3 Develop Cost Schedule

As discussed in Section 2, the purpose of stage 2a is to provide sufficient information to feed into the Issues and Options objectives in the JCS. The intention in developing the cost schedule is to provide an objective costing exercise for each of the PGAs and to identify the cost of the infrastructure necessary to provide the PDSs for each of them. The costs have been identified in the following areas:

- Wastewater transmission and treatment;
- Water transmission;
- Water resources;
- Flood defence; and
- Environmental.

In some instances it was not possible for costing to be carried out; hence in order to provide a *relative* comparison between sites, a traffic light system was used. An explanation of the traffic lights is provided where appropriate; however it is important to note that:-

A red traffic light does not necessarily mean that development cannot be progressed, it is intended to identify that there <u>may</u> be issues associated with development which will require further investigation.

In order to undertake the costing, a number of assumptions needed to be made. These are outlined in Sections 3.1 to 3.5 below. The assumptions were considered necessary to progress Stage 2a and intended to eliminate detailed issues and decisions which may add complications to what is essentially a strategic document. The assumptions have been collated by the design team and draw from their own experiences on other projects, as well as discussions with stakeholders (such as AWS, Environment Agency and Natural England). The reason for each of the assumptions has been provided in italics.

Assumption I: PGAs

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

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

3.1 Wastewater Treatment and Network

3.1.1 Assumptions

The assumptions relevant to the formulation of the wastewater strategy options include:

Assumption II: There is no spare capacity in the network

In line with AWS stance the costs exercise assumes that there is no spare capacity in the wastewater drainage network. Any spare capacity that may be available will be used to provide capacity for:

- Changes in flow due to the impacts of climate change on rainfall patterns;
- Additional flow from in-fill development within the existing developed areas.

Reason: Current AWS position (broadly confirmed by Scott Wilson independent analysis).

Assumption III: New infrastructure

It is assumed that because of Assumption II, all new development within the PGAs will require new wastewater drainage network infrastructure to be provided. It is assumed that there is sufficient capacity for infill development. All infrastructure will be designed to appropriate standards (e.g. Sewers for Adoption).

Reason: PGAs may not necessarily have existing infrastructure

Assumption IV: Optimise existing process capacity

There are a number of WWTW which have existing volumetric headroom within them. It is therefore assumed that these existing capacities will be optimised, where possible and practical, before providing new infrastructure. This is for a number of reasons:

- It is considered most cost-efficient and responsible to optimise these in the first instance;
- The lead-in time for construction of new WWTW is approximately 10-15 years[6]. Therefore, optimising the existing capacity will ensure that phasing of the development can take place (to be reviewed in **Stage 2b**).

Reason: This is considered to be best practice and optimises existing efficiency.

Assumption V: Meeting Standards

It is assumed that any new infrastructure, and in particular WWTW, will be designed and built to meet all necessary water quality standards for receiving watercourses. This is particularly relevant to phosphate, BOD and SS with the effluent discharge. Although the RoC have not yet been finalised, it is assumed that regardless of the consent conditions, as well as those imposed under the WFD, the WWTW will be required to accommodate these as a matter of course.

Reason: This is considered to be conservative in the absence of RoC conclusions.

Assumption VI: Pipe Network Costs

The cost estimate of the sewer network only includes main trunk sewers required from the PGA to the WWTW. It is assumed that the cost of collector sewer networks within the new development themselves will be covered by the individual developer.

Reason: For a strategic document this level of costing is considered to be appropriate.

3.1.2 Strategy Options

There are a number of broad options which have been costed for the provision of wastewater treatment for flows from the various PGAs. All of these options were applied to the different PGAs so that a costs comparison based on identical parameters could be made.

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

NPA

Option 1: Whitlingham WWTW

All of the NPA PGAs have been costed for their wastewater to go to Whitlingham WWTW. The following elements have been considered for costing:

- There are no significant costs for volumetric upgrade as it is understood there is spare headroom capacity;
- Nutrient load removal for the additional load to Whitlingham WWTW;
- The sewer required from the PGA to Whitlingham WWTW.

Option 2: Upgrade Existing WWTW

Where an alternative to Whitlingham WWTW is in the vicinity of a growth location (and wastewater from the region is currently treated there in some cases), the cost of upgrade of this WWTW to accommodate the additional flow has been undertaken. It is considered that any existing significant headroom in the existing WWTW would be utilised in the first instance and that the upgrade of the WWTW would be determined by the residual numbers on a pro rata basis. For the purposes of Stage 2a, it is assumed that the cost of an upgrade is equivalent to the cost of a new WWTW. Alternative WWTWs and the available headroom are outlined in Appendix G – only Wymondham, Swardeston and Long Stratton WWTWs are considered to have significant headroom to utilise.

Option 3: New WWTW

The cost of siting a new WWTW within the PGA was undertaken which considered the following:

- The cost of providing a WWTW with the capacity to receive all of the flow from the PGA;
- As per Assumption V, all of the final effluent from a new WWTW will be of an environmentally acceptable standard;
- The WWTW will be situated within the PGA, hence the cost of strategic trunk sewers was assumed to be zero.

RPA

Most of the RPA areas have a small WWTW associated with it. These are identified in Appendix G. The options available for the provision of WWTW in the RPA are outlined below:

Option 1: Upgrade Existing WWTW

Where the WWTW has existing headroom capacity this will be maximised in the first instance. The cost of providing additional treatment capacity has been calculated as a pro rata. If it is considered that the headroom is not significant in relation to the required capacity (e.g. Acle-Damgate WWTW ~ 141) it is assumed that there is no headroom. Costs considered include:

- There are no costs associated with maximising the volumetric headroom;
- Nutrient removal has been costed for the existing headroom capacity;
- The sewer network required from WWTW to the centre of the PGA.

3.1.3 Cost Mechanism

The cost mechanisms for providing wastewater treatment and network have been based on industry standard techniques and have been bench marked to a number of built schemes which have been carried out recently. The costs are made up of the following:

Table 3-1: Items included in and excluded from costs

Included in costs	Excluded from costs
Cost of trunk water main	Land purchase
Cost of trunk sewers	Legal fees
Water Pump stations	Design fees
Wastewater pump stations	Landscaping
NPV of energy costs for running pumping mains and pumped sewers	Temporary works
Maintenance costs for pumped mains (applied as a percentage of energy costs)	Ecological/EIA related
WWTW	Archaeological
	Planning supervisor costs
	Pre-construction costs (e.g. survey)
	OPEX costs (except NPV of energy costs)
	Service reservoirs

New WWTW

The cost of new WWTWs for varying development sizes have been estimated and are provided in Table 3-2 below.

Table 3-2: AWS Provided Approximate Cost Categories for new WWTW

PDS	Approximate Cost (£)
100	500,000
500	1,650,000
1,000	3,250,000
2,000	10,200,000
5,000	13,500,000
10,000	18,000,000
15,000	22,300,000
20,000	27,000,000

In reference to Table 3-2 above, the following should be noted:

- Costing of wastewater treatment works has been based on all new works serving 1,000 properties and less as being package WWTW.

- The costs for WWTWs serving more than 1,000 properties are based on an Activated Sludge (AS) process.
- Only sludge thickening and storage is included in the cost. i.e. sludge treatment and disposal is not included.

Upgrading Existing WWTW

Volumetric

The existing volumetric headroom in Whitlingham WWTW is approximately 109,000PE, which equates to approximately 52,000 properties. It was therefore assumed that there would be no significant costs associated with utilising the volumetric capacity of the WWTW (ignoring possible process capacity limitations).

Nutrient Removal

The cost of providing additional nutrient removal at existing WWTWs is based on standard costs as published by OFWAT in its report titled 'Capital works unit costs in the water industry: Feedback on our analysis of March 2003 water company cost base submissions May 2003.' These standard costs have been adjusted as follows:

- Increase by 50% to allow for other project costs incurred by water company;
- Applied a further 50% increase to account for non standard site conditions.
- Indexed to allow for inflation to 2008.

It is acknowledged that the cost of providing additional nutrient removal will vary from one existing WWTWs to another depending on the nature of the existing works or process and the required standard in the receiving watercourse. Assessing the details of existing treatment WWTWs processes is however beyond the scope of this report and may be addressed in **Stage 2b**.

Table 3-3 below illustrates how the capital cost of providing additional nutrient removal has been estimated for the various development sizes. This is based on:

BOD (kg/day)/PE	0.06
Unit Cost (£/kg)	1,053

Table 3-3: Approximate Costs of Nutrient Removal

PDS	Cost (£)
100	20,000
500	70,000
1,000	140,000
2,000	270,000
5,000	670,000
10,000	1,340,000
15,000	2,000,000
20,000	2,670,000

Sewerage Network

Table 3-4 below shows the estimated unit cost of trunk sewers of varying sizes.

Table 3-4: Sewerage network unit costs

	Rising Mains		Gravity Sewers	
PDS	Pipe Size (mm)	Cost (£/m)	Pipe Size (mm)	Cost (£/m)
100	100	224	150	323
500	100	232	150	323
1,000	150	262	225	373
2,000	150	292	300	452
5,000	250	375	375	524
10,000	350	519	525	637
15,000	450	734	600	681
20,000	500	845	600	681

The unit cost for sewer rising mains comprises capital cost plus a component of the present value of operating costs over a 25 year period.

In estimating the operating costs, the following parameters have been assumed:

- Hydraulic roughness (K_s) of pipes is 0.003mm;
- A static lift of 10m over a rising main length of 1km;
- Pumping efficiency is 75%;
- Rising Main is operational for 18 hours a day;
- Energy cost is 10 pence per kilowatt hour;
- Annual maintenance cost is roughly equal to 5% of the annual energy cost;
- Discount Rate is 5.34%.

These unit prices per m were then applied to the distances from the WWTW to the centre of the PGAs. The alignments of the sewers were measured along existing infrastructure lines (e.g. roads and railways) within the NPA areas to minimise disruption of the existing development. However, in the RPA the existing infrastructure line were used where possible and thereafter the most direct line was assumed in order to minimise costs.

WWTW Pumping Stations

Cost estimates have been bench marked against recent projects that have undertaken and costs per pumped distance outlined in Table 3-5 below.

Table 3-5: Wastewater Pump Station approximate costs

PDS	Installed Power (kW)	Cost (£/km of pumped distance)
100	0.3	40,000
500	2.0	60,000
1,000	3.3	70,000
2,000	9.6	100,000
5,000	18.3	140,000
10,000	33.7	190,000
15,000	46.8	240,000
20,000	62.6	290,000

3.2 Water Supply and Distribution

3.2.1 Assumptions

The assumptions relevant to the formulation of the water supply strategy options include:

Assumption VII: New Infrastructure

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

Reason: Current AWS position.

Assumption VIII: Heigham WTW

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

Reason: This method enables a like-for-like comparison and costs exercise and is considered appropriate at a strategic level. This is based on the AWS position that there are no water supply issues in the region.

3.2.2 Strategy Options

The mechanism for water supply is that all existing and new water resources will be directed to Heigham WTW and distributed from there to the PGAs.

3.2.3 Cost Mechanism

Water Treatment Works

As per Assumption VIII, there are no additional costs associated with Heigham WTW.

Trunk Mains

The cost of providing water supply mains were obtained from OFWAT tables (based on 2003 prices) and scaled up accordingly for 2008 prices These are shown in Table 3-6 below.

Table 3-6: Approximate Costs of Water Supply Network

PDS	PPE Pipe Size (mm)	Cost (£/m)
100	110	223
500	110	225
1,000	110	229
2,000	110	241
5,000	180	280
10,000	250	351
15,000	315	411
20,000	355	473

The unit cost for water mains comprises capital cost plus a component of the present value of operating costs over a 25 year period.

These unit prices were applied to the distances from the WTW to the centre of the PGAs. The alignments of the water mains were measured along existing infrastructure lines (e.g. roads and railways) within the NPA areas to minimise disruption of the existing development. However, in the RPA the existing infrastructure line were used where possible and thereafter the most direct line was assumed in order to minimise costs.

Water pumping costs

Cost estimates have been bench marked against recent projects that have undertaken and costs per pumped distance outlined in Table 3-7 below. These costs are additional to the trunk main costs outlined below and do not represent “double counting”.

Table 3-7: Approximate Pumping Station Costs

PDS	Capacity of Pump Stn (Ml/d)	Cost (£/km of Pumped distance)
100	0.03	80,000
500	0.16	100,000
1,000	0.32	120,000
2,000	0.64	140,000
5,000	1.61	180,000
10,000	3.22	230,000
15,000	4.83	260,000
20,000	6.44	290,000

These unit prices were applied to the distances from the WTW to the centre of the PGAs. The alignments of the water mains were measured along existing infrastructure lines (e.g. roads and railways) within the NPA areas to minimise disruption of the existing development. However, in the RPA the existing infrastructure line were used where possible and thereafter the most direct line was assumed in order to minimise costs.

3.3 Water Resources

3.3.1 Assumptions

The assumptions relevant to the formulation of the water resources strategy options include:

Assumption IX: Heigham WTW

It is assumed that all new water resources will be directed to Heigham WTW, and thereafter distributed to the potential growth sites.

Reason: This provides a single point from which to costs water supply rather than second guess the water resource detailed design. This has been agreed with AWS as the most reasonable option.

3.3.2 Strategy Options

Different sources of water resources to the study area have been considered and are described below. Although some of these are reflected in AWS Draft Water Resource management Plan (WRMP), there are additional options which have been included; in keeping with the competition commission, the preferred water supplier for a growth area cannot be assumed and as such options not considered in AWS's draft WRMP Have been included in Stage 2a.

Maximise existing borehole licences

There are a number of boreholes within the study areas which have existing capacity associated within their licensed abstraction volumes. These include Costessey AP, Thorpe St Andrews and Colney. As Costessey AP has associated low flow issues as described in the RoC, this will not be progressed; however the licences at Thorpe St Andrews and Colney, both of which have approximately 4Ml/day (totalling 8Ml/day) spare capacity, will be prioritised, in order to:

- Minimise the reliance on new water resources from outside of the study area;
- Provide water resource options for the initial phases of development (whilst strategic options are being investigated/implemented).

The identified 8 Ml/d is sufficient to supply up to 21,000[7] new homes, therefore:

- In order to provide sufficient water to the NPA *both* of these boreholes will need to be maximised and hence costs associated with this have been undertaken;
- In order to provide sufficient water to the RPA *only one* of these boreholes will need to be maximised and hence costs associated with the *closest* borehole to the RPA PGA has been undertaken

[7] Based on an average occupancy rate of 2.1, a water usage of 128 l/h/d and an extra allowance for mains leakage/ customer supply pipe leakage/operational losses etc.

River Wensum Reuse

It is assumed that the River Wensum has no spare capacity for abstraction because there are existing low flows issues associated with it, especially during droughts, which have significant ecological impacts on Wensum SAC. The River Wensum is designated as an SAC throughout its length adjacent to Costessey AP and this issue is being addressed through the RoC process.

The option of re-using the River Wensum water within the catchment has been considered and costed up below. It would involve the pumping of treated effluent from Whitlingham WWTW back up the River Wensum catchment and discharging downstream of Costessey AP. In order to minimise the impact on the existing ecology, it is assumed that only the additional discharge from Whitlingham WWTW (from the PGAs) will be re-used. This would be equivalent to a maximum of 44,500 properties from the NPA area[8]. This means that the existing discharge from the WWTW will remain downstream of WWTW. It is intended that this option will maximise the re-use of water and reduce the need for importation of water resource from outside of the catchment. The associated costs are outlined below:

AWS draft WRMP states the following:

> *We have considered the potential for the local re-use of water currently discharged to the tidal reaches of the River Yare at Whitlingham. The re-use option would require the transfer of part of this discharge, arising from the growth of Norwich, to be piped for discharge downstream of the river intake west of the city. The discharge would augment the flow in the River Wensum and enable the quantity of river water abstracted at our intake to be increased.*

This approach may be possible in all river systems but is likely to occur, if at all, in the River Yare and River Wensum systems.

Great Ouse Groundwater Development Scheme (GOGDS)

The GOGDS has been identified in the Draft WRMP and involves the transfer of treated groundwater to the south of the study area via the Thetford catchment area. The Draft WRMP has estimated that up to 12.3Ml/d may be available from this scheme.

Water resource storage

Water resource storage involves the abstraction and subsequent retention of water in storage basins during periods of high flows and the discharge of this water back into the river system during periods of low flows. This will ensure that the effects of abstraction are not significant during low flow periods by providing a constant base flow through the river system. There are two main ways that this can be achieved:

- On-line storage whereby a dam is constructed across the watercourse. This will retain water upstream of the structure and a control mechanism will allow sufficient water to flow down the watercourse. Such a scheme is likely to be strongly opposed as the site is a designated SAC and is therefore discounted as a viable option.
- Off-line storage, whereby water is taken from the watercourse by means of a gate, spillway or pipe, into an adjacent area which will store the water, until it is returned to the watercourse. This type of storage already exists at Costessey AP alongside the River Wensum but on a smaller scale.

[8] None of the RPA wastewater is proposed to go to Whitlingham WWTW.

3.3.3 Cost Mechanism

Maximise existing borehole licences

It is assumed that the cost of maximising the boreholes will only include the costs of the new distribution infrastructure and associated pumping costs. These costs are based on the unit costs for pipe network and pumping costs and it is assumed that the pipework is directed through Heigham WTW first before being piped to the PGA. These are summarised below:

Table 3-8: Approximate unit costs for Water Supply Network

PDS	PPE Pipe Size (mm)	Cost (£/m)	Capacity of Pump Stn (Ml/d)	Cost (£/km of Pumped distance)
100	110	223	0.03	80,000
500	110	225	0.16	100,000
1,000	110	229	0.32	120,000
2,000	110	241	0.64	140,000
5,000	180	280	1.61	180,000
10,000	250	351	3.22	230,000
15,000	315	411	4.83	260,000
20,000	355	473	6.44	290,000

The costs of the pipe and pumps were applied to the distance of the PGA to Heigham WTW to provide an overall cost.

River Wensum Reuse

A number of assumptions have been made and the costs structure shown in Table 3-9and below:

- It has been assumed that only 90% of the additional wastewater would be recycled because of losses;
- It is assumed that the treated effluent is discharged to a point downstream of the Costessey AP intakes;
- The costs of pipeline and pumps are based on those outlined in Section 3.2.3

Table 3-9: Approximate Costs of Wensum Reuse

PDS	PPE Pipe Size (mm)	Capacity of Pump Stn (Ml/d)	Cost (£)
100	110	0.03	6,100,000
500	110	0.16	6,500,000
1,000	110	0.32	6,900,000
2,000	110	0.64	7,700,000
5,000	180	1.61	9,200,000
10,000	250	3.22	11,600,000
15,000	315	4.83	13,300,000
20,000	355	6.44	15,300,000

The costs of the pipe and pumps were applied to the distance of the PGA to Heigham WTW to provide an overall cost.

Great Ouse Groundwater Development Scheme (GOGDS)

For the purpose of Stage 2a, and in the absence of detailed cost estimated from AWS, a number of factors have been considered during the costing of the GOGDS. These are outlined below and the approximate costing shown in Table 3-10:

- The scheme has been costed within the parameters; hence it is considered that there *will be additional costs associated with this scheme which are outside of the study area. Therefore, the costs for this option are from Heigham WTW only*
- It is understood that the water transfer will be from the area to the south of the study area and it is assumed that all water will be piped directly to Heigham WTW, and then to the PGAs. The costs are based on the costs outlined in Section 3.2.3 for pipe network and pumping costs.

Table 3-10: Approximate unit costs of GOGDS

PDS	PPE Pipe Size (mm)	Cost (£/m)	Capacity of Pump Stn (Ml/d)	Cost (£/km of Pumped distance)
100	110	223	0.03	80,000
500	110	225	0.16	100,000
1,000	110	229	0.32	120,000
2,000	110	241	0.64	140,000
5,000	180	280	1.61	180,000
10,000	250	351	3.22	230,000
15,000	315	411	4.83	260,000
20,000	355	473	6.44	290,000

The costs of the pipe and pumps were applied to the distance of the PGA to Heigham WTW to provide an overall cost.

Water resource storage

Although it is considered that this is may be an appropriate option for the River Wensum, it has not been considered in the draft WRMP. It is also recognised that as this option may have adverse ecological impacts on the watercourse and that the watercourse along a considerable length is a designated SAC, a full comparison of the benefits and dis-benefits will need to be undertaken to inform the decision-making process. The costs of any mitigation required are not taken account in this assessment. Approximate costs of the off-line storage option are outlined below.

Table 3-11: Off-line Storage Costs base costs

Reference	Unit	Total
Yield	(Ml/day)	6
Total Volume of storage	(m3/year)	2,190,000
Excavation Costs)	£20/m3	43,800,000
Civils Cost	20%	8,760,000
Structural Cost	20%	8,760,000
Other Cost	10%	4,380,000
Area of Land (m2)	Ave 2m depth	1,095,000
Cost of Land	£50,000/ha	5,475,000
Environmental Mitigation	£1M/Ml	6,000,000
TOTAL	£ (44,500)	77,175,000

The base costs were calculated on a PDS of 44,500 (the maximum NPA) and have been estimated to the various PDS by pro rata.

Table 3-12: Approximate costs of Offline Storage

PDS	Cost (£)
100	200,000
500	900,000
1,000	1,800,000
2,000	3,500,000
5,000	8,700,000
10,000	17,400,000
15,000	26,100,000
20,000	34,700,000

3.4 Flood Risk

3.4.1 Assumptions

The assumptions relevant to the environmental aspects of the study include:

Assumption X: Development and Flood Risk

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

Reason: This is considered best practice, especially in the absence of confirmed accurate PGAs.

3.4.2 Cost Mechanism

Costs for flood defence were not considered to be appropriate at this stage. This is for a number of reasons:

- The PGAs which were identified by the GNDP are not considered to be accurate therefore it is not known what length of flood defence is required. It is also conceivable that for areas that contain an element of flood zone 2 or 3, that development within the PGA can be proposed such that it is located outside of the high flood risk areas
- The type of housing densities is not yet known. This will determine the amount of land required to provide the necessary development. For instance, 2,000 dwellings which are incorporated into high rise buildings may cover considerably less than 2,000 detached properties;
- The preferred type of flood defence is unknown. As options for flood defence vary considerably and can be provided within the catchment or adjacent to the development, it is considered that costing these was not plausible;
- The standard of service of the flood defence is unknown, and although it is assumed that it will be in the order of a 1 in 100 year standard, it may be that either a higher or lower standard is required;
- The ambiguity of the extent of the PGAs means that land ownership issues cannot be considered. These may have significant financial implications, which depending on the location of the proposed defences, may skew the costing disproportionately;

Despite this, the impact of flood risk will need to be included in the selection of the preferred options, and will need to be represented across the assessment. Therefore, instead of a monetary cost the flood risk issues associated with each PGA have been given a traffic light in relation to a number of flood risk related considerations. These are:

Flood Risk *to* the Potential Development Area

The proportion of the total potential development area which is considered to be at risk from the medium (1 in 1000 year) and high (1 in 100 year) return period (flood zones 2 and 3 respectively) was assessed and traffic lights assigned accordingly. These are outlined below:

Table 3-13: Traffic lights associated with flood risk *to* the potential development area

Traffic Light	Description
	<10% of PGA in Flood Zone 2 or 3
	10-25% of PGA in Flood Zone 2 or 3
	>25% of PGA in Flood Zone 2 or 3

It is important to note that the PGAs are indicative only and so the traffic lights associated with them related to the indicative areas. Once the areas have been identified in more detail, flood risk to the site will need to be undertaken as part of a site specific detailed flood risk assessment.

Flood Risk *from* the Potential Development Area

The flood risk from the development was assessed by identifying the receiving WWTW for each PGA under the different wastewater strategy options (outlined in Section 3.1.2) and ascertaining the impacts from the additional discharge to both conservation sites and existing development sites. The assessment was undertaken using aerial photography and available GIS mapping to identify the WWTW and receiving watercourse and compare it to the downstream conservation sites and existing development sites. The appropriate traffic lights are outlined below:

Table 3-14: Traffic lights associated with flood risk *from the* potential development area to existing developed areas or ecological area

Traffic Light	Description
Green	If there are additional potential sources between the discharge point and existing developed area or conservation site, but it is likely that natural processes will reduce the effect of the additional discharge.
Amber	If there are no additional potential sources between the discharge point and existing developed area or conservation site, but it is likely that natural processes will reduce the effect of the additional discharge.
Red	If there are no additional potential sources between the discharge point and existing developed area or conservation site, and it is likely that natural processes are not likely to reduce the effect of the additional discharge.

These criteria were applied to each of the discharge points from the WWTW within the study area and are summarised below.

WWTW Ref	Traffic Light
Whitlingham WWTW	Receiving watercourse is tidal (Amber)
Rackheath WWTW	Other watercourse enter before ecological or existing development areas (Green)
Poringland WWTW	Other watercourse enter before ecological or existing development areas (Green)
Stoke Holy Cross WWTW	Receiving watercourse flows into River Yare before any ecological or existing development sites (Green)
Swardeston WWTW	Receiving watercourse flows into River Yare before any ecological or existing development sites (Green)
Long Stratton WWTW	Receiving watercourse flows into River Tas before any ecological or existing development sites (Green)
Wymondham WWTW	Receiving watercourse flows into River Tiffey before any ecological or existing development sites (Green)
Reepham WWTW	Receiving watercourse (Blackwell Ditch) flows into River Wensum before any ecological or existing development sites (Green)
Aylsham WWTW	There WWTW discharges directly into the River Bure, however there are no ecological or existing development adjacent to the River Bure (Amber)
Belaugh WWTW	The WWTW discharges directly into the River Bure and Hoveton lies directly downstream, however it is tidal in this reach. (Amber)
Acle-Damgate WWTW	The WWTW discharges directly into the River Bure which is tidal in this reach, however it forms part of The Broads. (Amber)
Wymondham WWTW	There WWTW discharges directly into the River Tiffey, however there are no ecological or existing development sites downstream before the River Tiffey joins the River Yare. (Green)
Diss WWTW	The WWTW discharges directly into the River Waveney, and although there are no ecological sites, there is existing development adjacent to the River Waveney. (Red)
Harleston WWTW	There are a number of minor settlements downstream of the WWTW; however there are no ecological sites. (Amber)
Sisland WWTW	There are no existing developments downstream of the site before it flows into the River Chet, and the watercourse is tidal just downstream of the WWTW, however there is a SAC located downstream. (Amber)

It is important to note that this assessment of the flood risk from the site does not include the risk generated by increase in impermeable surfaces post-development. These should be addressed using appropriate sustainable drainage systems (SUDS and addressed in detailed studies such as flood risk assessments).

Sustainable Drainage Systems (SUDS)

The suitability of SUDS is represented in a traffic light format and has been obtained using information contained within the SFRA[9]. For each of the PGAs the SFRA provide a description of the suitability of SUDS. The accompanying maps are shown in Appendix H. The traffic lights contained within the SFRA which accompany the suitability of the SUDS are described in Table 3-15 below.

Table 3-15: Suitability of SUDS traffic light (from SFRA)

Traffic Light	Description
Green	SUDS suitability is 'good' based on 'good' infiltration capacity of soils
Amber	SUDS suitability is 'average' based on 'average' infiltration capacity of soils
Red	SUDS suitability is 'poor' based on 'poor' infiltration capacity of soils

3.5 Environmental

3.5.1 Assumptions

The assumptions relevant to the environmental aspects of the study include:

Assumption XI: Phosphate levels

It is understood that current phosphate levels in The Broads is considered to be excessive. This is partly due to the phosphate loads which are carried there via the rivers in the area, such as the Yare, Wensum, Tiffey, Stone Beck and Waveney. Therefore, it is assumed that despite the current phosphate levels being an environmental concern, all new discharge into the receiving

[9] Obtained in GIS format and hard copy from Millard Consulting Engineers

watercourses will meet the necessary conditions, and will therefore not exacerbate any existing problems.

Reason: This is a conservative approach which will not increase phosphate loads above the current standard. In the absence of the RoC this is considered to be best practice.

3.5.2 Cost Mechanism

It is acknowledged that all development will need to be progressed through the planning system, and part of this may be to undertake either site specific planning applications, which will be reviewed by the planning authority; or if wider scale development options are preferred, then an Environment Impact Assessment (EIA). It is therefore considered that all development will require environmental considerations and, as such, the costs of maintaining or sustaining the environmental equilibrium will be included into this.

Therefore, instead of a monetary cost the environmental issues associated with each PGA have been given a traffic light in relation to a number of environmental considerations. The key potential impacts on the environment that require consideration are:

Conservation Designation

The proximity of a conservation designation *within* the PGA or *downstream* of the PGA (hence is hydrologically linked) is considered in Table 3-16.

Table 3-16: Designated conservation[10] area related traffic lights

Traffic Light	Description
(green)	No sites within or downstream
(amber)	Either a site within or downstream
(red)	Both a site within and downstream

Groundwater Vulnerability

The entire area around Norwich is designated as a Major Aquifer and leaching potential categories are all sub-sets of the Major Aquifer category. The leaching potential (LP) of the underlying rock was identified from the Environment Agency's Groundwater Vulnerability Sheet No. 26. This LP is classified into low, medium and high and is given green, amber and red traffic lights respectively. A high LP means that the underlying aquifer is more susceptible to pollution threat via infiltration.

Table 3-17: LP related traffic lights

Traffic Light	Description
(green)	Low LP
(amber)	Intermediate LP
(red)	High LP

Groundwater Source Protection Zones (SPZ) Vulnerability

The proximity of a SPZ around the major public water supply abstraction points has also been taken account of for each of the PGAs. The source for this information has been the Environment Agency SPZ Maps published on their website. Zone 1 represents a close proximity of the major public abstraction point source to the PGA, hence a higher risk of contamination to the underlying aquifer.

Table 3-18: SPZ related traffic lights

Traffic Light	Description
(green)	Zone 3
(amber)	Zone 2
(red)	Zone 1

3.6 PGA Assessment

Section 4 outlines the approximate costs associated with providing the PDS for each of the PGAs, as well as providing the proposed infrastructure routes shown on a site-by-site basis. A plan of each of the areas and the proposed infrastructure has been included for reference within these sections.

[10] Including SPA, SAC and SSSI