	Saving
135	N/A	-1069	-835	234	0	3.23	2.98	0
120	1 & 2	-1069	-516	553	0	3.23	2.65	0.58
105	3 & 4	-1069	-198	871	0	3.23	2.32	0.25
80	5 & 6	-1069	334	1403	1088	3.23	1.77	0.91

The sensitivity analysis shows that there are significant savings to be made if the water consumption targets could be guaranteed. The sensitivity shows that achieving grade 5 or 6 on the Code for Sustainable Homes targets would mean that there would be sufficient capacity to treat all the wastewater generated from new development up to 2021. The savings for the other scenarios are not sufficient to negate the requirement for additional treatment, but do show a significant saving that would reduce investment capital and allow more homes to be built and treated before the STW required upgrading (potentially into AMP6). The savings with respect to water demand are significant, and could result in the requirement to not rely on transfer of water into the area from cross-catchment in the longer term if the very high Codes are attained.

12 Policy, Developer Guidance & Funding Mechanisms

12.1 Introduction

An important outcome of a completed WCS is to ensure a link between the planning process and the infrastructure required to meet growth requirements. The Stage 2 WCS will define in more detail the infrastructure requirements for the proposed development areas, but a further key outcome will be the timing of implementation of that infrastructure and how it is funded.

The Stage 2 Thetford WCS will ultimately produce a programme or timeline for development with detail of the infrastructure required in order to facilitate this development. The timeline will also demonstrate when funding would need to be sought by AWS as well as the implementation of mechanisms for ensuring sufficient developer contribution towards strategic infrastructure required to meet the requirements of the overall water cycle Study.

It is intended that the completed Thetford WCS will produce an overall strategy that each of the key Stakeholders can sign up to. This will aid in the process of delivering development in Thetford by helping to ensure that objections to proposed development on the grounds of water issues such as flood risk and abstraction are avoided. By producing a completed WCS that is agreed by AWS, Natural England, the EA and Breckland Council, it will aid developers in understanding the requirements they need to meet in order to comply with the strategy produced from the WCS. It will also set the framework for how funding will be sought for the different water infrastructure requirements.

In order to achieve this, the Thetford WCS is required to produce the following:

- Guidance on planning policy with respect to development and the water cycle that Breckland Council can use to input into the Supplementary Planning Document being formulated as part of the LDF;
- Guidance for developers in terms of what developers need to achieve in order to comply with the overall water cycle strategy, such as flood risk mitigation; this will be in the form of a developer checklist and it is envisaged that this will eventually be a document which, if its criterion are all met for a proposed development, will help to ensure no objection from the EA or LPA on the grounds of water cycle issues. This type of checklist document has been successfully developed for other WCS such as the inaugural WCS completed for Corby;
- Agreement on funding mechanisms, particularly for strategic, development wide infrastructure required i.e. strategic scale surface water attenuation schemes;
- Planning timelines for provision of water infrastructure against growth to aid AWS in planning for water infrastructure within relevant business plans; and
- To provide justification for AWS in seeking funding through the PR and AMP process for the required infrastructure.

In terms of the overall funding mechanism, it is important to consider that the Government has laid down strict rules on how water companies are funded, especially with regard to domestic development, and this overall process is heavily regulated by the industry's economic regulator – OFWAT. Essentially, AWS has the responsibility for providing wastewater treatment and water supply costs and this is funded through charges to customers within its operating area through the Price Review Process and Asset Management

Plan (AMP) process (see section 2.2.2.2). Therefore, developer contributions relate largely to strategic scale flood management infrastructure.

This Stage 1 WCS report introduces the various policy, funding and developer requirement elements to the Thetford WCS, but it is envisaged that these will be developed further in the detailed Stage 2 WCS.

12.2 Developer Checklist

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 Breckland Council, Natural England and the local water undertaker, i.e. Anglian Water Services. The checklist provided in this Stage 1 Thetford WCS has been developed from examples used in previous WCS as well as the EA'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 EA requirements and which are driven by local policy. The checklist also includes recommended policy which has emerged from this Stage 1 WCS and which is likely to be required to ensure sustainable delivery of housing with respect to the Water Cycle and Water Environment.

The Stage 1 checklist has been provided as a 'working document' which should be revised in Stage 2, once more is known about the development scenarios and housing numbers to be taken forward for detailed assessment. 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.

The checklist is provided in Appendix G – Developer Checklist.

12.3 Funding and Cost Apportionment Mechanisms

This Thetford Water Cycle Study 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
- Flood risk management

Although the options for providing the additional infrastructure will be developed in further detail in the Stage 2 WCS, it is important to consider funding at a strategic level now to inform the development of the Stage 2 study.

Both water supply and water resources are the responsibility of Anglian Water Services within Thetford and as a result, the proportion of which can be charged to Developers is set down by agreements with OFWAT. In general, WCS have not considered the apportionment of developer contributions towards strategic water supply and wastewater facilities; however in the specific case of Thetford, this Outline Study has identified that there is a potential preferred option for the provision of new strategic scale sewerage mains for the transmission of wastewater. Because these mains would be constructed solely for the proposed new development, it is considered that developer contributions could be made towards the funding of this infrastructure on a scale commensurate with the number of housing proposed by each developer. It is recommended that this option is taken forward in the Stage 2 WCS, and that developer contributions are worked up with AWS and Breckland Council within the limits set down by OFWAT.

In summary, developers can be included into the financial contribution in two ways:

Stage 1 & 2 - Stakeholder Participation

In developing other Water Cycle Studies, property developers have been incorporated into the stakeholder group to provide an input into the direction of the study. In so doing, the developers who are involved would be best placed to undertake the recommendations from Stage 2 of the Water Cycle Study, and ensure that these are incorporated into the design of the developments.

Stage 3 – Infrastructure Funding

Developers may also contribute to the capital works of infrastructure required within the Water Cycle Study. Although in general (and with the potential exception of sewerage infrastructure for Thetford) this would not apply to wastewater or water supply infrastructure as this is regulated by the Water Companies through OFWAT it would include contributions for funding for example towards large scale flood attenuation storage. This has therefore been considered.

12.3.1 Minimisation of Cost

Despite this, developers can at least contribute to minimising the capital cost of water infrastructure. It can be seen from the assessment of whether existing infrastructure is adequate that a key variable is water consumption per capita (see section 11.7). 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 (see section 11.7.1) 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 m^3d^{-1} 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 m^3d^{-1} headroom at the same STW can be further increased.

12.3.2 Water Resource Provision - Employment

From 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.

These are potential options for the sources of employment to be provided in Thetford.

12.3.3 Cost Apportionment Mechanism

This Outline Study WCS has considered the size of surface water attenuation that may be required in order for new development to comply with PPS25 and that developers could contribute towards the cost for provision of this on a strategic level. In addition, it has identified that there are potential options for developer contribution towards strategic sewerage infrastructure provision. Dependent on the options taken forward in Stage 2, a potential charge could be made to developers through the Section 106

mechanism with Breckland Council setting up a fund to receive Developers' contributions and to use them to fund works.

Research for the Corby WCS has identified a legal requirement for such contributions to be made on the basis of commensurate impact of each development, for instance according to its location in the catchment. This mechanism has already been applied in Corby, whereby contributions have been agreed via Section 106 agreements for two key developments; this is an important precedent.

13 Conclusions and Recommendations

13.1 Overview

The Outline Thetford WCS has identified the existing capacity of the current water environment and water cycle infrastructure and has used this assessment to determine where additional investment is required to supply new infrastructure or protect the water environment. The conclusions of each assessment are presented here.

13.1.1 Flood Risk and Water Environment

There is sufficient 'water quality' capacity in the Little Ouse (the most likely receiving watercourse) for additional wastewater flow up to the existing consented discharge limits from Thetford STW; therefore, development up to 2021 will not require significant investment in treatment processes at the works. It is recommended that a process capacity assessment is undertaken in the Stage 2 study to verify this. Beyond 2021, the majority of the project growth up to 2031 will require investment in process capacity such that the additional wastewater flow is treated to a better quality, particularly in respect to ammonia both for current statutory water quality standards, but also for future proposed WFD standards. It is considered that the improvements required are not beyond the capability of Best Available Technology (BAT) such that water quality capacity (in terms of existing standards and legislation) is sufficient for growth up to 2021.

With respect to the WFD, there is likely to be a requirement to reduce P concentrations discharged from the STW for the additional wastewater, but also from the existing works and it is recommended that this is investigated in more detail in the Stage 2 Study. This will require a catchment focused study on how to reduce in-stream P concentrations in the Little Ouse which are already failing expected P standards under the WFD.

The assessment of hydraulic capacity has shown that there will be a negligible impact on peak flood flows from the discharge of additional wastewater, and that for the bankfull limit flow, the increase in water level is likely to be less than 10 cm resulting in a negligible impact on flood levels. It is considered that there is sufficient hydraulic capacity in the Little Ouse to accept the increase in flow from Thetford STW.

The Habitats Regulation assessment has not identified any hydrologically linked conservation sites as being adversely affected by the proposed development in Thetford due to the likely increase in P load and discharge volumes. However, there is a potential for impact to Thetford Golf Course SSSI and a component part of the Breckland SAC as a result of abstraction from Two Mile Bottom PWS and hence, this will need to be further investigated in Stage 2.

13.1.2 Wastewater Treatment and Transmission

There is generally sufficient capacity in the existing system to accommodate growth up to 2021 for four of the five potential development scenarios in terms of wastewater treatment. Some Strategic scale investment will be required from 2010 in terms of wastewater network infrastructure in order to service the new development, but there is existing capacity in the existing wastewater system to allow development to occur with site specific connections up to approximately a 1000 homes (estimated to take place between 2008 and 2010).

Sensitivity testing has shown that aspirations to meet lower water consumption targets for new homes could reduce the investment required in treatment capacity upgrade and hence allow more of the development between 2021 and 2031 to be accommodated before an upgrade is required (potentially into AMP6). However, whilst water efficiency will reduce the volume of sewerage produced from new housing,

this will tend to increase the strength of the sewage. Consequently, as the volumetric capacity is increased, the biological capacity is reduced, and therefore the capacity at the works is not necessarily released for more housing as a result of these measures.

Development for the projected development up to 2031 will require additional wastewater treatment and the outline study has identified an upgrade to the existing Thetford STW as the most likely option for delivery of the additional treatment capacity.

13.2 Water Resources and Supply

It is concluded that there is sufficient capacity in the existing licences feeding Thetford to accommodate growth in the short to medium term up to 2021. Growth up to 2031 will require investment in local sources (dependent on CAMS limitations, of which the only likely option is a recharge scheme) supplemented with cross-catchment transfer of raw water in the longer term.

Sensitivity testing has shown that aspirations to meet lower water consumption targets for new homes could reduce the demand for water and hence reduce reliance on transfer of raw water into the area from cross-catchment in the longer term.

The projected development up to 2021 is unlikely to require strategic level investment in water supply network and should be able to connect to all proposed development areas via the existing strategic mains; site specific connections will still be required. Beyond 2021, there is likely to be the requirement to undertake reinforcement and upgrades of the strategic mains in order to facilitate development up to 2031.

13.3 Scenario and Phasing recommendations

13.3.1 Scenario Recommendations

A comparative assessment has been undertaken of the five potential development scenarios to provide outline guidance on phasing of development and required planning in terms of AWS's AMP process. In general, there is little difference between the five scenarios assessed; however it is possible to make some broad statements on preferences between the scenarios.

It is generally considered that Scenario B "Key Site North developed to maximum (2010 to 2021) before development of Key Site South East commences (2021 – 2031)" is the best option in terms of the water cycle. The key reasons being that by developing Key Site North only up to 2021 it:

- has a slightly lower flood risk and flood management limitation that Scenarios A and C;
- It would require less investment in wastewater network provision and pumping costs up to 2021 (although these would be largely the same as other scenarios moving into the period up to 2031);

These two issues are not seen as significantly overriding to make Scenario B much more favourable than the other two key scenarios. Wastewater treatment capacity issues are similar for all three scenarios, as are water supply considerations, water resources and water environment; hence in phasing terms, there is no significant difference between the key scenarios.

The two further scenarios (D and E), which involve over 600 more houses than Scenarios A, B and C, would obviously require additional investment in water resource provision and wastewater treatment provision to supply the additional homes, potentially considerably so and disproportionately so on a pro rata per house basis. They could impact on water quality in terms of the need for P reduction and increases reliance on development of local sources for water supply (potential CAMS conflict and

designated site impact) as well as cross-catchment transfer. As such it is concluded that Scenarios A, B or C are probably better than Scenarios D and E.

However, it should not be dismissed entirely that Scenario D, which involves no housing to the South East, could be considered a better option than scenarios which involve developing the Key Site South East. The main advantage would be a reduction in wastewater network supply costs and associated pumping costs (potentially lower carbon footprint) when compared to the options that consider development of Key Site South East; flood risk management is also considered to be easier and preferential for the sites to the north. A caveat should be added that this assessment only considers water cycle aspects and does not consider other sustainability or planning issues that may make development of the sites C and E less preferable.

Scenario E appears, at present, to be the least preferred option.

13.3.2 Phasing Recommendations

Until a decision is made in the LDF process as to the preferred development scenario and hence areas for development, detailed recommendations on the phasing requirements for infrastructure cannot be made; it is considered that this will be undertaken in Stage 2 of the WCS. However, an indication of phasing requirements can be given in this outline study by assessing Scenario B as a potential preferred option, the outputs of which are provided in Box 13-1.

Box 13-1: Representation of Phasing and investment programme for new development

Year	AMP	Completions	Existing Urban Area	Urban Extensions South East	Urban Extensions North	Total	Cumulative Total - to be Developed	Wastewater treatment	wastewater netowrk	water resources	water supply	Flood Management
2001-02		72				72						
2002-03		96				96						
2003-04		188				188						
2004-05		277				277						
2005-06		141				141						
2006-07		130				130						
2007-08	AMP 4		90			90	90	Neglible	Neglible	Negligible	Negligible	Minor
2008-09	AMP 4		140			140	230	Neglible	Neglible	Negligible	Negligible	Minor
2009-10	AMP 4		210			210	440	Neglible	Neglible	Negligible	Negligible	Minor
2010-11	AMP 5		223		120	343	783	Neglible	Neglible	Negligible	Negligible	Minor
2011-12	AMP 5		160		190	350	1133	Neglible	Minor	Negligible	Minor	Minor
2012-13	AMP 5		80		270	350	1483	Neglible	Moderate	Negligible	Minor	Minor
2013-14	AMP 5		80		270	350	1833	Neglible	Moderate	Negligible	Minor	Minor
2014-15	AMP 5		90		280	370	2203	Neglible	Moderate	Negligible	Minor	Minor
2015-16	AMP 6				400	400	2603	Neglible	Moderate	Negligible	Minor	Minor
2016-17	AMP 6				500	500	3103	Neglible	Moderate	Moderate	Minor	Minor
2017-18	AMP 6				500	500	3603	Neglible	Moderate	Moderate	Moderate	Minor
2018-19	AMP 6				500	500	4103	Neglible	Moderate	Moderate	Moderate	Minor
2019-20	AMP 6				500	500	4603	Neglible	Moderate	Moderate	Moderate	Minor
2020-21	AMP 7				500	500	5103	Neglible	Moderate	Moderate	Moderate	Minor
2021-22	AMP 7			120	440	560	5663	Major	Major	Major	Moderate	Moderate
2022-23	AMP 7			220		220	5883	Major	Major	Major	Moderate	Moderate
2023-24	AMP 7			220		220	6103	Major	Major	Major	Moderate	Moderate
2024-25	AMP 7			220		220	6323	Major	Major	Major	Moderate	Moderate
2025-26	AMP 8			220		220	6543	Major	Major	Major	Moderate	Moderate
2026-27	AMP 8			240		240	6783	Major	Major	Major	Moderate	Moderate
2027-28	AMP 8			240		240	7023	Major	Major	Major	Moderate	Moderate
2028-29	AMP 8			240		240	7263	Major	Major	Major	Moderate	Moderate
2029-30	AMP 8			240		240	7503	Major	Major	Major	Moderate	Moderate
2030-31				240		240	7743	Major	Major	Major	Moderate	Moderate
Total		904	1073	2200	4470	7743						

PR09
PR14
PR24
PR29

PR09 Planning for AMP5 (2010 - 2015)

AWS's PR09 business plan submission will need to allow for the following investment to be implemented during AMP5:

- minor investment for the wastewater network to be implemented for 2012 and for moderate investment in strategic wastewater mains between 2012 and 2015;
- minor investment in the water supply network in order to connect new homes to the existing system

There will also be a requirement for the set up of developer contribution systems for flood management, mainly infiltration SUDS and some surface water attenuation for Key Site North. There is also the potential need for a developer contribution towards the provision of strategic mains.

PR14 planning for AMP6 (2015 - 2020)

AWS's PR014 business plan submission will need to allow for more significant investment than PR09 to allow the following investment to be implemented during AMP6:

- Further Moderate investment in the strategic wastewater main for the entire AMP6 period in order to supply the majority of the Key Site North and to lay the foundations for connection to Key Site South East;
- Increase to moderate investment in the water supply network in order to uprate and reinforce the water supply system for additional housing between 2016 and 2020.
- Investment in local water resource, potentially from groundwater recharge dependent on CAMS from 2017 to 2020

In addition, there will also be a continued requirement for developer contributions towards flood management, mainly infiltration SUDS and some surface water attenuation for Key Site North. There is also the potential need for a developer contribution towards the provision of strategic mains.

PR24 & 29 planning for AMP6 (2020 - 2025) and AMP7 (2025-2030)

AWS's later business plans are less certain as much depends on the level of growth that will be targeted in Thetford beyond 2021 but also that funding may be sought for longer term strategic water cycle infrastructure requirements throughout AMP6. It maybe more cost efficient to provide the strategic, major level investment in AMP6 via planning in PR24. Either way, the investment needed through AMPs 6 and 7 is:

- Major investment in new wastewater capacity from 2021-2031;
- Provision of strategic wastewater network to serve population of Key Site South East as well as Key Site North between 2021 and 2031.
- Investment in long-term cross catchment transfer with some of this strategic resource being supplied to Thetford between 2021 and 2031
- More widespread investment in water supply mains upgrade including WTW uprating for development between 2021 and 2031.

In addition, there will also be a requirement for moderate scale developer contributions towards flood management, with the South East area requiring development of large scale surface water attenuation features. There is also the potential need for a developer contribution towards the provision of strategic mains.

13.4 Scope for Stage 2 Thetford WCS

The following areas of specific assessment have been identified in this Outline Study as crucial to further developing the detailed study in Stage 2 and therefore should form the scope of Stage 2.

In describing these assessment areas, it has been assumed that prior to commencing Stage 2, decisions will be made as to the key development scenario that will be taken into the more detailed assessment. It is considered that much of the detailed assessment work required in Stage 2 would have to be carried out on a single or perhaps two development scenarios only. As such, some elements of Stage 2 should be undertaken once the Preferred Options element of the Thetford Area Action Plan has been published (due January 2009).

- Continuation of wider stakeholder consultation and consideration of public exhibitions at the draft report stage for Phase 2;
- SFRA Level 2: It is recommended that the Level 2 SFRA for Breckland is undertaken in conjunction with the Stage 2 WCS as Thetford is the only area within the district requiring assessment with regards to fluvial flood risk on the town centre and infill development;
- Consider the overall catchment considerations for reducing P concentrations in the Little Ouse by making use of, or building on previous catchment based modelling (such as SIMCAT or PSYCHIC) and, specifically for Thetford STWs, define the significance in the catchment management of P pollution;
- Define the process capacity of Thetford STW as opposed to relying on the assessment of volumetric capacity alone: especially important given the requirement to treat imported sludge liquors and inputs from septic tanks;
- Undertake Sewerage modelling (using updated April 2008 model) of the existing wastewater catchment to confirm 1000 home capacity conclusion from Stage 1 to determine level of growth that can be accommodated without the need for strategic mains provision. The model will need to consider the percentage of town centre network which is combined; Model proposed options for providing new strategic mains for remaining development;
- Consider options for innovative wastewater treatment; undertake Monte Carlo analysis modelling of the requirements for reduced ammoniacal-N concentrations at expanded Thetford STW;
- Undertake water supply network modelling to confirm timings for provision of new mains, reinforcement of existing mains and layout of new development for chosen scenarios;
- Determine potential spare capacity in groundwater source feeding Cambridge Water's sources south east of Thetford;
- Use outputs of consultation draft of WRMP09 to confirm capacities in existing licences and to assess options for providing additional water resource in more detail;
- The Habitats Regulation assessment should include an assessment of the impact of abstraction from Two Mile Bottom on Thetford Golf Course and Marshes and the component part of Breckland SAC;
- Consider more detailed representation of employment/industrial water demand as well demand from other social infrastructure/institutions;

- Work up a detailed water efficiency plan for existing development and new development areas;
- Look at potential WFD targets from additional abstractions and impacts on low flows/good ecological status;
- Options are developed for providing Strategic, large scale assessment of runoff attenuation volumes using LiDAR data;
- Develop outline strategies for the preferred development sites towards the end of the Stage 2 study, to provide indicative layouts of SUDS techniques and surface water attenuation features/linkage with green infrastructure;
- Costings to be worked up in detail for the chosen development scenario for all water cycle infrastructure and management; and
- Further increase detail of the developer checklist to make it site specific to make it a guide through the planning process with respect to the Water Cycle.

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Appendix A - Possible Dwelling Scenarios

Scenario A - Staggered Approach to Development of the Potential Urban Extension Areas - Northern Five Years Before Eastern

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	**Total**	
Completions	72	96	188	277	141	130																									904	Developed
Existing Urban Area							90	140	210	223	160	80	80	90																	1073	
Urban Extensions South East															120	220	220	220	220	220	220	220	220	220	100						2200	
Urban Extensions North										120	190	270	270	280	280	280	280	280	280	280	280	280	280	280	280	260					4470	
Total	72	96	188	277	141	130	90	140	210	343	350	350	350	370	400	500	500	500	500	500	500	500	500	500	380	260					**7743**	To be developed
Cumulative Total - to be Developed							90	230	440	783	1133	1483	1833	2203	2603	3103	3603	4103	4603	5103	5603	6103	6603	7103	7483	7743						

Scenario B- Northern Potential Urban Extension Area Developed Out Before Eastern Area

	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	**Total**	
Completions	72	96	188	277	141	130																									904	Developed
Existing Urban Area							90	140	210	223	160	80	80	90																	1073	
Urban Extensions South East																					120	220	220	220	220	240	240	240	240	240	2200	
Urban Extensions North										120	190	270	270	280	400	500	500	500	500	500	440										4470	
Total	72	96	188	277	141	130	90	140	210	343	350	350	350	370	400	500	500	500	500	500	560	220	220	220	220	240	240	240	240	240	**7743**	To be developed
Cumulative Total - to be Developed							90	230	440	783	1133	1483	1833	2203	2603	3103	3603	4103	4603	5103	5663	5883	6103	6323	6543	6783	7023	7263	7503	7743		

Scenario C - Northern and Eastern Potential Urban Extension Areas Developed in Parallel																													
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	**Total**
Completions	72	96	188	277	141	130																									904 Developed
Existing Urban Area							90	140	210	223	160	80	80	90																	1073
Urban Extensions South East										120	205	220	220	220	220	220	220	220	220	115											2200
Urban Extensions North										120	205	270	270	280	280	280	280	280	280	280	280	280	280	280	280	245					4470
Total	72	96	188	277	141	130	90	140	210	463	570	570	570	590	500	500	500	500	500	395	280	280	280	280	280	245					To be **7743** developed
Cumulative Total - to be Developed							90	230	440	903	1473	2043	2613	3203	3703	4203	4703	5203	5703	6098	6378	6658	6938	7218	7498	7743					

Housing built since 2001
Housing to be built to meet Emerging RSS Target of 6,000 between 2001 and 2021 excluding housing already built
Housing to be built post 2021 to meet extrapolated Emerging RSS Target to 2031 (3,000)

Source: Breckland Council and EDAW (2007)

Appendix B – Stakeholder Consultation

Who From	When	What Response	Project Group response
Jim Hook, Hannah Reed	14/12/2007	SPZ's should be included in the data collection	SPZs have been collected and are being included in the assessment process
Jim Hook, Hannah Reed	14/12/2007	Data collection should include full extents of land ownership of key landowners, to be taken into account for feasibility of infrastructure options	Comments noted. The deatailed aspects of infrastrucute provision will be covered in Stage 1 WCS
Jim Hook, Hannah Reed	14/12/2007	Data collection should include sewers that have not been constructed but that are subject to S104 agreements	Data to be considered
David Paddon, Alan Baxter Associates	14/12/2007	The study should include all areas of development considered in the EDAW report. Currently the NE corner of the estate falls outside tier 2 this should be within tier 2	Original scope of the WCS was to cover the two growth areas identified in the EDAW reprt (Growth and Infrastructure frameowrk study) - the scope has now been increased following wider consultation to include areas C & E
David Paddon, Alan Baxter Associates	14/12/2007	Essential that kilverstone estate are consulted early n the next stage so key oppertunities for GI links, SuDS, Housing Densities and waste water infrastructure are identified.	This will be detail for a level 2 WCS and consultation will be maintained
David Paddon, Alan Baxter Associates	14/12/2007	All scenarios should consider the areas proposed for the developmen for the periods 2021-2031 in the EDAW reoirt. Refer to submissions made by Kilverstone Estate	The scope has been increased to include the most feasible options for development - see response 7
David Paddon, Alan Baxter Associates	14/12/2007	Essential that Kilverstone estate are consulted early so oppertunities like those listed above are identified particularly since the level of infrastructure will be influence by topo and proposed spatial arrangement of development.	This will be detail for a level 2 WCS and consultation will be maintained
David Maxwell, AMA planning	14/12/2007	recommend that development of the eastern area ahead of the northern area should be considered	The reasons for this option not being considered relate to issues being raised as a consequence of work being undertaken around Stone Curlews, transport infrastructure, electricity and schools which are all indicating that the northern extension should be phase 1. In terms of reasonable and realistic options to be tested – the Eastern extension being deliverd prior to any northern extension would appear to be highly unlikely. The Issue will be explored in the Issues and Options for the Thetford Area Action Plan could be ruled out early on for the reasons above
David Maxwell, AMA planning	14/12/2007	The progress report places undue reliance on the EDAW master Plan and the LUC GI study. These have not been tested under the LDF process and don't contain enough detail. AMA Planning's representation were not taken in to account	The scope has been increased to include the most feasible options for development - see response 7. The WCS is therefore no longer reliant solely on EDAW report or GI study
David Maxwell, AMA planning	14/12/2007	Appendix B indicates that the BDC has supplied details of the boundary for future development, explaination and details should be made availiable to takeholders and landowners	The likely boundary supplied was the information provided in the EDAW report
Adam Ireland, EA	14/12/2007	Appendix footers need to be updated with the correct date!	Progress report updated
Adam Ireland, EA	14/12/2007	Definition of Study Area, Final line on page 4, Brandon is downstream of Thetford, not upstream.	Progress report updated
Adam Ireland, EA	14/12/2007	Status Query: GQA info has been provided	Yes - data has been provided via Steve Hopper
Adam Ireland, EA	14/12/2007	Is the location and detial of discharges to ground and to the Thet and Little Ouse still needed?	This information has been recieved

Appendix C – Request for Information

Data Type	WCS	WCS Phase	Priority	Stakeholder source	status	format/Notes
Data and information from Water Resource Plans draft (2009) and interim 2006	Thetford	1	1	AWS	Part provided	WRP09 info not ready to release given that draft for consultation is not due until mid March - WRP04 provided instead
Location of current STWs, their consent details, treatment type and spare capacity details	Thetford	1	1	AWS	Provided	Volumetric capacity provided, agreed that process capacity would be assessed in Stage 2 and that the assessment of capacity for stage 1 would be based on volumetric alone with assupmtion that AWS would get funding to upgrade process acpacity to mee volume
Data from sewerage and treated water capacity assessment studies in support of the development of Business Plans for Price Review 09.	Thetford	1	1	AWS	agreed not required	
Information pertaining to relevant schemes proposed for the development of draft Business Plans 09.	Thetford	1	1	AWS	agreed not required	
Anticipated growth, and identification of major water users	Thetford	1	3	AWS	agreed not required	
Existing Water Volumes being supplied (i.e. current and also projected), including:	Thetford	1	1	AWS	Part provided	Some Info in WRP04, but not latest WRP09
Water Consumption per capita/property or per property/day	Thetford	1	1	AWS	Provided	latest figures recently provided based on what was published on Ofwat website
water treatment works current and projected outputs (capacities), location (layout drawings and location maps), treatment levels (chemical, power consumptions, etc rough cost of treatment/m3)	Thetford	1	1	AWS	Part provided	AWS felt they could not provide WTW capacity info but did give approx locations and links to reservoirs and specific abstarctions
Distribution Network layout, (trunk mains, pipe diameters and capacities)	Thetford	1	1	AWS	Provided	Recently provided in GeoPDF
Bulk meter readings (from/to service reservoirs, within system, and location of same)	Thetford	1	2	AWS	agreed not required	
Domestic, Institutional, Industrial and Commercial consumer meter readings, (if any)	Thetford	1	2	AWS	agreed not required	
Bulk Supplies, including locations of service reservoirs	Thetford	1	2	AWS	Part provided	supply reservoirs provided
Raw Water Abstraction License and limits including Locations	Thetford	1	1	AWS	Part provided	Gave names and rought locations of abstarctions, including licenced limits but could not give info on percentage utilisation in order to agree headroom in licence for additional asbtraction. Also, exact loation considered sensitive on basis of national s
Pumping Stations, including duties of pumps and hours run	Thetford	1	2	AWS	agreed not required	
Unaccounted for water (whatever information available)	Thetford	1	2	AWS	Provided	This has been provided indirectly via figures for assumed infiltration
Total number of connections by category (if information available)	Thetford	1	2	AWS	agreed not required	
Existing water consumption control measures	Thetford	1	2	AWS	Provided	AWS published efficiency plans
Coverage of clean water network models	Thetford	1	1	AWS	Provided	
Existing Sludge treatment and disposal, (current capacities and plant design horizon)	Thetford	1	3	AWS	Provided	
Sewerage Network layout, pipe diameter, capacities and CSOs, (Combined Sewer Overflows) and coverage of network models	Thetford	1	1	AWS	Provided	Given GIS layers
Pumping Stations, including duties of pumps and hours run	Thetford	1	2	AWS	agreed not required	
Discharge consent locations	Thetford	1	1	AWS	Provided	Actual consents provided
The latest demand forecasts – Dry Year Annual Average unrestricted daily demand and Average Day Demand in Peak Week. Do these include the latest growth forecasts contained in the East of England RSS Plan?	Thetford	1	1	AWS	Part provided	As much info as possible was given at a meetign with Resource planners who provided outline drfat figures on the S/D balance up to 2031 and inidcative idea of options being considered to fill gap - confirmed methods for estimating population growth in lin
1. The latest Annual Water Resources Plan update 2006/07 as submitted to the EA.	Thetford	1	1	AWS	Not Provided	But did recieve basic info from latest WRP09 draft and full WRP04
1. Location of abstraction points and details of abstraction licences used to supply Thetford	Thetford	1	1	AWS	Part provided	Licences not supplied, btu are on public register if needed - AWS gave us names and licenced quantiteis anyway
1. Details of any water quality issues affecting outputs from the WTWs supplying Thetford.	Thetford	1	1	AWS	agreed not required	
1. Pressure information in water distribution system	Thetford	1	1	AWS	Provided	Agreed no properties on DG2 regsiter
1. Per capita usage assumptions for residential use and business use	Thetford	1	1	AWS	Provided	
1. Location of service and supply reservoirs and information on size	Thetford	1	1	AWS	Part provided	Approx locations provided

1. Coverage of water supply network models	Thetford	1	1	AWS	Provided	Provided
Pumping Stations, including duties of pumps and hours run	Thetford	1	1	AWS	Provided	
1. Any known problem locations for the existing sewer network	Thetford	1	1	AWS	Provided	Full DG5 postcode supplied and info on recent incidents on GIS files - not used directly in report but use to assess capacity issues
1. Location of combined sewer overflows	Thetford	1	1	AWS	Provided	
1. coverage of sewer network models	Thetford	1	1	AWS	Provided	Model updates due in April 2008
Distribution and total number of existing Residential Properties in Study Area	Thetford	1	2	Breckland	Provided	When Study area is defined
Projected Growth (2021 Horizon and 2031 Horizon for context)	Thetford	1	1	Breckland	Provided	Contained within the TGFI study
Master Plan Layout Drawing to enable ID of wastewater drainage & water supply areas;	Thetford	1	2	Breckland	Provided	Contained within the TGFI study
OS Base Mapping;	Thetford	1	2	Breckland	Provided	Agreement signed - awaiting receipt of data
Aerial Photography;	Thetford	1	3	Breckland	Provided	CDs
All current approved planning applications above 10 dwellings ;	Thetford	1	2	Breckland	Provided	email attachment - excel spreadsheet
The likely boundary for future development and growth.	Thetford	1	1	Breckland	Provided	The 2 areas for growth have been defined; SWK to define extent of the study area in terms
Thetford Growth Framework and Infrastructure Study (masterplan) final report	Thetford	1	1	Breckland	Provided	CD
Green Infrastructure Strategy	Thetford	1	1	Breckland	Provided	CD
SFRA (2005)	Thetford	1	1	Breckland	Provided	Hard Copy only
SFRA (2007 updated for PPS25)	Thetford	1	1	Breckland	Provided	
Emerging Local Development Frameworks	Thetford	1	2	Breckland	Provided	Link to Breckland council website
Local Plans	Thetford	1	2	Breckland	Provided	Link to Breckland council website
Development Plan Documents	Thetford	1	2	Breckland	Provided	Link to Breckland council website
Other relevant planning documentation relating to development i.e. SPDs	Thetford	1	2	Breckland	Provided	Link to Breckland council website
Drainage Problem areas	Thetford	1	1	Breckland	Provided	in SFRA
Records of surface water flooding	Thetford	1	1	Breckland	Provided	in SFRA
Topographic data (river surveys etc)	Thetford	1	2	EA	Provided	Channel cross-sectional data provided for channel capacity calculations
Remote Topographic Data (LiDAR and/or SAR data) for the study area	Thetford	1	2	EA	agreed not required	required for Stage 2
Existing Hydrometric Monitoring	Thetford	1	2	EA	Provided	
General Quality Assessment (GQA) data – water quality	Thetford	1	1	EA	Provided	
WFD status	Thetford	1	2	EA	Provided	
Ecological monitoring data for the two main Rivers	Thetford	1	2	EA	Provided	Summary data for 4 sites for macroinverts, some plants and MTR score - email attachment
Fisheries data for Thet and Little Ouse	Thetford	1	2	EA	agreed not required	
Information on Existing Hydraulic Models	Thetford	1	3	EA	provided	basics provided in SFRA
Identification of Main River, Critical Ordinary Watercourses	Thetford	1	2	EA	Provided	
Gauged fluvial data sets	Thetford	1	2	EA	Part provided	for Abbey Heath gauging station
Location of flood defences or alleviation schemes	Thetford	1	2	EA	Provided	no defences in Thetford
Design standards	Thetford	1	2	EA	Provided	no defences in Thetford
Condition of existing defences	Thetford	1	2	EA	N/A	no defences in Thetford
Flood Zone outlines - 2, 3a, and 3b and flood levels	Thetford	1	1	EA	Provided	SFRA
Historical flooding records (from rivers and groundwater)	Thetford	1	2	EA	Provided	SFRA
Details of Improvements Programme top flood defences / schemes	Thetford	1	3	EA	N/A	no defences in Thetford
Areas benefiting from flood warning procedures and management strategies	Thetford	1	3	EA	Provided	SFRA
Location and details of abstractions (groundwater and surface) in the study area	Thetford	1	1	EA	Provided	
Location and details of discharges to ground and to the Thet and Little Ouse	Thetford	1	1	EA	agreed not required	
Geology for the Breckland district	Thetford	1	2	EA	Provided	Info provided and used hydrogeological maps
Groundwater level records	Thetford	1	2	EA	Provided	
Observation Borehole locations in the study area	Thetford	1	2	EA	Provided	
Areas of protected or designated status (SSSI, SAC, SPA) - boundaries and reasons for designations	Thetford	1	1	NE	Provided	nature on the map & Magic
Areas of national or local conservation / interest (SNCI, NNR, LNR)	Thetford	1	1	NE / Breckland	Not Provided	collected independently

Appendix D – STW Headroom Calculations

input value
calculated value
from other cell

ORIGINAL CALCS BASED ON INITIAL CALCULATED DWF

		consented	actual	spare capacity
	l/s	101.9675926	59.78009259	42
	l/m	6118.055556	3586.805556	2,531
	l/hr	367083.3333	215208.3333	151,875
	l/d	8810000	5165000	3,645,000
DWF	M3/d	8810	5,165	3,645

l/h/s calc headroom 24965.75 population
l/h/d calc headroom 11888.45 homes
NB sludge liquer inputs from sludge treatment & transfer centre imports not included.
NB assessing DWF hydrualic capacity only

NEW CALCS BASED ON NEW CALCULATED DWF

		consented	actual	spare capacity
	l/s	101.9676	75.9887	26
	l/m	6118.056	4559.322	1,559
	l/hr	367083.3	273559.3	93,524
	l/d	8810000	6565424	2,244,576
DWF	M3/d	8810	6,565	2,245

l/h/s calc headroom 15373.81 population
l/h/d calc headroom 7320.862 homes
NB sludge liquer inputs from sludge treatment & transfer centre imports not included.
NB assessing DWF hydrualic capacity only

assumptions

	usage (l/h/d)	146	
	future usage (l/h/d	80	
G	usage (m3/h/d)	0.146	0.146 is currently linked to the value provided by AWS, but this can be changed for sensitivty in this s.sheet
G(future)	usage future (m3/h/d)	0.08	change for future housing target
G(hol)	usage hol (m3/h/d)	0.55	
	pop per home	2.1	
I	Infiltration (curernt)	1.032	
I	Infiltration (future housing)	340	total I 1,372
E	trade flow	1,405	
E(future)	Trade flow future	211	assumes a 15% increase in tradeflow for new employment areas, but only if housing is assumed
P	Pop Equiv	22,257	
P(hol)	Pop Equiv (hol)	1,598	
	PG	3,250	
	PG hol	879	
	PG (future)	1,360	
	Future housing	8,096	enter future housing number
	Additional pop	17,002	

DWF calcs PG+I+E
DWF current calcs 6,565 m3/d

DWF (additional homes only) 1,911 m3/d

total new DWF 8,476 m3/d

FTFT calcs 3PG+I+3E, where P= domestic pop, G = per capita consumption, I = infiltration & E = trade discharge (hol)= additional holidy wastewater
FTFT current calcs 17632.0 m3/d

additional FFT 5052.598 m3/d
0.058479 m3/s

future FFT 22684.6 m3/d
0.262554 m3/s

GOAL SEEK BUTTON - NO. OF HOUSES BEFORE STE UPGRADE REQUIRED

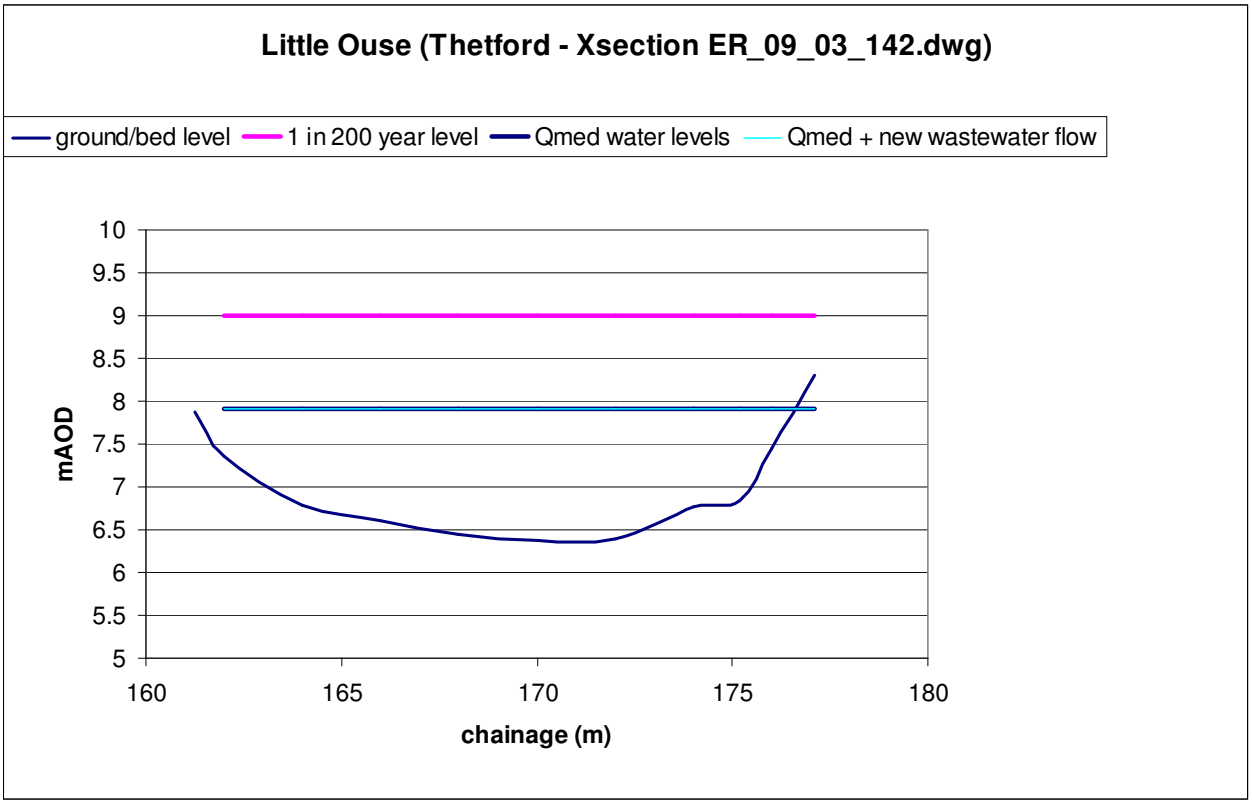
diff in capacity and future DWF 334 m3/d
Pop requiring new STW works/upgrade 0 population
Pop that can still be accomodated 2286 population

No. of new Houses requiring new STW works/upgrade 0 homes
No of hosuing that can still be accomodated 1088 homes

Flood flow Return Period	Flood Flow (FEH statistcial method analysis) (m^3s^{-1})	Additional flow from increase in FtFT (m^3s^{-1})	Additional flow as a % of river flood
Qmed (1 in 2 year)	17.93	0.058	0.33
Q5 (1 in 5 year)	23.94	0.058	0.24
Q10 (1 in 10 year)	27.62	0.058	0.21
Q20 (1 in 20 year)	31.1	0.058	0.19
Q50 (1 in 50 year)	35.69	0.058	0.16
Q100 (1 in 100 year)	39.2	0.058	0.15
Q100 + cc[1] (1 in 100 year + allowance for climate change	47.04	0.058	0.12
Q200 (1 in 200 year)	42.81	0.058	0.14

Appendix E – FEH calculations & Cross Section data

Cross Section Data (Taken from EA survey data provided)



Assumptions on Cross section (to match trapezoidal channel)

Channel depth =		8.31	to	6.38	equals	1.93
slope width =		165	to	161.25	equals	3.75
side slope =	(1 in..)		1/2			
base width =		165	to	172.5	equals	7.5

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Input	SUMMARY SHEET	Output
	Flood Estimation Handbook Calculations for: **Little Ouse at Thetford**	
	Method Chosen for derivation of Peak Flows	
	Peak flows were generated using Statistical (General Logistic (GL)). Pearson 3 was recommended by WINFAP and the growth curves were created using GL, GEV and P3.	

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Summary Results

Return Period	Flow (m^3/s)		
1 in 100 + cc	**GL**	**GEV**	**P3**
1 in 100			
1 in 50			
1 in 20			
1 in 10			
1 in 5			
1 in 2			

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Input	RATIONALE	Output
	Flood estimates are being undertaken for the Little Ouse to assess the effect of increased treated sewage effluent discharge into the Little Ouse which is likely to occur with increased growth in Thetford. Flow estimations were made for Little Ouse at the gauging station at Abbey Heath, NGR TL85108440. Flow estimations made for the Little Ouse are based on station records updated as part of the HiFlows-UK project. Hi-Flows UK provides flood peak data and station information, at around 1,000 river flow gauging stations throughout the UK, for use with the statistical flood estimation methods set out in the Flood Estimation Handbook. The data are provided as both annual maxima and peaks-over-threshold. The Hi-Flows data originates from the hydrometric data archives held by the Environment Agency for England and Wales, the Scottish Environment Protection Agency for Scotland and the Rivers Agency for Northern Ireland. Additional data and background information have also been supplied by the National River Flow Archive, held at CEH Wallingford, and the University of Dundee. This dataset should be regarded as superseding that on the CD in the back of Volume 3 of the FEH, and that included with version 1.0 of the WINFAP-FEH program supplied by CEH Wallingford. Data is presented on approximately 960 gauging stations, including photographs, indication of the stations suitability for estimation of QMED, and its use in pooling groups. HiFlows-UK increases the original FEH data by approximately 40% with 32,000 annual maxima values, increasing the average station record length from approximately 16 years to 33 years. Further information can be found at http://www.environment-agency.gov.uk/hiflows.	

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Input	SUBJECT CATCHMENT	Output
	Location National grid reference of the downstream boundary of southern watercourse catchment: TL 85050 84350 Name of watercourse: Little Ouse Geology of catchment: Chalk, Sands and Gravels	
	Purpose of Flood Flow Estimate To assess the effect of increased treated sewage effluent discharge into the Little Ouse which is likely to occur with increased growth in Thetford.	

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Input	Catchment Descriptors	Output

Little Ouse at Thetford

National Grid Reference	585050, 284350
DTM AREA	707.72 km²
FARL	0.959
PROPWET	0.29
ALTBAR	42
ASPBAR	351
ASPVAR	0.05
BFIHOST	0.694
DPLBAR	29.07
DPSBAR	16.3
LDP	50.58
RMED-1H	10.9
RMED-1D	28.2
RMED-2D	35.3
SAAR	607
SAAR4170	618
SPRHOST	24
URBCONC	0.57
URBEXT1990	0.013
URBLOC	0.884
SMDBAR	-999999

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Input	Details of Checking of Catchment Descriptors	Output
	Details of any checking of catchment characteristics: Check against OS 1:50,000 maps Yes/~~No~~ Field assessment ~~Yes~~/No Review of catchment geology BGS Website Assessment of urban area Yes/~~No~~	

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Catchment Adjustments

If the answer to any of the following questions is yes then the catchment is potentially a problem catchment and extra care or additional field validation maybe necessary. There may also be adjustments to be made to the catchment descriptors.

Is the catchment small?	AREA < 5km^2	~~Yes~~/No	
Is the catchment permeable?	SPRHOST < 20	~~Yes~~/No	No adjustment required
Is the catchment urbanised?	URBEXT > 0.025	~~Yes~~/No	URBEXT not required to be updated with national equation.
Is the catchment flat?	DPSBAR < 20	Yes/~~No~~	No validation required
Is the catchment low lying?	ALTBAR < 20	~~Yes~~/No	No validation required
Is it subject to attenuation from reservoirs or lakes?	FARL < 0.95	~~Yes~~/No	No validation required

STATISTICAL

Initial Pooling Group

From the default pooling group additional stations were added in order of hydrological similarity according FEH-WINFAP to generate the initial pooling group. These were added to gain more flexibility in the revision of the pooling group.

Details of the initial pooling group are: -

- Target Return Period = 100
- Years of Record = 683
- H_2 = 2.7142
- Strongly Heterogeneous

Initial Pooling Group – H2 = 2.7142

Station	Years	L-CV	L-Skewne	L-Kurtosis	Discordancy	Distance
33034 (Little Ouse @ Abbey Heath)	34	0.252	-0.01	0.111	0.216	0
39034 (Evenlode @ Cassington)	17	0.177	-0.412	0.268	4.185	0.434
33019 (Thet @ Melford)	43	0.278	0.1	0.046	0.669	0.445
33021 (Rhee @ Burnt Mill)	41	0.258	-0.158	0.09	0.921	0.507
27087 (Derwent @ Low Marishes)	14	0.181	0.301	0.313	1.905	0.569
54012 (Tern @ Walcot)	44	0.157	-0.011	0.133	0.862	0.636
40011 (Great Stour @ Horton)	39	0.182	0.043	0.046	1.445	0.673

39081 (Ock @ Abingdon)	24	0.182	0.082	0.333	1.324	0.703
33014 (Lark @ Temple)	42	0.229	0.062	0.156	0.036	0.784
39016 (Kennet @ Theale)	42	0.157	0.036	0.19	0.488	0.789
54016 (Roden @ Rodington)	42	0.172	0.065	0.229	0.3	0.817
30001 (Witham @ Claypole)	44	0.274	0.144	0.09	0.574	0.822
30003 (Bain @ Fulsby)	41	0.307	0.098	0.084	1.069	0.822
54041 (Tern @ Eaton-on-tern)	31	0.208	0.122	0.106	0.395	0.873
39006 (Windrush @ Newbridge)	53	0.165	0.16	0.201	0.647	0.906
54020 (Perry @ Yeaton)	40	0.153	-0.041	0.183	0.635	0.933
33011 (Little Ouse @ County Bridge Euston)	42	0.321	0.028	0.059	1.395	0.936
10003 (Ythan @ Ellon)	20	0.232	-0.035	0.041	0.649	0.961
43007 (Stour @ Throop)	30	0.224	0.169	0.289	1.284	0.966
Total	683					
Weighted means		0.217	0.024	0.139		

Stations were reviewed using the graphs available within FEH-WINFAP. This was undertaken to ensure that the dataset used in extracting growth curves and growth factors is the most suitable based on availability and hydrological similarity to the subject site.

Pooling Group Revision/Justification

Stations selected for review based on characteristics being outliers on the WINFAP diagnostic plots in the 1st Revision:

Station	Reason	Status
33014	FARL, URBEXT	
39016	Discharge under estimation at high flows	
39006	FARL, Weir unreliable at high flows	
40011	URBEXT	

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1st Revision Pooling Group H2 = 2.3334						
Station	Years	L-CV	L-Skewne	L-Kurtosis	Discordancy	Distance
33034 (Little Ouse @ Abbey Heath)	34	0.252	-0.01	0.111	0.227	0
33019 (Thet @ Melford)	43	0.278	0.1	0.046	0.723	0.445
33021 (Rhee @ Burnt Mill)	41	0.258	-0.158	0.09	1.802	0.507
27087 (Derwent @ Low Marishes)	14	0.181	0.301	0.313	1.864	0.569
54012 (Tern @ Walcot)	44	0.157	-0.011	0.133	1.213	0.636
39081 (Ock @ Abingdon)	24	0.182	0.082	0.333	1.593	0.703
54016 (Roden @ Rodington)	42	0.172	0.065	0.229	0.393	0.817
30001 (Witham @ Claypole)	44	0.274	0.144	0.09	0.643	0.822
30003 (Bain @ Fulsby)	41	0.307	0.098	0.084	0.79	0.822
54041 (Tern @ Eaton-on-tern)	31	0.208	0.122	0.106	0.921	0.873
54020 (Perry @ Yeaton)	40	0.153	-0.041	0.183	1.032	0.933
33011 (Little Ouse @ County Bridge Euston)	42	0.321	0.028	0.059	1.08	0.936
10003 (Ythan @ Ellon)	20	0.232	-0.035	0.041	0.668	0.961
43007 (Stour @ Throop)	30	0.224	0.169	0.289	1.05	0.966
Total	490					
Weighted means		0.232	0.038	0.132		

Calculations

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Flood Estimation by FEH											
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Originator	Checked	Rev	Suffix	Orig							
AS	CP	1	Date	Check							

Input	Summary Revision of Pooling Group	Output
	• The stations deemed to be inappropriate were removed from the Initial Pooling Group to create the 1st Revision Pooling Group. 1st Revision Pooling Group details: ○ Total Record Length = 490 ○ H_2 value = 2.3334 • Details of the initial pooling group are included on pages 9 and 1st Revision included on page 10. • Printout of 'all diagnostic plots' included in Appendix A. • In order to achieve an optimum H_2 value (< 2.0) the stations were further analysed and stations 10001 was added to achieve a record length of 500 years.	
	An H_2 value of 1.9811 indicates that a review of the pooling group is optional, however from additional reviews of the pooling group this H_2 could not be reduced further. It is our opinion that we have tested the group to rigorous criteria, replacing stations where necessary. This is therefore considered to be the best pooling group available for the study site.	
	Selected Distributions of Final Pooling Group G-o-F : goodness-of-fit ≡ z value Generalised Logistic (GL) Generalised Extreme Value (GEV) Pearson Type 3 (PE3) Gen Pareto Therefore adopt the GL and PE3 distribution to apply to the growth curve.	G-o-F 1.3480 -2.0040 -1.4063 -8.3691

Calculations

Project	Thetford Water Cycle Strategy						Flood Estimation by FEH				
Job Number		D117544		Date	18th March 2008		Page	12 of 20			
Originator	Checked	Rev	Suffix	Orig							
AS	CP	1	Date	Check							

Input	QMED DATA TRANSFER	Output
	Subject Site QMED from Catchment Characteristics Is gauged data from a donor or analogue site to be used? Yes/ ~~No~~ $QMED_{cds}$ = 27.508 calculated by WINFAP when deriving the flood frequency curve). See page 13 for manual check which gives QMED = 27.508	

Calculations

Project	Thetford Water Cycle Strategy							Flood Estimation by FEH			
Job Number		D117544		Date	18th March 2008			Page	13 of 20		
Originator	Checked	Rev	Suffix	Orig							
AS	CP	1	Date	Check							

Input	Manual Checks	Output
	Check on QMED calculation for the southern catchment only using the Catchment Descriptors **Calculation of QMED from catchment Descriptors** **Data from catchment descriptors** AREA 707.72 km^2 FARL 0.959 BFIHOST 0.694 SAAR 607 mm SPRHOST 24 URBEXT 0.013 **Calculation of rural QMED** RESHOST = 0.019 **QMED rural = 27.508** m3/s **Calculation of urban adjusted QMED** **Applicable if catchment is urban (URBEXT > 0.025)** N/A as URBEXT =0.001 PRUAF = 1.015 UAF = 1.026 **QMED urban = 28.230** m3/s	

Calculations

Project	Thetford Water Cycle Strategy						Flood Estimation by FEH				
Job Number		D117544		Date	18th March 2008		Page	14 of 20			
Originator	Checked	Rev	Suffix	Orig							
AS	CP	1	Date	Check							

Input	Donor and Analogue Catchment Calculations	Output
	There is 1 available donor sites for this subject site, they are located at the same location as the subject site.	

Calculations

Project	Thetford Water Cycle Strategy										Flood Estimation by FEH	
Job Number		D117544		Date	18th March 2008			Page	15 of 20			
Originator		Checked		Rev	Suffix	Orig						
AS		CP		1	Date	Check						

Catchment Characteristics: Detailed Assessment

Site	Subject Site	Donor 33034
RECORD LENGTH		34
AREA	707.72	708.28
SAAR	607	607
BFIHOST	0.694	0.694
SPRHOST	24	24
FARL	0.959	0.973
URBEXT	0.013	0.0131
PROPWET	0.29	0.29
DPLBAR	29.07	29.34
DPSBAR	16.3	16.57
ALTBAR	42	42

Note: Grey boxes indicate that the sites do not meet the following criteria:
AREA [within factor of 4, small if < 5km^2]
SAAR [within factor of 1.25]
BFIHOST [max difference 0.18]
SPRHOST [max difference 15.0]
FARL [problem if < 0.95]
URBEXT [urbanised if > 0.025 – manual check required]
PROPWET [max difference 0.1]
DPSBAR [flat if < 20]
ALTBAR [low lying if < 20]

Calculations

Project	Thetford Water Cycle Strategy										Flood Estimation by FEH	
Job Number		D117544		Date	18th March 2008			Page	16 of 20			
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Input	QMED Observed	Output

Table below gives a summary of $QMED_{Obs}$ (See pages 21 – 26 for the full data sets).

Station	Record Length	$QMED_{Obs}$ (AM/POT)	$QMED_{cds}$	Weighting
33034	34	17.934	27.508	1

Note: The method used to estimate $QMED_{Obs}$ was based on the Annual Maxima series or Peaks Over Threshold where the record length is less 14 years than for each station. QMED estimation from POT was carried out with reference to FEH Vol 3, page 7 – 9.

$QMED_{cds} = 27.508 \ m^3/s$

Geometric Adjustment Factor based on Data transfer = 0.652

$QMED_{adj} = 17.934 \ m^3/s$

Calculations

Project	Thetford Water Cycle Strategy			Flood Estimation by FEH						
Job Number	D117544	Date	18th March 2008	Page	17 of 20					
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Input	Flood Frequency

Urban adjustment applied to growth curve? ~~YES~~/NO

These flow rates are based on the growth curve fittings from the final pooling group using a General Logistic distribution, Generalised Extreme Value, Pearson type 3 and the Gen Pareto

	Growth Curve Fitting	Flow (m^3/s)	Growth Curve Fitting	Flow (m^3/s)	Growth Curve Fitting	Flow (m^3/s)	Growth Curve Fitting	Flow (m^3/s)
Return Period	GL	GL	GEV	GEV	GP	Gp	P3	P3
Q2 (QMED)	1	17.934	1	17.934	1	17.934	1	17.934
5	1.335	23.94189	1.373	24.623382	1.442	25.860828	1.364	24.461976
10	1.54	27.61836	1.575	28.24605	1.609	28.855806	1.564	28.048776
20	1.734	31.097556	1.741	31.223094	1.703	30.541602	1.735	31.11549
50	1.99	35.68866	1.922	34.469148	1.766	31.671444	1.933	34.666422
100	2.186	39.203724	2.036	36.513624	1.79	32.10186	2.068	37.087512
120	2.239	40.154226	2.063	36.997842	1.794	32.173596	2.102	37.697268
200	2.387	42.808458	2.133	38.253222	1.803	32.335002	2.194	39.347196

Calculations

Project	Thetford Water Cycle Strategy				Flood Estimation by FEH					
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REFERENCES

1. Institute of Hydrology (1999) *'Flood Estimations Handbook'* Institute of Hydrology: Oxford, UK.
2. Kjeldsen, T. R., Stewart, E. J. *et al* (2005) *'Revitilisation of the FSR/FEH rainfall-runoff method: R &D Ttechnical Report FD1913/TR'* DEFRA/Environment Agency.

Calculations

Project	Thetford Water Cycle Strategy						Flood Estimation by FEH				
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Appendix A: Final Pooling Group Diagnostic Plots

Calculations

Project	Thetford Water Cycle Strategy						Flood Estimation by FEH				
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Appendix F – SUDS Options Details

Soakaways

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.

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

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.

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

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.

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.

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

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.

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).

Other Methods

Other typical SUDS methods include techniques such as Greenroofs, water harvesting, 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 G – 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 Breckland 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 floorspace is 1,000m^2 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 Breckland 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 Breckland 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 Breckland to ensure that there is no requirement for a FRA on the grounds of critical drainage issues. Does the SFRA or do Breckland Council 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 Breckland SFRA?	Y/N or N/A	
	Surface water runoff		
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	EA Requirement for FRA.
10	If development is on a Greenfield site, have you provided evidence that post development run-off will not be	Y/N or N/A	PPS25

	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	
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 EA?	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)		

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 site above a Source Protection Zone (SPZ)?	If Y go to 22 If N go to 23	Groundwater Regulations 1998
21	A) Is the development site 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 EA 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?	Y/N	

	Alternatively, have you provide details of the maintenance contributions to be provided over the life of the development.	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		
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 2.5m^3 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		
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		
35	Have you provided evidence to confirm that water supply capacity is available, and that demand can be met in accordance with the Thetford Stage 1 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 Thetford Stage 1 Water Cycle Strategy?	Y/N	
	Conservation / Enhancement of Ecological Interest		
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 H – Habitats Regulation Assessment

Local Sites Assessment

Special Areas of Conservation (SAC)

Breckland SAC

Three parts of Brecklands SAC lie in close proximity to Thetford – Thetford Golf Course and Marsh SSSI to the west and Barnhamcross Common SSSI and Thetford Heath SSSI immediately to the south. Breckland was designated as a Special Area of Conservation for the following features:

- Inland dunes with open *Corynephorus* and *Agrostis* grasslands (although these habitats are not represented anywhere near Thetford);
- Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition*-type vegetation - They are examples of hollows within glacial outwash deposits and are fed by water from the underlying chalk aquifer. Natural fluctuations in groundwater tables mean that these lakes occasionally dry out. The flora is dominated by stonewort – pondweed associations.
- European dry heaths - The dry acidic heath of Breckland represents H1 *Calluna vulgaris – Festuca ovina* heath in the SAC series.
- Semi-natural dry grasslands and scrubland facies on calcareous substrates - Breckland is the most extensive surviving area of the rare grassland type CG7 *Festuca ovina – Hieracium pilosella – Thymus praecox* grassland. The grassland is rich in rare species typical of dry, winter-cold, continental areas, and approaches the features of grassland types in central Europe more than almost any other semi-natural dry grassland found in the UK.
- Alluvial forests with Alnus glutinosa and Fraxinus excelsior; and
- Great crested newt *Triturus cristatus*.

Screening opinion

Only two of the features identified above are sensitive to changes in water quality – the eutrophic lakes and the great crested newt population that depends upon them. However, treated wastewater from Thetford is, and will continue to be, discharged to the River Little Ouse. Downstream of Thetford this river has no hydraulic continuity with any of the lakes at Breckland as far as can be determined. As such, there is no scope for adverse effects on the water quality of the lakes as a result of effluent discharge from Thetford. Local groundwater abstraction is known to have had a deleterious impact on the natural eutrophic lakes and this may therefore be an issue requiring exploration when the abstraction patterns to service the new homes at Thetford are determined.

Special Protection Areas (SPA)

Thetford is surrounded to the west, north, south and southeast by constituent SSSI's of the Breckland SPA (Breckland Farmland SSSI to the southeast, Barnhamcross Common SSSI to the south and Breckland Forest SSSI and Thetford Golf Course and Marsh SSSI to the west). Breckland was designated as a Special Protection Area for supporting breeding populations of European importance of the following species listed on Annex I of the EC Birds Directive (1979):

- Nightjar *Caprimulgus europaeus*, 415 pairs representing up to 12.2% of the breeding population in Great Britain
- Stone Curlew *Burhinus oedicnemus*, 142 pairs representing up to 74.7% of the breeding population in Great Britain
- Woodlark *Lullula arborea*, 430 pairs representing up to 28.7% of the breeding population in Great Britain

Screening opinion

All of these species are essentially dependent on dry, free-draining habitats (dry heath and grassland, arable and forestry) Woodlark and Nightjar breed in recently felled areas and open heath areas within the conifer plantations, while Stone Curlew establishes nests on open ground provided by arable cultivation in the spring. There are large areas of Breckland SPA to the west and south of Thetford, but none of the species for which the SPA was identified depend upon hydrologically sensitive habitats (except in as much as they must be free draining) and therefore will be unaffected by any changes in the water quality of the River Little Ouse.

Sites of Special Scientific Importance (SSSI)

Breckland Farmland SSSI

Breckland Farmland SSSI lies between Bury St Edmunds in Suffolk and Swaffham in Norfolk. The predominant land use within the SSSI is arable. This is characterised by field scale vegetables and root crops, generally in rotation with cereals and outdoor pig units. Management for gamebirds is also a characteristic feature. Stone curlews nest from March each year in cultivated land, which has plenty of bare ground and very short vegetation. Stone curlews are very sensitive to recreational disturbance and benefit from lack of recreational access on agricultural land; they are not usually affected by mechanised agricultural operations. Other habitats such as grassland are used for foraging.

Barnhamcross Common SSSI

Barnhamcross Common is a sizeable area of public open space on the southern edge of Thetford. The Common supports well-developed areas of calcareous and acidic Breckland grassland heath and some tall neutral grassland. Lack of grazing and frequent fires have led to the development of areas of scrub and woodland. The site has a rich flora, including several nationally rare plants and the considerable diversity of habitat attracts a corresponding diversity of birds.

Thetford Heath SSSI

A large area of dry Breckland heath that covers a wide range of soil-types, supporting areas of calcareous, neutral and acidic grassland, heather heath and lichen/moss dominated heath. The site also includes areas of scrub and developing secondary woodland as well as some old plantations. It is noted for its population of a rare heathland bird and for a number of nationally rare plants some of which have been introduced to the site. Patterned ground, the result of frost sorting at the end of the Ice Age, increased the diversity of the vegetation and is of physiographic interest. Part of the site is managed as a National Nature Reserve, part as an army training area.

Much of the site is covered by species-rich calcareous grassland, some areas of which are heavily grazed by sheep, others are ungrazed, or grazed only by rabbits. Sheep's fescue *Festuca ovina*, crested hair-grass *Koeleria macrantha* and meadow oat-grass *Helictotrichon pratense* are the most abundant grasses. In the shortest, most open areas, however, there may be very little grass and small herbs such as purple

milk-vetch *Astragalus danicus*, early forget-me-not *Myosotis ramosissima* and little mouse-ear *Cerastium semidecandrum* are amongst the most abundant species, with lichens and mosses also being abundant.

Thetford Golf Course and Marsh SSSI

This site contains the only surviving area of a once extensive track of Breckland heath known as Thetford Warren. A wide range of heathland plant communities still occur in the occasionally mown “roughs” on the golf course and on other parts of the site. Dry grass heath on both acidic and calcareous glacial drifts covers much of the area but there are also good examples of open lichen heath and heather heath. The diverse flora includes two locally rare plants. Horse Meadows, an area of low-lying ground by the River Little Ouse forms a marked contrast to the dry heathland. The wet peaty soils support a range of fenland plant communities and a fine example of valley alder woodland. Horse Meadows support a series of fen and wet grassland communities under scattered plantings of poplar. reed canary-grass *Phalaris arundinacea*, purple small-reed *Calamagrostis canescens*, reed sweet-grass *Glyceria maxima*, common reed *Phragmites australis*, greater pond sedge *Carex riparia* and tufted sedge *C. elata* provide the dominant or co-dominant species on the wet fen. Much of the variation in the vegetation is due to the differing degrees of wetness and depth of standing water on the site.

Bridgeham to Brettenham Heaths SSSI

Bridgham and Brettenham Heaths are linked via East Wretham Heath to the Stanford Training Area, forming the largest remaining block of Breckland heath. This is a very localised and declining habitat. The soils are predominantly acidic sands, heavily podsolised in places, but chalk comes near to the surface towards the eastern boundary. The vegetation is mainly heather and acidic grassland with considerable areas of bracken and some scrub. However it also includes small areas of neutral and calcareous grassland to the east and associated with ‘patterned ground’: stripes and polygons or nets formed during the last glaciation.

Screening opinion

Only one of these sites is hydrologically sensitive – **Thetford Golf Course and Marsh SSSI**. This site may be hydraulically connected to the river given its proximity and may be subject to greater flooding from additional treated effluent volumes being discharged to the river from Thetford, as the STW outfall is located less than 200m upstream of the SSSI on the opposite bank. However, the Stage 1 WCS assessment has determined that the additional wastewater discharged from the proposed developments is unlikely to impact on flood flows and frequency of flooding downstream of Thetford STW.

Downstream Sites Assessment

Special Areas of Conservation (SAC)

Ouse Washes SAC

The Ouse Washes are located in eastern England on one of the major tributary rivers of The Wash. It is an extensive area of seasonally flooding wet grassland ('washland') lying between the Old and New Bedford Rivers (which are hydraulically connected to the River Great Ouse) and acts as a floodwater storage system during winter months. The cycle of winter storage of floodwaters from the river and traditional summer grazing by cattle, as well as hay production, have given rise to a mosaic of rough grassland and wet pasture, with a diverse and rich ditch fauna and flora. The Ouse Washes were designated as an SAC for their population of spined loach. This fish is thought to be largely confined to oxygen rich waters where the substratum consists of fine, organic rich sediment.

The Wash and North Norfolk Coast SAC

The Wash is located on the east coast of England and is the largest estuarine system in the UK. It is fed by the rivers Witham, Welland, Nene and Great Ouse that drain much of the east Midlands of England. The Wash comprises very extensive saltmarshes, major intertidal banks of sand and mud, shallow waters and deep channels.

The eastern end of the site includes low chalk cliffs at Hunstanton. In addition, on the eastern side, the gravel pits at Snettisham are an important high-tide roost for waders. The intertidal flats have a rich invertebrate fauna and colonising beds of Glasswort *Salicornia* spp. which are important food sources for the large numbers of waterbirds dependent on the site. The sheltered nature of The Wash creates suitable breeding conditions for shellfish, principally Mussel *Mytilus edulis*, Cockle *Cardium edule* and shrimps. These are important food sources for some waterbirds such as Oystercatchers *Haematopus ostralegus*. The Wash is designated as a Special Area of Conservation for supporting the following features of European importance: Subtidal sandbanks; Intertidal mudflats and sandflats; Shallow inlets and bays; Reefs; Mediterranean saltmarsh scrub; Lagoons; Common seal; and Otter.

Screening opinion

Reduced flows (rather than increased flows) are more likely to have an adverse effect on The Wash; siltation resulting from low flows is already recognised as a problem. Therefore (when the dilution effect that will be experienced by any increased nutrient loading is considered) it is unlikely that the potential developments will result in a significant adverse effect on this site.

Increased flows can lead to prolonged flooding of the Ouse Washes SAC and the spined loach (for which the SAC was designated) is associated with slow flowing watercourses, such that a significant increase in flow rates may render the Ouse unsuitable for the species. However, the Ouse Washes SAC lies upstream of the River Little Ouse confluence with the River Great Ouse, such that water flows or quality are unlikely to be affected by discharges from Thetford. It is therefore unlikely that significant adverse effects will result on this site.

Special Protection Areas (SPA)

Ouse Washes SPA

The washlands support both breeding and wintering waterbirds. In summer, there are important breeding numbers of several wader species, as well as spotted crake *Porzana porzana*. In winter, the site holds very large numbers of swans, ducks and waders. During severe winter weather elsewhere, the Ouse Washes can attract waterbirds from other areas due to its relatively mild climate (compared with continental Europe) and abundant food resources. In winter, some wildfowl, especially swans, feed on agricultural land surrounding the SPA. The site was designated as an SPA for regularly supporting 64,392 waterfowl, including populations of European importance of the following migratory species: Ruff; Spotted Crake; Bewick's Swan; Hen Harrier; Whooper Swan; Black-tailed Godwit; Gadwall; Shoveler; Pintail; Pochard; and Wigeon.

The Wash SPA

The Wash is of outstanding importance for a large number of geese, ducks and waders, both in spring and autumn migration periods, as well as through the winter. The SPA is especially notable for supporting a very large proportion (over half) of the total population of Canada/Greenland breeding knot *Calidris canutus islandica*. In summer, the Wash is an important breeding area for terns and as a feeding area for marsh harrier *Circus aeruginosus* that breed just outside the SPA. The Wash was designated as a Special Protection Area for supporting a bird assemblage of international importance by regularly supporting over

400,000 waterfowl and for supporting populations of European importance of the following migratory species: Common Tern; Little Tern; Marsh Harrier; Avocet; Bar-tailed Godwit; Golden Plover; Whooper Swan; Ringed Plover; Sanderling; Black-tailed Godwit; Curlew; Dark-bellied Brent Goose; Dunlin; Grey Plover; Knot; Oystercatcher; Pink-footed Goose; Pintail; Redshank; Shelduck; and Turnstone.

Screening opinion

Reduced flows (rather than increased flows) are more likely to have an adverse effect on The Wash; siltation resulting from low flows is already recognised as a problem. Therefore (when the dilution effect that will be experienced by any increased nutrient loading is considered) it is unlikely that the proposed developments will result in a significant adverse effect on this site.

Increased flows can lead to prolonged flooding of the Ouse Washes SAC. However, the Ouse Washes SAC lies upstream of the River Little Ouse confluence with the River Great Ouse, such that water flows or quality are unlikely to be affected by discharges from Thetford. It is therefore unlikely that significant adverse effects will result on this site.

Ramsar sites

The Wash Ramsar site

The Wash is designated as a Ramsar site for the following reasons:

- The Wash is a large shallow bay comprising very extensive saltmarshes, major intertidal banks of sand and mud, shallow water and deep channels.
- Qualifies because of the inter-relationship between its various components including saltmarshes, intertidal sand and mud flats and the estuarine waters. The saltmarshes and the plankton in the estuarine water provide a primary source of organic material, which, together with other organic matter, forms the basis for the high productivity of the estuary.
- The site supports a wintering waterbird assemblage of international importance
- Species occurring at levels of international importance are: Oystercatcher; Grey plover; Red knot; Sanderling; Curlew; Common redshank; Ruddy turnstone; Pink-footed goose; Dark-bellied brent goose; Common shelduck; Northern pintail; Dunlin; Bar-tailed godwit; Ringed plover; Black-tailed godwit; Golden plover; and Northern lapwing.

Ouse Washes Ramsar site

The Ouse Washes is designated as a Ramsar site for the following reasons:

- The site is one of the most extensive areas of seasonally-flooding washland of its type in Britain.
- The site supports several nationally scarce plants, including small water pepper *Polygonum minus*, whorled water-milfoil *Myriophyllum verticillatum*, greater water parsnip *Sium latifolium*, river waterdropwort *Oenanthe fluviatilis*, fringed water-lily *Nymphoides peltata*, long-stalked pondweed *Potamogeton praelongus*, hair-like pondweed *Potamogeton trichoides*, grass-wrack pondweed *Potamogeton compressus*, tasteless water-pepper *Polygonum mite* and marsh dock *Rumex palustris*.
- Invertebrate records indicate that the site holds relict fenland fauna, including the British Red Data Book species large darter dragonfly *Libellula fulva* and the rifle beetle *Oulimnius major*.

- The site also supports a diverse assemblage of nationally rare breeding waterfowl associated with seasonally-flooding wet grassland.
- The site supports a wintering waterbird assemblage of international importance
- Species occurring at levels of international importance are: Tundra swan; Whooper swan; Eurasian wigeon; Gadwall; Eurasian teal; Northern pintail; Northern shoveler; Mute swan; Common pochard; and Black-tailed godwit.

Screening opinion

Reduced flows (rather than increased flows) are more likely to have an adverse effect on The Wash; siltation resulting from low flows is already recognised as a problem. Therefore (when the dilution effect that will be experienced by any increased nutrient loading is considered) it is unlikely that the proposed developments will result in a significant adverse effect on this site.

Increased flows can lead to prolonged flooding of the Ouse Washes SAC. However, the Ouse Washes SAC lies upstream of the River Little Ouse confluence with the River Great Ouse, such that water flows or quality are unlikely to be affected by discharges from Thetford. It is therefore unlikely that significant adverse effects will result on this site.

Sites of Special Scientific Importance (SSSI)

The Wash SSSI

The whole area is of exceptional biological interest. The intertidal mudflats and saltmarshes represent one of Britain's most important winter feeding areas for waders and wildfowl outside of the breeding season. Enormous numbers of migrant birds, of international significance, are dependant on the rich supply of invertebrate food. The saltmarsh and shingle communities are of considerable botanical interest and the mature saltmarsh is a valuable bird breeding zone. In addition the Wash is also very important as a breeding ground for Common Seals.

Ouse Washes SSSI

The site is one of the country's few remaining areas of extensive washland habitat. It is of particular note for the large numbers of wildfowl and waders that it supports, for the large area of unimproved neutral grassland communities that it holds and for the richness of the aquatic fauna and flora within the associated watercourse. The grassland communities of the area are characterised by such grasses as reed and floating sweet-grass *Glyceria maxima* and *G.fluitans*, reed canary-grass *Phalaris arundinacea*, marsh foxtail *Alopecurus geniculatus* together with a variety of sedges and rushes. Typical herbs include amphibious bistort *Polygonum amphibium*, water-pepper *Polygonium hydropiper* and tubular water-dropwort *Oenanthe fistulosa*. The associated dykes and rivers hold a great variety of aquatic plants, the pondweeds *Potamogeton* spp. are particularly well represented. Other aquatic species include the fringed water-lily *Nymphoides peltata*, greater water-parsnip *Sium latifolium* and the four species of duckweeds *Lemna* spp.

The limnological interest of the Ouse Washes is further diversified by the Old Bedford River and River Delph, both good examples of base-rich, sluggish, lowland rivers. The flora includes the fan-leaved water-crow foot *Ranunculus circinatus*, yellow water-lily *Nuphar lutea*, arrowhead *Sagittaria sagittifolia*, long-stalked pondweed *Potamogeton praelongus*, perfoliate pondweed *Potamogeton perfoliatus*, and river water-dropwort *Oenanthe fluviatilis*. The associated aquatic and semi-aquatic fauna is similarly diverse.

Screening opinion

Reduced flows (rather than increased flows) are more likely to have an adverse effect on The Wash; siltation resulting from low flows is already recognised as a problem. Therefore (when the dilution effect that will be experienced by any increased nutrient loading is considered) it is unlikely that the Water Cycle Strategy will result in a significant adverse effect on this site.

Increased flows can lead to prolonged flooding of the Ouse Washes SAC and the spined loach, limnological interest and several of the aquatic macrophytes for which this site was designated are associated with slow flowing watercourses, such that a significant increase in flow rates may render the Ouse unsuitable for the species. However, the Ouse Washes SAC lies upstream of the River Little Ouse confluence with the River Great Ouse, such that water flows or quality are unlikely to be affected by discharges from Thetford. It is therefore unlikely that significant adverse effects will result on this site.

Non-statutory designated sites

No non-statutory sites (County Wildlife Sites, Sites of Importance for Nature Conservation etc.) were identified downstream of the sewage treatment works on the Little River Ouse.

Appendix I – Figures

THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Thetford, East Anglia

Scale at A3: 1: 60,000

Drawn: SLK | Approved: JR

Date: 25/04/2008

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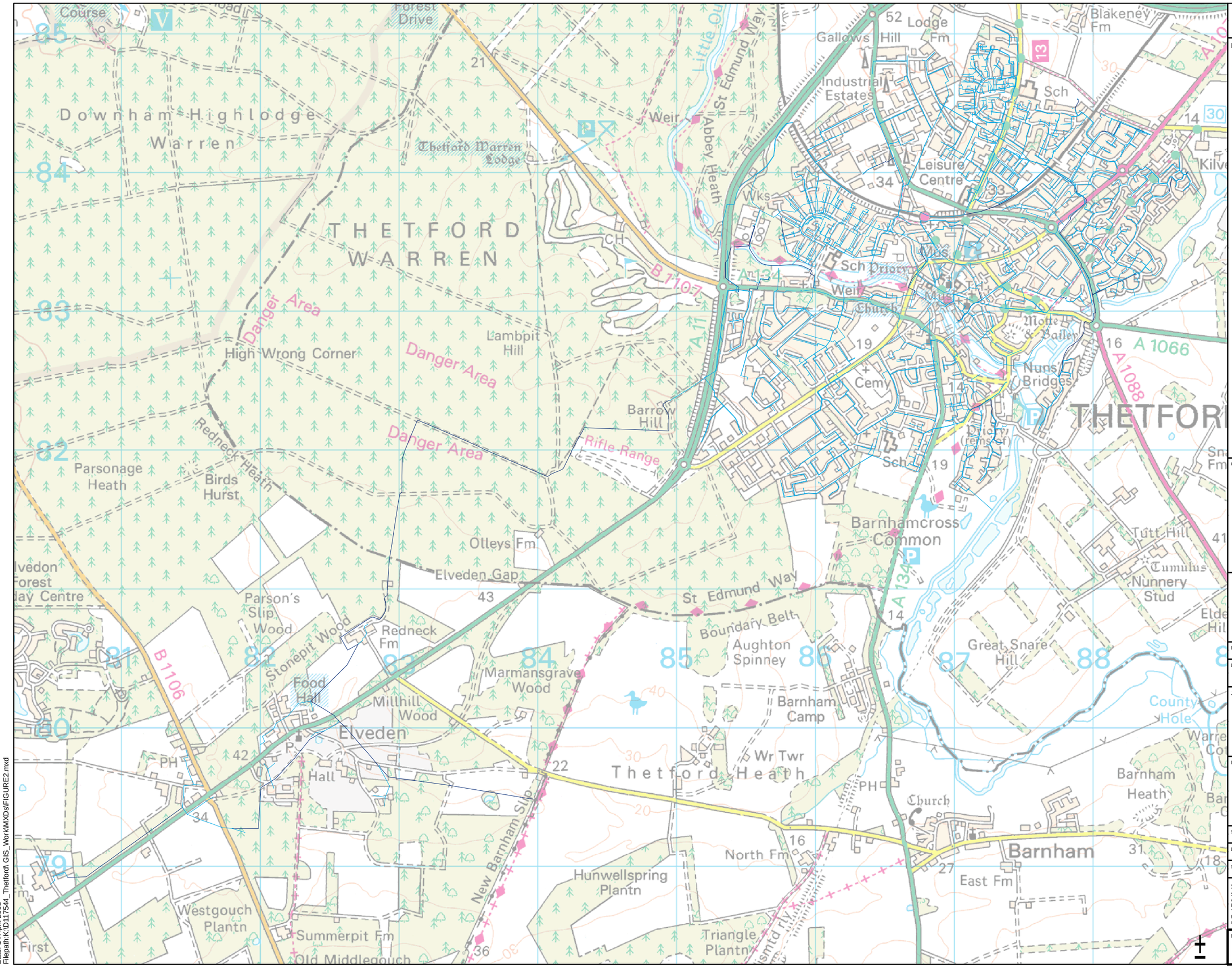
Drawing Number: D117544 - Figure 1

Rev:



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NOTES

- Rising Mains
- Conduits

Revision Details	By / Check	Date	Suffix

Drawing Status: DRAFT

Job Title: Thetford

Drawing Title: WASTEWATER NETWORK

Scale at A3: 1:25,000

Drawn	Approved
SB	MP

Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 2** Rev

Date: 14 April 2008
Filepath:K:\D117544_Thetford\ GIS_Work\MXDs\FIGURE2.mxd

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Potential Development Areas
(EDAW Report, 2007) - Ref. 12

- Original Sites
- Additional Sites
- River
- Extent of extreme flood
- Flooding from rivers or sea without defences

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Potential Development Locations in Thetford

Scale at A3: 1: 30,000

Drawn: SLK | Approved: JR

Date: 25/04/2008

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Drawing Number: D117544 - Figure 3 | Rev

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River

Flooding from rivers or sea without defences

Extent of extreme flood

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Little Ouse River and River Thet - Flood Risk

Scale at A3: 1: 30,000

Drawn: SLK | Approved: JR

Date: 25/04/2008

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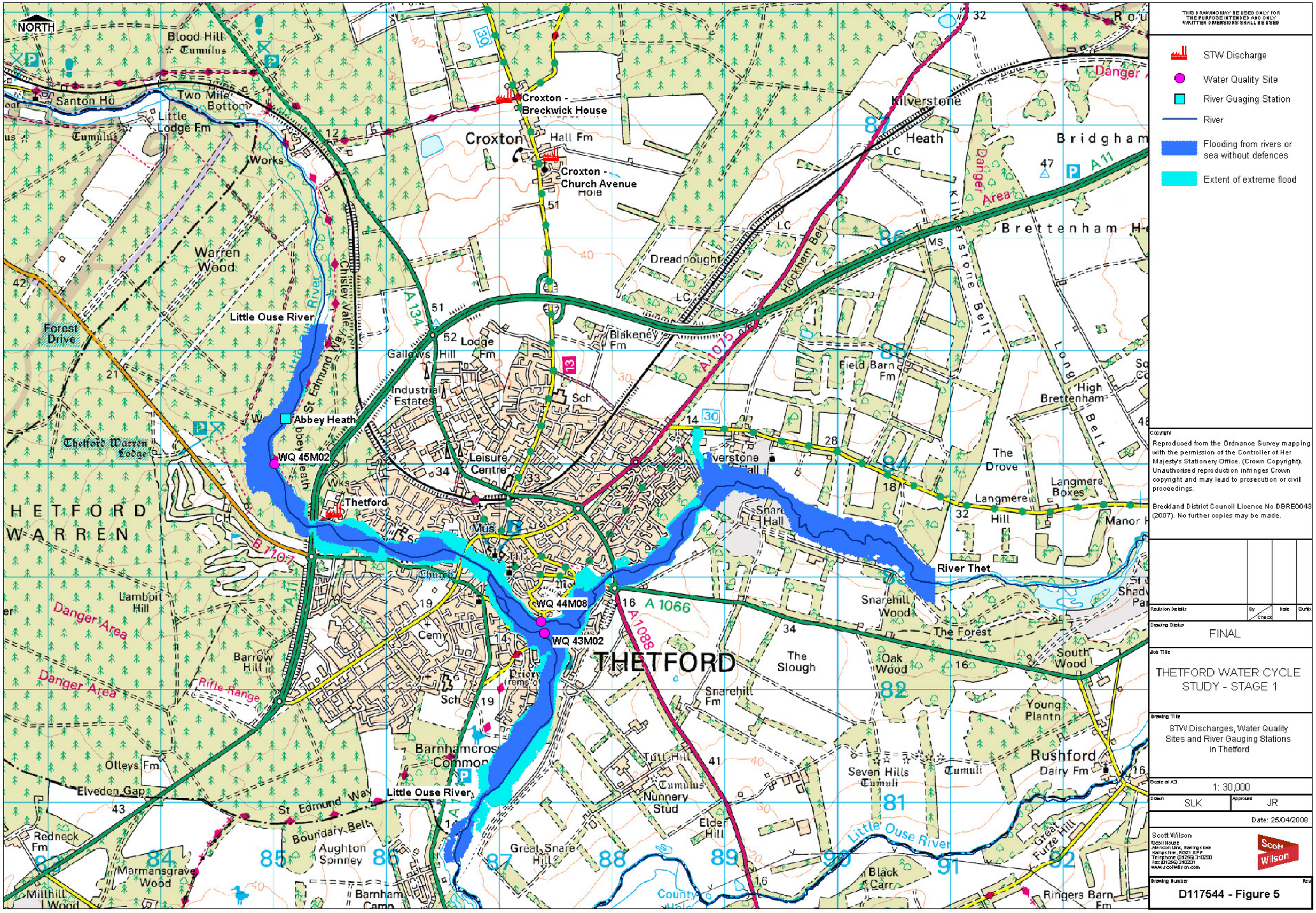
Drawing Number: D117544 - Figure 4 | Rev:



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

- STW Discharge
- Water Quality Site
- River Guaging Station
- River
- Flooding from rivers or sea without defences
- Extent of extreme flood

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: STW Discharges, Water Quality Sites and River Gauging Stations in Thetford

Scale at A3: 1: 30,000

Drawn: SLK | Approved: JR

Date: 25/04/2008

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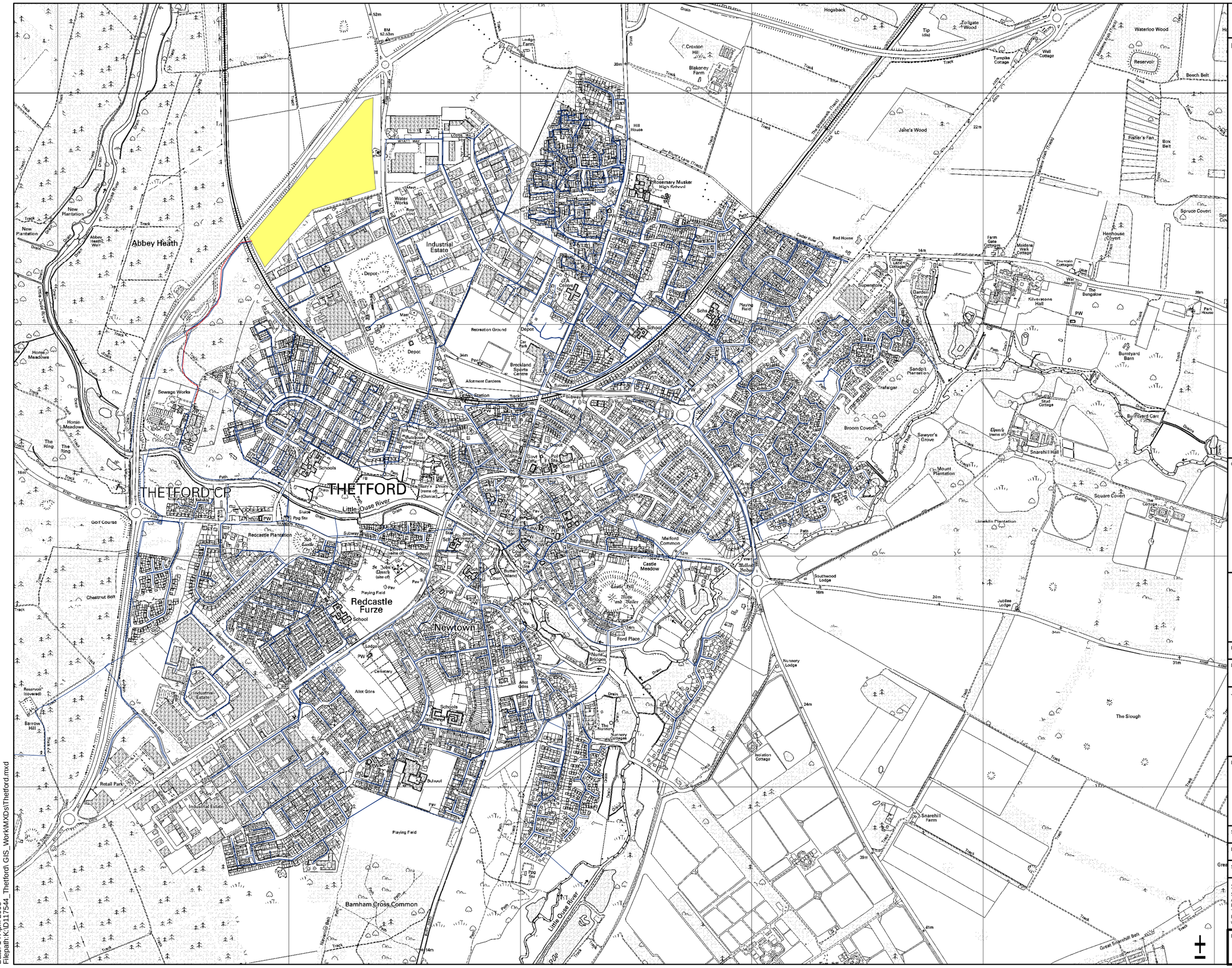
Drawing Number: D117544 - Figure 5 | Rev



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

NOTES

- Area 1
- Route to works 1
- Rising Mains
- Conduits

Mains & Conduits provided by anglian water.

Revision Details	By / Check	Date	Suffix

Drawing Status: DRAFT

Job Title: Thetford

Drawing Title: AREA 1 DRAINAGE PATH

Scale at A3: 1:15,000

Drawn	Approved
SB	MP

Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 6A** Rev

Date: 14 April 2008
Filepath:K:\D117544_Thetford\ GIS_Work\MXDs\Thetford.mxd

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NOTES

- Area 2
- Route to Works 2
- Rising Mains
- Conduits

Mains & Conduits provided by anglian water.

Revision Details	By / Check	Date	Suffix

Drawing Status: DRAFT

Job Title: Thetford

Drawing Title: AREA 2 DRAINAGE PATH

Scale at A3: 1:15,000

Drawn	Approved
SB	MP

Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 6B** Rev

Date: 14 April 2008
Filepath:K:\D117544_Thetford\ GIS_Work\MXDs\Thetford.mxd

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NOTES

- Area 3
- Route to Works 3
- Rising Mains
- Conduits

Revision Details	By / Check	Date	Suffix

Drawing Status: DRAFT

Job Title: Thetford

Drawing Title: AREA 3 DRAINAGE PATH

Scale at A3: 1:15,000

Drawn	Approved
SB	MP

Stage 1 check	Stage 2 check	Originated	Date

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Drawing Number: **FIGURE 6C** Rev

Date: 14 April 2008
Filepath:K:\D117544_Thetford\ GIS_Work\MXDs\Thetford.mxd

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NOTES

- Area 4
- Route to Works 4
- Rising Mains
- Conduits

Mains & Conduits provided by anglian water.

Revision Details	By / Check	Date	Suffix

Drawing Status: DRAFT

Job Title: Thetford

Drawing Title: AREA 4 DRAINAGE PATH

Scale at A3: 1:15,000

Drawn	Approved
SB	MP

Stage 1 check	Stage 2 check	Originated	Date

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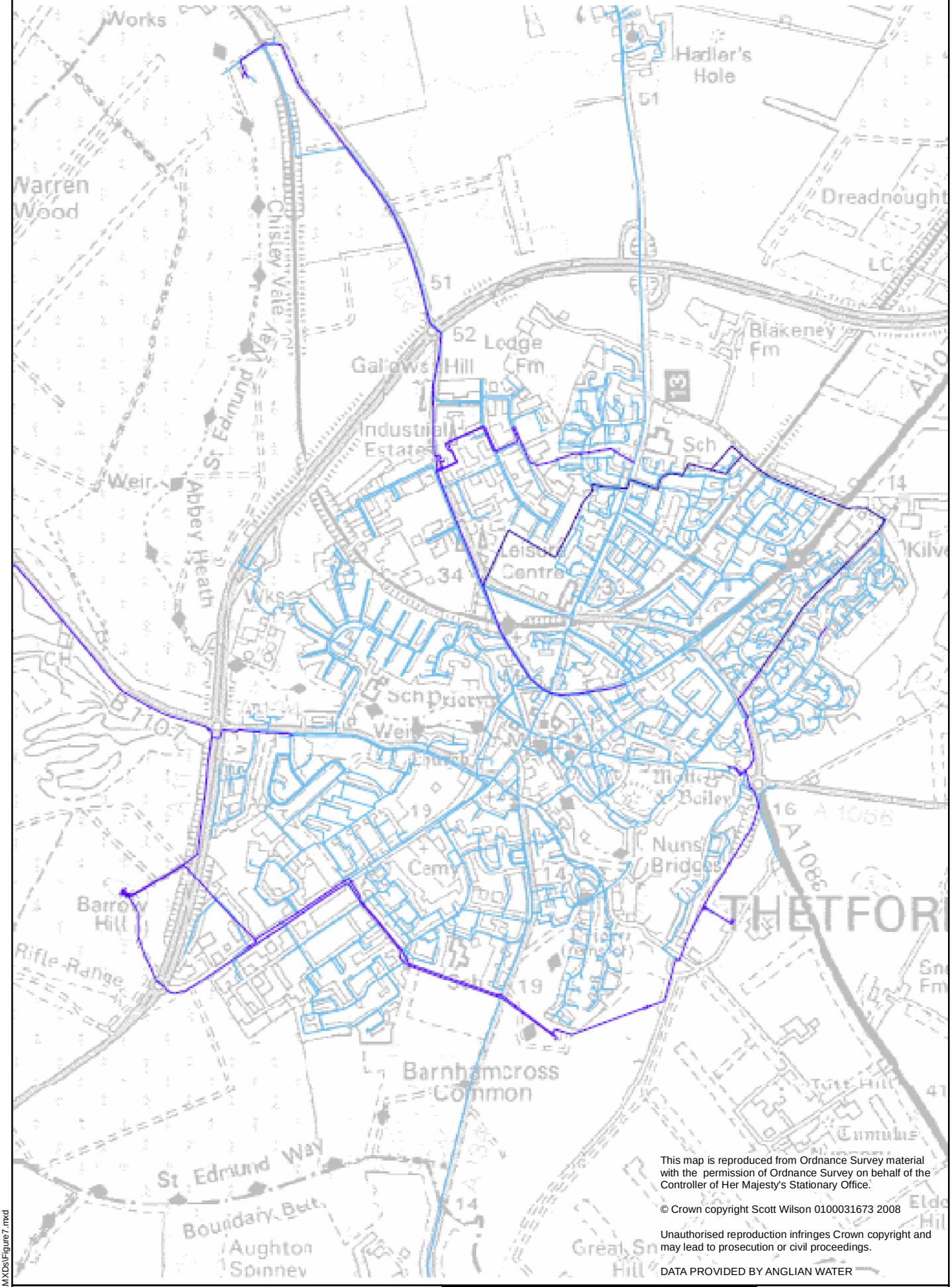
Drawing Number: FIGURE 6D

Rev:

Date: 14 April 2008
Filepath:K:\D117544_Thetford\ GIS_Work\MXDs\Thetford.mxd



DATA PROVIDED BY ANGLIAN WATER

Project Title: THETFORD	**FIGURE No7**			
	Scale at A4			
Drawing Title: WATER SUPPLY NETWORK	Drw SB	App	Rev	
	Chk CP	Date 14.04.08	Date	

Scott Wilson

www.scottwilson.com

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THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

Sewer Routes

- Proposed Route (Gravity)
- Proposed Route (Pumped)
- Alternative Route (Gravity)
- Alternative Route (Pumped)

Potential extent of scheduled Boudicca Site

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Proposed Sewer Routes in Thetford

Scale at A3: 1: 30,000

Drawn: SLK | Approved: JR

Date: 25/04/2008

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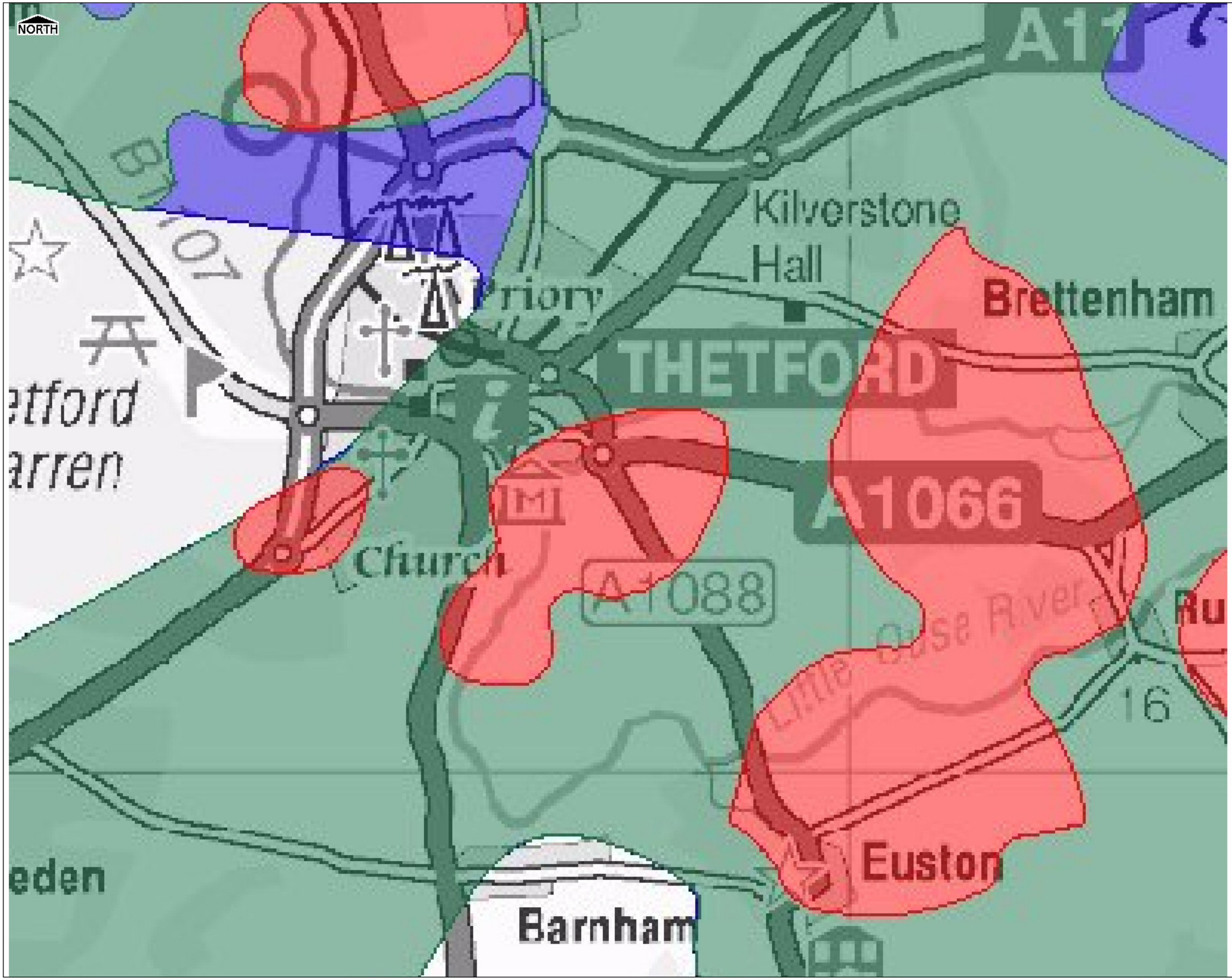
Drawing Number: D117544 - Figure 8

Rev:



THIS DRAWING MAY BE USED ONLY FOR THE PURPOSE INTENDED AND ONLY WRITTEN DIMENSIONS SHALL BE USED

- Inner zone
- Outer zone
- Total catchment
- Special interest

Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Source Protection Zones in Thetford

Scale at A3

Drawn	Approved
SLK	JR

Date: 25/04/2008

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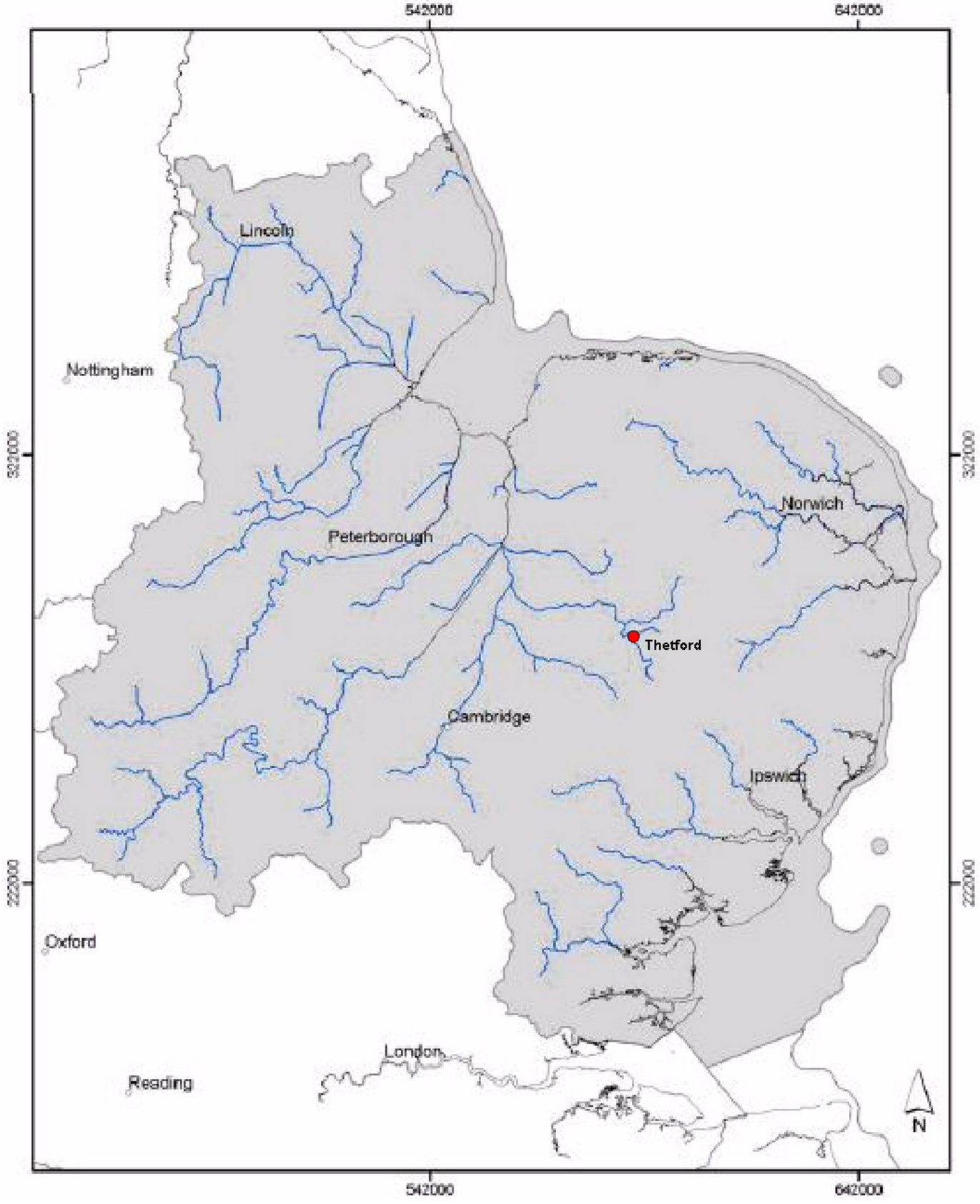
Drawing Number: D117544 - Figure 9

Rev

NORTH



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Revision Details	By / Check	Date	Suffix

Drawing Status: FINAL

Job Title: THETFORD WATER CYCLE STUDY - STAGE 1

Drawing Title: Anglian River Basin District

Scale at A3

Drawn: SLK | Approved: JR

Date: 25/04/2008

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Drawing Number: D117544 - Figure 10

Rev