3 Data Collection and Catchment Characteristics

The data collection was the first process in Stage 1 of the Water Cycle Study. A request of information was sent to the stakeholders and interested parties and is outlined in Appendix H. Missing data were identified and subsequent requests were undertaken in discussion with the relevant stakeholders. The information was recorded on an external hard-drive and it is intended that this will be submitted to the GNDP on completion of the study.

GIS formed the cornerstone of the data analysis, and where possible the data requested was inclusive of a spatial referencing so that it could be compared and contrasted with other datasets. The analysis was undertaken using MapInfo software.

Other reports were reviewed to assist in the generation of this document. These are referenced in Section 10 and include:

- JCS Strategic Growth Options
- Corby Water Cycle Strategy – Phase 1
- North Northamptonshire Outline Water Cycle Strategy
- Initial Growth Paper (GNDP)

The major disciplines within the WCS are identified below.

3.1 Flood Risk & Hydrology

The Environment Agency is responsible for managing flood defence in England and Wales and has provided the flood risk and hydrology information for the Study Area. A Strategic Flood Risk Assessment has been commissioned for the Greater Norwich area; however, this was not available for review during Stage 1 of the Water Cycle Study. Therefore, for the purpose of this report the floodplain outlines that have been used in the assessment of the growth areas are those provided by the Environment Agency. If necessary, the findings of the Strategic Flood Risk Assessment will be incorporated into Stage 2 of the Greater Norwich Water Cycle Study. Information pertaining to the outputs from a Strategic Flood Risk Assessment is outlined in Appendix I.

3.1.1 Flood Zones

Flood risk is classified in accordance with Table D.1 of PPS25 (Development and Flood Risk) that defines 3 primary Flood Zones. These Flood Zones do not take account of the presence of flood defences. These are summarised below:

Table 3-1: Flood Risk Zones Defined in PPS25

Flood Zone	Description
Flood Zone 1 Low Probability	Less than 1 in 1,000 annual probability of flooding in any year (less than 0.1%).
Flood Zone 2 Medium Probability	Between a 1 in 100 and 1 in 1,000 annual probability of river flooding (1% - 0.1%) or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding (0.5% - 0.1%) in any year.
Flood Zone 3a High Probability	A 1 in 100 or greater annual probability of river flooding (greater than 1%) or a 1 in 200 or greater annual probability of flooding from the sea (greater than 0.5%) in any year.
Flood Zone 3b The Functional Floodplain	The Functional Floodplain is defined as the "land where water has to flow or be stored in times of flood". Strategic Flood Risk Assessments should identify this Flood Zone (land which would flood with an annual probability of 1 in 20 (5%) or greater in any year or is designed to flood in an extreme (0.1%) flood, or at another probability to be agreed between the Local Planning Authority and the Environment Agency, including water conveyance routes.

Based on the PPS25 classification and the best available data the flood risk has been used to assess flood risk to each of the potential development areas. The flood risk in the region has been assessed and the floodplain extents for the area are shown in Appendix B.

3.1.2 River Catchments

The Greater Norwich Water Cycle Study area covers the major catchments of the rivers Yare, Bure, Waveney and Wensum. Tributaries of these rivers include amongst others, the Tiffey and Chet. Appendix B shows the location of the major river systems within the Study Area, which are summarised in Table 3-2 below.

It is understood that the SFRA will produce a comprehensive analysis of the catchment characteristics.

Table 3-2: Major Catchment Characteristics

River	Major Tributaries	Catchment Area	Local Authority	Fluvial/ Tidal
Upper Yare	Mulbarton watercourse, River Tiffey, Shortesham watercourse	461km^2	Norwich District, South Norfolk Broadland and Broads Authority	Fluvial & Tidal
Wensum	River Whitewater, River Tud	640km^2	Norwich District, South Norfolk, Broads Authority and Broadland	Fluvial
Upper Waveney	River Tas, Denton Tributary, Broome Beck	650km^2	South Norfolk and Broads Authority	Fluvial & Tidal
Upper Bure	Dobb's Beck, The mermaid	419km^2	Broadland and Broads Authority	Fluvial & Tidal

All of the rivers flow in a general easterly direction before their confluence in the tidal estuary area of the River Yare, known as The Broads.

3.1.3 Types of Flood Risk

Fluvial Flood Risk

The catchment is influenced by both fluvial and tidal flow mechanisms. The main source of fluvial flooding as noted by the Broads Catchment Flood Management Plans (CFMP) is associated with intense, heavy rainfall when ground is saturated or channels are blocked.

Tidal Flood Risk

The River Yare has components of fluvial and tidal characteristics – its tidal limit is at New Mills weir in Norwich. It has smaller tributaries, namely the Tiffey, Tas and Chet that drain into the Broads area, east of Norwich. Tidal flooding is associated with storm surges; these are a combination of high tides and high winds causing wave inundation. However, it is understood that the rivers within the catchment differ in their responses. The River Bure responds to small tidal ranges and is more sensitive to longer duration events, whereas the rivers Waveney and Yare have larger tidal ranges and respond to shorter events.

Foul Sewer Flooding

Information on foul sewer flooding in the existing network has not been provided to date. This information is deemed sensitive by AWS, especially internal flooding to properties (DG5 Register) which is the sewer flooding indicator. However, there are certain areas known to flood during peak flows. Hence these will be identified through hydraulic modelling in Stage 2 of the Water Cycle Study. Failure to include this will jeopardise the credibility of the assessment of flooding.

Surface Water Drainage

AWS has not provided any information on surface water flooding in the existing network. It is anticipated that this will be identified through hydraulic modelling in Stage 2 of the Water Cycle Study.

3.1.4 Capacity of the Receiving Watercourse

The capacity of the receiving watercourse is a crucial element of the Water Cycle Study. If the receiving watercourse does not have spare capacity to receive additional flows created by development in the area, then any water that is discharged into the watercourse is likely to have flood risk implications to third parties downstream. In accordance with Planning Policy Statement (PPS) 25, this is deemed an unacceptable risk, and should either be mitigated against or avoided.

It has been acknowledged that the assessment of the receiving watercourses is not being undertaken within the Water Cycle Study or the Strategic Flood Risk Assessment; hence it has been identified as a crucial part of Stage 2 of the Water Cycle Study.

3.2 Water Resources and Supply

3.2.1 Water Resources

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' 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.

In drought years, the rainfall across the Anglian Region can be as low as 450mm, which reduces the amount of 'effective rainfall' to less than 50mm. The climate gradient from West to East and from North to South is accentuated across the region. The water is resourced from two main sources:

- River abstraction – 60%
- Groundwater abstraction – 40%

These are summarised below and shown in Appendix D.

River Water Abstraction

In the case of Norwich, a direct surface water supply from the River Wensum occurs at Costessey, which in turn feeds Heigham Water Treatment Works (WTW). There are also a number of groundwater sources across the city and in surrounding areas (see below). The main sources of supply are summarised in Table 3-3

The main raw water supply for Norwich Policy Area (NPA) is the surface water source at Costessey WTW; with a daily and annual licence quantity of 240 Ml/d and 17,000 Ml/year respectively.

The Broadland Rivers CAMS indicates that summer flows in rivers are already a problem and that the River Wensum will not sustain an increase in the licence quantity. The other rivers in the area, Tud, Tas, Yare and Bure (none of which have direct supplies from them) have their flows effectively maintained by discharges from STW.

Groundwater Abstraction

The Costessy Borehole is an important source of supply in the NPA in the summer. Concern has been expressed by Natural England with regard to the Costessy abstraction which at current levels is having an adverse impact on the integrity of the River Wensum SAC.

Most of the Rural Policy Area is supplied from a number of boreholes. AWS confirmed there was adequate capacity from these boreholes to sustain future developments. The major borehole at Strumpshaw is due to close in 2008 (there is concern over its impact on protected habitat) with a loss in deployable output of 7.4 Ml/d for AWS. It is understood that the licence quantity may be transferred to other borehole sources in the Norwich area. Other borehole sources operated by AWS include:

- The Caistor St Edmunds and Thorpe St Andrews boreholes (both close to capacity)
- The Bowthorpe (Bland Road) borehole in Norwich (recently renovated)
- The Colney and Bixley boreholes
- River Yare Licences – Marlingford, Barford, Colney, High Oak and Mattishall boreholes

The current Environment Agency policy as detailed in the Broadland Rivers CAMS regarding license agreements is that maximum use must be made of existing license agreements before new licenses will be granted and new licenses and variations to existing licenses will be subject to a time-limit. On average the boreholes are said to generate approximately 3 Ml/d. These are summarised in Appendix D.

3.2.2 Water Supply

No water treatment capacities were provided by AWS but confirmation was made that capacities were adequate for the planning period of 2031 as outlined in their Norwich Area Strategy Document, which included the provision of water supply for 51,000 new properties. This position will need to be assessed during Stage 2 of the Water Cycle Study.

3.3 Wastewater Drainage and Treatment

3.3.1 Existing STW

There are a number of STW situated within the Study Area, with a variety of consents. These are summarised in Table 3-4:

Table 3-3: Summary of STW in Study Area

Potential Growth Area	STW currently receiving Flows from this Area	Capacity	Headroom PE	Headroom Property	Watercourse
NPA 1	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 2	Rackheath – The Springs	260	-343	-163	Dobbs Beck
NPA 3	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 4	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 5	Poringland	930	809	385	R.Chet Nt
NPA 6	Stoke Holy Cross	341	164	78	Unknown
NPA 7	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 8	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 9	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 10	Whitlingham	66,250	108,908	51,861	R.Yare T
NPA 11	Wymondham	4,400	8,521	4,058	River Tiffey
City	Whitlingham	66,250	108,908	51,861	R.Yare T
RPA 1	Reepham	850	682	325	Blackwater Drain (R.Wensum Nt)
RPA 2	Aylsham	1,440	-474	-226	R Bure
RPA 3	Belaugh	2,273	4,021	1,915	River Wensum
RPA 4	Acle-Damgate Lane	720	297	141	Unknown
RPA 5	Wymondham	4,400	8,521	4,058	River Tiffey
RPA 6	Diss	4032	10,160	4,838	River Waveney
RPA 7	Harleston	1,392	2,503	1,192	Starston Brook (Trib River Waveney)
RPA 8	Sisland	1,600	2,221	1,058	Unknown

Where it exists, the PE headroom at each of the STW has been expressed as Property headroom i.e. the number of additional properties that can be drained to the STW without exceeding the STW's consented DWF. The conversion has utilised an average occupancy rate of 2.1 people per property. It is these property headrooms that have been used in assessing

the wastewater constraint at each potential growth area outlined in Section 5. It should however be noted that some of the PE headroom can be used up by non-domestic connections to the sewer network. This stage of the study has assumed that domestic properties will be additional. This will be classified in Stage 2.

3.3.2 Sewer Network

Existing sewer networks in Potential Growth Areas and the Policy Areas as a whole will need further investigation to ascertain capacities. This will be achieved through hydraulic modelling in Stage 2 of the Water Cycle Study and it is proposed that InfoWorks software should be utilised for this work.. It is intended that this hydraulic modelling will identify areas prone to flooding and will be used as a guide to determine the spread of the proposed developments in relation to existing sewer networks and STWs. *It should be noted that depending on the existing capacity of the sewer networks, it may not be possible to fully exploit some of the headroom at existing STWs.*

In areas where wastewater is pumped to STWs, the constraints on development have been assessed on the basis of the quantity of additional flow that can be reasonably pumped. Pending more investigation of the sewer networks and pump rising mains, the following criteria has been applied:

- Combinations of existing pump stations can accept an increase of up to 5,000 new properties without a need for major upgrade to civil infrastructure but perhaps only upgrading of mechanical and electrical equipment e.g. pumps.
- Where there is an increase of properties between 10,000 and 15,000 it is assumed that some upgrading of mains will be required hence this has been assigned an 'amber' light.
- An increase of 20,000 properties within a single potential growth area and above has been assigned red because it is not considered environmentally friendly to pump large volumes of sewage.

3.3.3 Review of Consents

The driver for the Review of Consents process is Regulation 50 of the Conservation (Natural Habitats &c.) Regulations 1994, which 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, amend or revoke these permissions in light of the impacts on European Sites. Therefore it should be noted that the figures shown are subject to review and as such, may be subject to change on completion of the Stage 4 of the Review of Consents.

The conclusions of Stage 4 of the Review of Consents will be superimposed upon the Broadland Rivers CAMS and it is therefore important to qualify the CAMS through the Environment Agency understanding emerging through the Review of Consents process. For instance, it is stated that the River Wensum will not sustain an increase in licence quantity in the Broadland Rivers CAMS, but under the Environment Agency Review of Consents, it will be necessary to address the abstraction of water from the SSSI.

In addition to the Review of Consents for the Broads European Sites and the River Wensum SAC, the study should make reference to the Review of Consents for the Norfolk Valley Fens,

as recommended in the issues paper submitted by Natural England. This is especially the case where potential for development is assessed in outlying towns. Norfolk Valley Fens within the Study Area include Buxton Heath, Booton Common, Coston Fen and Flordon Common. AMP4 investigations are underway in relation to Coston Fen and Booton Common. However, there could be impacts to Norfolk Valley Fens outside of the Study Area, depending on the source of groundwater proposed for utilisation.

As the strategy extends to the very south of the county, it will be necessary to consider issues relating to the Review of Consents for Redgrave and Lopham Fens SSSI and Blo' Norton & Thelnetham Fens SSSI, where water resources issues have been identified.

It is recommend that contact is made with the Habitats Regulations Officer for Eastern Anglia Environment Agency, as at the present time the full implications of the Environment Agency Review of Consents do have not been adequately reflected in the current document.

In response to the planned development in Greater Norwich, the Environment Agency carried out a Review of Consents[6] examining the existing water quality of two sites of European importance, namely the River Wensum SAC and part of the Broadland SCA/SPA/Ramsar. Using analysis and modelling they assessed the significance and contribution of Environment Agency consented sources, including STW.

The Environment Agency have concluded that nutrient enrichment of both the River Wensum and the Yare Broads and Marshes is now a concern. In particular, phosphorous concentrations are shown to be elevated above acceptable appropriate standards. In addition, the Environment Agency suggest that discharge consents have been shown to contribute nearly 75% of all phosphorous loads to the river system. However, consent holders were operating below levels permitted by the consent, giving rise to flow (volumetric) headroom. Environment Agency modelling has shown that if discharges were to operate under fully consented conditions (phosphorous and flow) the concentration of phosphorous in the river would be similar to that under current (measured) conditions.

The Environment Agency identified 20 point sources of phosphorous, that contribute nearly 95% of the phosphorous loading to the River Wensum catchment. These discharges were to be considered at Stage 4 of their Review of Consents, which is to be carried out. Of the 20 consents, 14 STW are said to account for nearly 62% of point source loads and are listed below:

Table 3-4: Major STW – River Wensum

Environment Agency Ref	Description of permission, plan or project
AEELF12301	South Raynham HSW
AEENF1189	Sculthorpe STW
AEENF119B	Weasenham St Peter
AEENF12055	Foulsham STW
AEENF12100	Stibbard Moor End STW

[6] It should be noted that the review of consents is abstractions and discharges

Environment Agency Ref	Description of permission, plan or project
AEENF12129	Horningtoft STW
AEENF1305	Reepham STW
AEENF1327	East Rudham STW
AEENF15448	Fakenham STW
AEENF527	Dereham STW
AW4NF1046X	Swanton Morely Airfield STW
AW4NF199X	North Elmham STW
AW4NF405X	Weasenham All Saints STW
AW4NF624X	Bylaugh STW

Source: Environment Agency

Phosphorous standards are understood to be excessive in the River Yare. Only Whitlingham STW has a consent limit for phosphorous. Environment Agency modelling has indicated that despite having phosphorous stripping in place, Whitlingham STW contributes 41% of phosphorous loads to the Yare Broads and Marshes site.

Four major sites were identified as having an adverse effect on the integrity of the Yare Broads and Marshes and are listed below:

Table 3-5: STW with Major Impact – Yare Broads and Marshes.

Environment Agency Ref	Description of permission, plan or project
AW4TF1789	Whitlingham STW
AEENF1305	Reepham STW
AW4NF430X	Wymondham STW
AEENF1406	Long Stratton STW

Source: Environment Agency

3.4 Environmental

The boundaries of the environmental designated sites within the Study Area were obtained from Natural England's website (www.naturalengland.org.uk).

3.4.1 Designated Sites

Because the Water Cycle Study includes an Appropriate Assessment, the level of environmental designation that was identified within the Study area was represented accordingly. Therefore the following designations were identified and are shown in Appendix E:

- Ramsar sites
- Sites of Special Scientific Interest (SSSI)

- Special Areas of Conservation (SAC)
- Special Protection Areas (SPA)

3.4.2 Environmental Concerns

Consultations with Natural England, the Environment Agency and other stakeholders have raised a number of environmental concerns within the Study Area. These include

Abstraction and Discharge

There is concern about the impacts which both abstraction and discharges may be having on certain protected sites outlined above. Specific concerns include:

- Abstractions at Costessy on the River Wensum, particularly at times of low flows;
- Discharges at Whitlingham STW; and impacts downstream on the Broads.
- Discharges from Whitlingham STW, despite improved water quality phosphate stripping, downstream on the Broads.
- The catchment response and subsequent impact on the Sweetbriar Meadow SSSI within Norwich

Water Framework Directive

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 river basins 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.

In August 2007, a list of significant issues across the Anglian Region was be published by the Environment Agency. A consultation on the priorities for this region will end in January 2008. This will be followed a Programme of Measures to be published at the end of 2008.

An indication of what the costs of implementing the directive might be will be issued by the Environment Agency at the end of 2007. In all likelihood the directive will lead to changes in water tariffs (with an emphasis on water efficiency – see Section 7.5) and a rise in the environmental permitting costs for any discharges in the future.

Nitrate Vulnerable Zones

Levels of nitrate in groundwater and surface waters have been the cause of some concern to both Environment Agency and AWS. Large areas within the Anglian Region have been

declared Nitrate Vulnerable Zones (NVZs). These are areas where agricultural management practices, including the use of organic and inorganic fertilisers, are modified to reduce pollution to the water environment. The scheme is administered by the Environment Agency. The concern is that if this scheme is not successful and nitrate concentrations in the boreholes continue to increase, then this will represent to threat to both the city's drinking water supplies and also to baseflows to the rivers which flow into downstream protected areas.

Groundwater Vulnerability

The Environment Agency has produced a Groundwater Vulnerability Map for the East Norfolk Region (Sheet No. 26). The map shows Norwich and its surrounds as being almost entirely classified as a major aquifer. In this area both the Chalk and Crag Group (excluding mudstones) are defined as major aquifers (highly permeable). Within this geological class are a number of sub-divisions based on soil class. These are *High*, *Intermediate* and *Low* Leaching Potentials (LP), and relates to the physical properties of soils/geology which effect the downward movement of pollutants. The approximate distribution of the different sub-divisions is as follows:

- Norwich, the Wensum and Tud valley upstream of Norwich and the area north of the city are all High LP.
- The area to the south and east are either Intermediate or Low LP. The Intermediate class occur in a swathe south of Norwich and extending eastwards. It also occurs along the river valleys of the Yare and Tas.
- Low LP occurs in the areas between the river valleys.
- Further south again around Diss and Harleston, and along the river Waveney, then a small patch of High LP is present.

Source Protection Zones (SPZ)

The Environment Agency has also produced SPZ maps showing the 50 day (Zone 1), 400 day (Zone 2) and Total Catchment area (Zone 3) for all sources over 1 Ml/d (mainly public water supplies), of which there are several in the Greater Norwich area (see Section 5.4.1). Some are situated along the line of the main rivers west of Norwich (at Costessy), to the east (as far as Strumpshaw) and to the south along the River Tas valley.

The close proximity of these sources, their size and the recharge mechanisms through the drift, all combine to effectively mean that the entire City of Norwich (within the ring road at least) sits on one of these catchment areas that supply the city's water supply (including Zone 1's). Outside this central zone, then the coverage of these areas becomes less (Zones 2 and 3).

The purpose of these maps has been to provide the Environment Agency with a tool by which to determine what developments may be permitted to take place in the future. The heavy reliance on groundwater for the City's water supply will therefore affect the location for development across the city. Where possible, Zone 1 should be avoided by major developments. Guidance on what developments should take place in each zone is given in Environment Agency Groundwater Protection Policy (currently being updated).

3.5 Data Limitations

There were a number of limitations to the data collection process:

- Flood Risk: No Strategic Flood Risk Assessment available
- Water supply: Sensitivity issues preventing Anglian Water release data
- Wastewater: Sewer capacities information not available

3.5.1 Flood Risk & Hydrology

The Water Cycle Study is intended to be undertaken in conjunction with the Strategic Flood Risk Assessment, and as outlined in Section 1.2.2 they are intended to inform each other. However, at the time of writing the Strategic Flood Risk Assessment was not available for consultation hence a number of assumptions were made:

- The floodplain extents used were obtained from the Environment Agency and any modifications undertaken within the Strategic Flood Risk Assessment will not be included in this Water Cycle Study. It is suggested that this is incorporated into Stage 2 of the Water Cycle Study;
- There is no information pertaining to the functional floodplain (1 in 20 year return period);
- There is no information pertaining to the proposed wide scale uses of SUDS, such as balancing ponds or attenuation schemes.
- Information relating to any foul water flooding was deemed to be sensitive by AWS, and as such has not been made available for this study.

It is assumed that these datasets will be available in Stage 2 of the Water Cycle Study.

3.5.2 Water Resources and Supply

Data on local water supply infrastructure was not available, However AWS have provided outline information on adequacy of water resources. In addition, information on required water supply infrastructure improvements for specific areas that AWS have already reviewed was also made available.

3.5.3 Wastewater Drainage and Treatment

Some of the data that was required for the study was deemed by AWS to be commercially sensitive, and has not therefore been included in this report. It is recommended that on commencement of Stage 2 of this Study, discussions should be held with AWS to confirm which additional data would be made available.

3.5.4 Environmental

Inevitably, the need to rely on existing data has required the assessment process to err on the side of caution, such that the evaluation is essentially a risk assessment, determining whether there are likely to be significant adverse effects on site (particularly European sites) as a result

of the Water Cycle Study. It is possible that these impacts may be able to be investigated in greater detail during Stage 2 of Study development.