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Colchester Borough Council Water Cycle Study

Final Report

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AMP	Asset Management Plan
AWS	Anglian Water Services
BAP	Biodiversity Action Plan
BGS	British Geological Society
BOD	Biochemical Oxygen Demand
BREEAM	Building Research Establishment Environmental Assessment Method
CAMS	Catchment Abstraction Management Strategy
CBA	Cost Benefit Analysis
CFMP	Catchment Flood Management Plan
CIL	Community Infrastructure Levy
CIRIA	Construction Industry Research and Information Association
CLG	Communities and Local Government
DEFRA	Department for Environment, Food and Rural Affairs
DWF	Dry Weather Flow
EA	Environment Agency
EFI	Environmental Flow Indicator
GI	Green Infrastructure
GWR	Greywater Recycling
l/h/d	Litres/head/day (a water consumption measurement)
LCT	Limits of Conventional Treatment
LDF	Local Development Framework
LFE	Low Flow Enterprise (low flow model)
LLFA	Lead Local Flood Authority
LNR	Local Nature Reserve
LPA	Local Planning Authority
Ml	Mega Litre (a million litres)
NE	Natural England
NPPF	National Planning Policy Framework
OAHN	Objectively Assessed Housing Needs
OFWAT	The Water Services Regulation Authority (formerly the Office of Water Services)
OR	Occupancy Rate
P	Phosphorous
PE	Population Equivalent
Q95	The river flow exceeded 95% of the time
RAG	Red/Amber/Green Assessment
RBMP	River Basin Management Plan
RoC	Review of Consents (under the Habitats Directive)
RQP	River Quality Planning (tool)
RWH	Rainwater Harvesting
S106	Section 106 (Town and Country Planning Act 1990)
SAC	Special Area for Conservation
SFRA	Strategic Flood Risk Assessment
SPA	Special Protection Area
SPD	Supplementary Planning Document
SPZ	Source Protection Zone
SSSI	Site of Special Scientific Interest
SUDS	Sustainable Drainage Systems
SWMP	Surface Water Management Plan
UKTAG	United Kingdom Technical Advisory Group (to the WFD)
UKWIR	United Kingdom Water Industry Research group
UWWTD	Urban Wastewater Treatment Directive
WCS	Water Cycle Study
WFD	Water Framework Directive
WN	Water Neutrality
WRMP	Water Resource Management Plan
WRMU	Water Resource Management Unit (in relation to CAMS)
WRZ	Water Resource Zone (in relation to a water company's WRMP)
WSI	Water Services Infrastructure
WRC	Water Recycling Centre

Non-Technical Summary

Colchester Borough Council is expected to experience significant growth, particularly in relation to domestic redevelopment over the period to 2033. This growth represents a challenge in ensuring that both the water environment and water services infrastructure has the capacity to sustain this level of growth and development proposed.

This Colchester Borough Council Water Cycle Study (WCS) update forms an important part of the evidence base that will help Colchester Borough Council determine the most appropriate options for development within the Borough (with respect to water infrastructure and the water environment) to be identified in the Council's New Local Plan (2017 to 2033).

The planned future growth across Colchester Borough, including the proposed 'garden communities ' to the west and east of Colchester, have been assessed with regards to water supply capacity, sewage capacity, any water quality issues and infrastructure upgrades that may be required to identify any potential constraints to the water cycle which such development may pose, This WCS update then provides information at a level suitable to demonstrate that there are workable solutions to key constraints to deliver growth for the preferred development allocations, including recommendations on the policy required to deliver it.

An updated Water Cycle Strategy is presented for the Borough as a whole and for each of the new Local Plan Preferred Sites.

Wastewater Strategy

Wastewater Treatment

The WCS identifies that one Water Recycling Centre (WRC) does not have sufficient capacity to accommodate additional wastewater from the proposed increase in development within the WRC catchment.

The phasing of developments draining to Langham (East) WRC will need to be discussed between the Environment Agency, Colchester Borough Council and Anglian Water. The WRC is shown to already be exceeding its current flow permit with current housing, and results from this WCS indicate that the WRC is over performing in terms of the level of wastewater treatment provided, as the improvements required would require advanced treatment technologies beyond what is considered within the water industry and by the Environment Agency to be conventional technology.

Despite the over performance of the WRC, a solution may still need to be identified by the Environment Agency and Anglian Water in order to accommodate growth at the WRC to ensure that the increase in treated wastewater discharged does not impact on the current quality of the receiving watercourse, the associated ecological sites and to ensure that the watercourse can still meet with legislative requirements.

The WCS has concluded that the study partners, including Colchester Borough Council, the Environment Agency, and Anglian Water Services should work together to determine if the potential solution proposed in this WCS is acceptable and hence conclude if the proposed development within the Langham (East) WRC catchment can be accommodated.

Water Supply Strategy

Based in the growth assessed, the WCS has concluded that, allowing for the planned resource management of AWS' South Essex Resource Zone, Colchester would have adequate water supply to cater for growth over the plan period.

However, the WCS has identified that there are long term limitations on further abstraction from the raw water resources supplying the Borough and that there is a drive to ensure the delivery of sustainable development for Colchester. Hence there are key drivers requiring that water demand is managed in the study area for all new development in order to achieve long term sustainability in terms of water resources.

In order to reduce reliance on raw water supplies from rivers and aquifers, the WCS has set out ways in which demand for water as a result of development can be minimised without incurring excessive costs or resulting in unacceptable increases in energy use. In addition, the assessment has considered how far development in the Borough can be moved towards achieving a theoretical 'water neutral' position i.e. that there is no net increase in water demand

between the current use and after development across the plan period has taken place. A pathway for achieving neutrality as far as practicable has been set out, including advice on:

- what measures need to be taken technologically to deliver more water efficient development;
- what local policies need to be developed to set the framework for reduced water use through development control;
- how measures to achieve reduced water use in existing and new development can be funded; and
- where parties with a shared interest in reducing water demand need to work together to provide education and awareness initiatives to local communities to ensure that people and business in the Borough understand the importance of using water wisely.

Five water neutrality scenarios have been proposed and assessed to demonstrate what is required to achieve different levels of neutrality in the Borough. The assessment concluded that measures should be taken to deliver the first step on the neutrality pathway by implementing the medium scenario, which would require a significant level of funding and joint partnership working. The following initial measures are therefore suggested by the WCS:

- Ensure all housing is water efficient, with new housing development meets the mandatory national standard as set out in the Building Regulations;
- Carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings. Aim to move towards delivery of 25% of the existing housing stock, with easy fit water saving devices; and;
- Establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

Water Cycle Strategy Recommendations and Policy

The WCS should also set out recommendations for what is required, when, and where in order to address any emerging issues from investigating the key questions. These recommendations must take account of the likely phasing of development, potential environmental impacts, and the availability of funding and future management arrangements.

In order to support the further development of Colchester's new Local Plan with respect to water services infrastructure and the water environment, the WCS provides a site specific assessment of the potential constraints on each of the proposed major development sites.

It is recommended that policies are developed similar to those suggested in the WCS to include within each of the Local Plan documents.

1 Introduction

1.1 Background

Colchester is a large urban area located in the County of Essex. The administrative area of Colchester Borough Council covers Colchester town centre in addition to a number of surrounding villages including Abberton, Birch, Great Horkesley, West Bergholt, Tiptree and Mersea Island. Colchester contains both fluvial and tidal watercourses.

Colchester Borough Council was identified as a major growth area, particularly in relation to domestic redevelopment, as identified within the Haven Gateway Water Cycle Study (2008). This updated Water Cycle Study (WCS) is an important part of the evidence base that will help to identify sites with the potential for development throughout the New Local Plan period from 2017 to 2033.

The aim of this WCS is to aid the Council in determining the most appropriate locations for development with respect to water infrastructure and the water environment. The New Local Plan will supersede the current Local Plan which set a target of (19,100 new dwellings to be developed by 2023). As part of the development of the New Local Plan, the WCS and associated Strategic Flood Risk Assessment (SFRA) (completed in 2016)[1] will both form a revised evidence base which include the proposed 'garden communities ' (partially within Tendring District Council and Braintree District Council) situated to the west and east of Colchester.

The objective of the WCS is to identify any constraints on planned housing growth that may be imposed by the water cycle. The WCS then identifies how these can be resolved i.e. by ensuring that appropriate Water Services Infrastructure (WSI) can be provided to support the proposed development. Furthermore, it should provide a strategic approach to the management and use of water which ensures that the sustainability of the water environment in the Borough is not compromised.

1.2 WCS History

The Haven Gateway WCS Stage 1 Report considered the Haven Gateway Sub Region (HGSR) which comprises the Local Authorities of Tendring, Colchester, Ipswich, part of Suffolk coastal and part of Babergh.

The Haven Gateway WCS was undertaken 'to ensure that water supply, water quality, sewerage and flood risk management issues can be properly addressed, thus enabling the substantial growth proposed in the East of England Plan (EEP) to 2021 to be accommodated in a sustainable way'.

The previous WCS concluded that:

- The infrastructure capacity in the HGSR is close to capacity in some areas and will require investment to accommodate projected growth;
- There are a large number of oversubscribed wastewater treatment works across the sub region; and,
- The development of employment land is a key factor is the ability of the water cycle to accommodate the growth in the sub region.

Specifically relating to Colchester, the Haven Gateway WCS considered Colchester to be one of the largest growth areas in the HGSR and identified as an area with issues relating to water, waste water and flooding. The WCS concluded that growth in Colchester could be fed from existing resources. However, this assessment was based on average demand, and made no assessment on the ability of the existing infrastructure to treat or distribute any additional flow.

The previous WCS made multiple recommendations, a number of which have been addressed by this updated WCS such as:

- Obtain and evaluate outstanding data to ensure the current situation is addressed;
- Carry out further detailed assessment or sewage treatment capacity in the areas most affected by growth (of which Colchester is one);

[1] AECOM (2016) Colchester Strategic Flood Risk Assessment

- Consider the impact of discharge consents on Sewage Treatment Works in respect of increased volumetric discharges and the quality related discharge limits;
- Carry out further assessment of the environmental impact of growth; and,
- Consider the use of Sustainable Drainage Systems (SuDS) and other demand management techniques to manage water and surface water runoff.

1.3 Study Governance

Through the development of the WCS update, a focused steering group has been convened and facilitated by Colchester Borough Council, comprising representatives from the following key stakeholders; Colchester Borough Council, Anglian Water Services (AWS), and the Environment Agency.

A project inception meeting was held on 15 September 2015 with the project steering group.

1.4 WCS Update Scope

This WCS update provides information at a level suitable to ensure that there are workable solutions to deliver growth for the preferred development allocations, including the policy required to deliver it. The planned future growth across Colchester Borough, including the proposed 'garden communities ' to the west and east of Colchester, have been assessed with regards to water supply capacity, sewage capacity, any water quality issues and infrastructure upgrades that may be required to identify any potential constraints to the water cycle which such development may pose.

1.5 Study Drivers

A summary table of key legislative drivers shaping the development of this WCS is included in Appendix A of this study for reference purposes. However, it is important to note that the key driver for this study is Water Framework Directive (WFD) compliance.

It is important to ensure that growth, through abstraction of water for supply and discharge of treated wastewater, does not prevent waterbodies in the Colchester Borough Council administrative area (and more widely) from achieving the standards required of them as set out in the WFD River Basin Management Plan (RBMP).

Other relevant studies that have a bearing on the provision of water services infrastructure for development include, but are not limited to, the following key documents:

- Colchester Borough Council Level 1 SFRA Update (August 2016);
- Essex Biodiversity Action Plan 2010-2020 (2011);
- Colchester Parks and Green Space Strategy (2008); and,
- AWS Water Resource Management Plan (WRMP) (2014).

1.6 Water Use – Key Assumptions

For the water supply assessment, the published measured household consumption for AWS' South Essex Resource Zone of 138l/h/d has been applied, as published in AWS' WRMP.

For the wastewater assessments, a different assumption was made on the likely consumption of water per new household going forward in the plan period. A starting assumption of 150l/h/d (litres per head per day) was agreed with AWS to calculate wastewater demand per person. The wastewater consumption rate figure is higher in order to take into account additional wastewater demand from employment growth (for which the location has not yet been allocated) and other misconnections (i.e. surface water drainage) which increase the demand for wastewater treatment.

It is acknowledged that the 138l/h/d assumption exceeds the current Building Regulations requirement of 125l/h/d for all new homes. However, in their asset planning, AWS will continue to assume this higher water use for new homes. Analysis has shown that even when homes are built to a standard of 125l/h/d, the average household use increases over time due to various factors. The 125l/h/d requirement is an aspirational target only and AWS are required under their remit to the industry regulator OFWAT, to plan for the expected actual use.

It is therefore important that conclusions made on infrastructure capacity within this study are consistent with AWS' planning strategy. This represents a precautionary approach and the assessments are based on a 'worst case scenario' for water consumption in the Borough.

This study has also considered the effect of achieving lower average per person consumption on infrastructure capacity and the water environment to assist in developing policy that supports and helps lead to a lower per capita consumption.

1.7 Report Structure

The WCS has outlined the proposed number of dwellings which will need to be catered for. Secondly the current wastewater treatment network has been assessed in regards to both compliance and capacity. This enables Water Recycling Centres (WRCs) which are at capacity or have remaining capacity, to be identified. The wider, supporting environment has also been considered, including climate change and local ecology.

In regards to water supply, this report outlines water resource planning targets, discusses current and proposed efficiencies within the water network and introduces the concept of water neutrality.

Each proposed settlement area has subsequently been assessed. For each settlement local receptors such as watercourses have been identified, current and future flood risks outlined (inclusive of surface water and groundwater flood risks) and the current wastewater network assessed.

Ultimately recommendations have been made by the WCS in regards to wastewater, water supply, surface water management and flood risk, ecology and stakeholder liaison.

2 Proposed Growth

2.1 Preferred Growth Strategy

The purpose of the WCS update is to assess the potential impact of a revised wide dispersal of proposed development upon Colchester Borough's water environment and WSI, including flood risk, surface water drainage, water resources, wastewater infrastructure and water quality and ecological issues. Colchester Borough Council's revised spatial approach of future expected development are detailed in Colchester Borough Council's New Local Plan 2017-2033, which at the time of undertaking this WCS, was in development.

This WCS update is based on figures for committed allocations as detailed in the Adopted Local Plan and the Proposed Allocations to be put forward within the draft New Local Plan including two proposed garden communities:

- East Colchester (of which 1,650 dwellings are to be delivered within Colchester's New Local Plan); and,
- West Colchester (of which 1,350 dwellings are to be delivered within Colchester's New Local Plan).

The focus of this study is on wastewater treatment infrastructure and the impact of wastewater treatment on water quality and ecology within the Borough.

2.2 Housing

The WCS incorporates all proposed major development sites[2] across the Borough at differing stages of development which have been put forward to meet this target, including:

- Committed developments (with planning permission, under construction),
- Outstanding commitments (with planning permission, construction not yet started),
- Current allocations (without full planning permission), and
- Proposed allocations (no planning permission).

2.2.1 Completions and Outstanding Developments

The WCS acknowledges that since the beginning of the plan period in 2011, a number of dwellings which form part of the Objectively Assessed Housing Needs (OAHN) target have been built (completed). This WCS has assumed that wastewater flows from completed properties are already accounted for in the measured flows at the WRCs and have therefore not been included as part of the assessments within the WCS.

The OAHN identified for Colchester is 14,720 dwellings required in the Borough over a 16 year period (920 dwellings per annum). This target will be met under the New Local Plan which sets out the strategy for the growth of the Borough from 2017 to 2033 and beyond. To date, 1,986 dwellings have been built since 2011.

Table 2-1 provides an overview of the number of dwellings still to be built within the plan period within major development sites (>10 dwellings) and therefore assessed as part of the WCS.

Table 2-1 Colchester Borough Council Housing Commitments and Allocations to assess within the WCS

Type of Sites	No. Dwellings
Committed Sites and Outstanding Commitments (Adopted Local Plan)	5,793
Proposed Allocations	
Magdalen Street	165
Hythe Special Policy Area	656

[2] Sites containing less than 10 dwellings are not considered major development sites and have therefore not been included for assessment as part of this WCS

Type of Sites	No. Dwellings
Colchester (and Stanway) urban area allocations	4,545
Other	1,115
Emerging Neighbourhood Plans	
Eight Ash Green	150
Tiptree	600
West Bergholt	120
New Garden Communities	
West Colchester	1,350
East Colchester	1,650
Total potential dwellings assessed	**16,144**

3 Wastewater Treatment Assessment

3.1 Wastewater Treatment Assessment Approach

An increase in residential and employment growth will have a corresponding increase in the volume and flow of wastewater generated within the Borough and hence it is essential to consider:

- Whether there is sufficient capacity within existing treatment facilities (WRCs) to treat the additional wastewater;
- What new infrastructure is required to provide for the additional wastewater treatment; and,
- Whether waterbodies receiving the treated flow can cope with the additional flow without affecting water quality.

There are therefore two elements to the assessment of existing capacity (and any solutions required) with respect to wastewater treatment:

- The capacity of the infrastructure itself to treat the wastewater (infrastructure capacity); and,
- The capacity of the environment to sustain additional discharges of treated wastewater (environmental capacity).

3.1.1 Wastewater Treatment in Colchester Borough Council Administrative Area

Wastewater treatment in the Borough is provided via several WRCs operated and maintained by AWS, which discharge to either fluvial watercourses or tidally influenced estuaries. Each of these WRCs is fed by a network of wastewater pipes (the sewerage system) which drains wastewater generated by property to the treatment works; this is defined as the WRCs 'catchment'.

3.1.2 Management of WRC Discharges

All WRCs are issued with a permit to discharge by the Environment Agency, which sets out conditions on the maximum volume of treated flow that it can discharge and also limits on the quality of the treated flow. These limits are set in order to protect the water quality and ecology of the receiving waterbody. They also dictate how much flow can be received by each WRC, as well as the type of treatment processes to be used at the WRCs.

The volume element of the discharge permit determines the maximum number of properties that can be connected to a WRC catchment. When discharge permits are issued for the first time, they are generally set with a volume 'freeboard', which acknowledges that allowance needs to be made for additional connections. This allowance is termed 'permitted headroom'. The quality conditions applied to the discharge permit are derived to ensure that the water quality of the receiving waterbody is not adversely affected, even when the maximum amount of flow is discharged. For the purposes of this WCS, a simplified assumption is applied that the permitted headroom is usable[3] and would not affect downstream water quality. This headroom therefore determines how many properties can be connected to the WRC before a new discharge permit would need to be issued (and hence how many properties can connect without significant changes to the treatment infrastructure).

When a new discharge permit is required, an assessment needs to be undertaken to determine what new quality conditions would need to be applied to the discharge. If the quality conditions remained unchanged, the increase in flow would result in an increase in total load of some substances being discharged to the receiving waterbody. This may have the effect of deteriorating water quality and hence in most cases, an increase in permitted discharge flow results in more stringent (or tighter) conditions on the quality of the discharge. The requirement to treat to a higher level may result in an increase in the intensity of treatment processes at the WRCs which may also require improvements or upgrades to be made to the WRC to allow the new conditions to be met.

In some cases, it may be possible that the quality conditions required to protect water quality and ecology are beyond that which can be achieved with conventional treatment processes and as a result, this WCS assumes that a new solution would be required in this situation to allow growth to proceed.

The primary legislative driver which determines the quality conditions of any new permit to discharge are the Water Framework Directive (WFD) and the Habitats Directive (HD) as described in the following subsections.

[3] In some cases, there is a hydraulic restriction on flow within a WRCs which would limit full use of the maximum permitted headroom.

3.1.3 WFD Compliance

The WFD is the most significant piece of water legislation since the creation of the EU. The overall requirement of the directive is that all waterbodies in the UK must achieve "Good Status". The definition of a waterbody's 'status' is a complex assessment that combines standards for water quality with standards for hydromorphology (i.e. habitat and flow quality) with ecological requirements.

The two key aspects of the WFD relevant to the wastewater assessment in this WCS are the policy requirements that:

- Development must not cause a deterioration in status of a waterbody[4]; and
- Development must not prevent attainment of the future target status, hence it is not acceptable to allow an impact to occur just because other impacts are causing the status of a water body to already be less than the target status.

Where permitted headroom at a WCS would be exceeded by proposed levels of growth, a water quality modelling assessment has been undertaken to determine the quality conditions that would need to be applied to the new permit to ensure the two policy requirements of the WFD are met. The modelling process (assumptions and modelling tools) is described in detail in Section 3.2.

3.1.4 Habitats Directive

The Habitats Directive and the Habitats Regulations has designated some sites as areas that require protection in order to maintain or enhance the rare ecological species or habitat associated with them. A retrospective review process has been on-going since the translation of the Habitats Directive into the UK Habitats Regulations called the Review of Consents (RoC). The RoC process requires the Environment Agency to consider the impact of the abstraction licences and discharge permit it has previously issued on sites which became protected (and hence designated) under the Habitats Regulations.

If the RoC process identifies that an existing licence or permit cannot be ruled out as having an impact on a designated site, then the Environment Agency are required to either revoke or alter the licence or permit. As a result of this process, restrictions on some discharge permits have been introduced to ensure that any identified impact on downstream sites is mitigated. Although the Habitats Directive does not directly stipulate conditions on discharge, the Habitats Regulations can, by the requirement to ensure no detrimental impact on designated sites, require restrictions on discharges to (or abstractions) from water dependent habitats that could be impacted by anthropogenic manipulation of the water environment.

Where permitted headroom at a WRC would be exceeded by proposed levels of growth, a Habitats Regulations assessment exercise has been undertaken in this WCS to ensure that Habitats Directive sites which are hydrologically linked to watercourses receiving wastewater flows from growth would not be adversely affected. The scope of this assessment also includes non-Habitats Directive sites designated at a national Sites of Special Scientific Interest (SSSI) and Local Nature Reserves (LNRs). This assessment is reported in Section 3.4 of this chapter (Ecological Appraisal).

3.1.5 Assessment Methodology Summary

A stepped assessment approach has been developed for the WCS to determine the impact of the proposed growth on wastewater treatment capacity and the environmental capacity of the receiving watercourse. The assessment steps are outlined below:

i. Determine the amount of growth draining to each WRC and calculate the additional flow generated;
ii. Calculate available permitted flow headroom at each WRC;
iii. Determine whether the growth can be accommodated within existing permitted flow headroom;
iv. For those WRCs where flow headroom is exceeded, calculate what quality conditions need to be put in place to ensure:
  - No deterioration of more than 10% of the current water quality immediately downstream of the WRC (i.e. the mixing point);
  - No deterioration from the current downstream sampling point WFD status, immediately downstream of the WRC (i.e. the mixing point); and,
  - Future target status immediately downstream of the WRC (i.e. the mixing point) is not compromised by growth.

[4] i.e. a reduction High Status to Good Status as a result of a discharge would not be acceptable, even though the overall target of good status as required under the WFD is still maintained

v. Determine whether any quality conditions required to meet WFD objectives would be beyond the limits of conventional treatment for WRCs;

vi. Where the conditions are achievable, indicate where infrastructure upgrades are required to be undertaken by AWS, to meet the new permit conditions and phasing implications of these upgrades;

vii. Where the conditions are not achievable, indicate where there are alternative solutions for treatment in that catchment which would need to be pursued by AWS; and,

viii. Undertake an ecological site screening assessment to determine if any Habitats Directive (or other nationally or locally) designated sites are likely to be affected.

In order to complete the above steps, the following assessment techniques were developed (details of the procedures can be found in Appendix B);

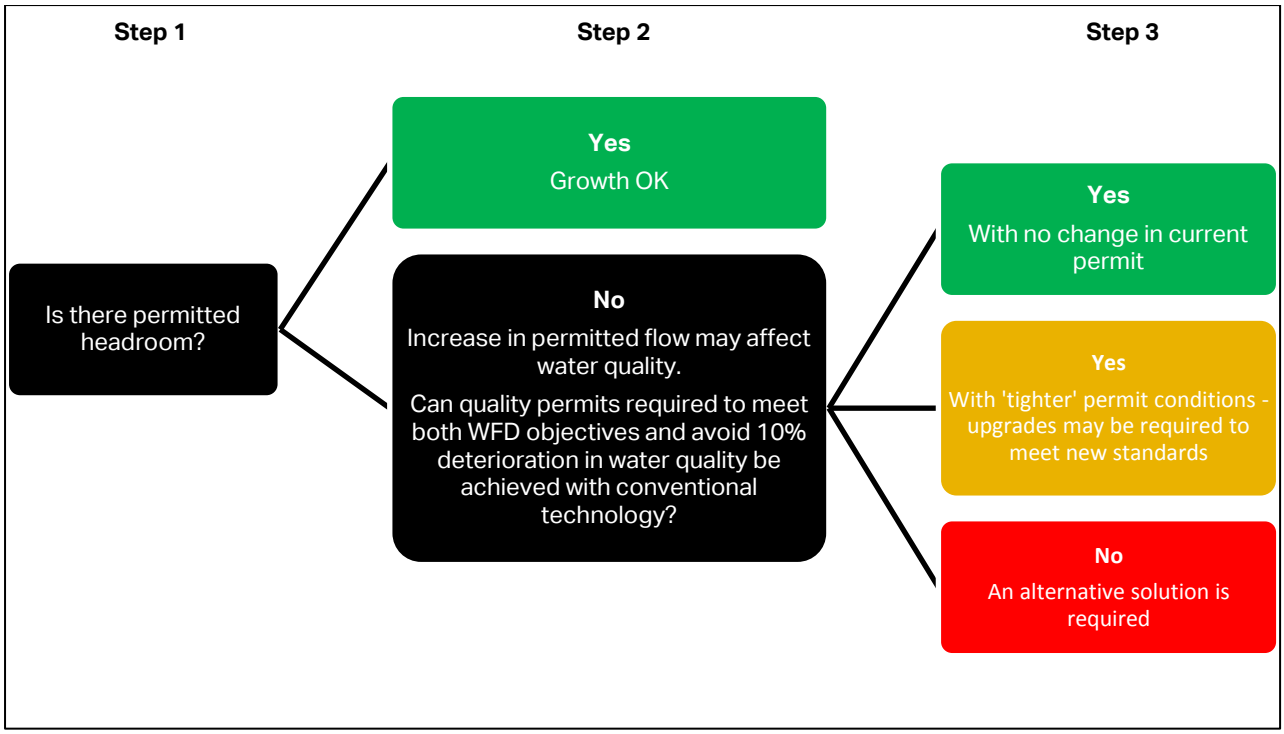
- A permitted headroom calculation spreadsheet was developed; and,
- A water quality modelling procedure was agreed with the Environment Agency using Environment Agency software (River Quality Planning (RQP)) and load standstill calculations designed for determining discharge permit conditions.

3.1.6 Assessment Results Overview

The results for each WRC are presented in a Red/Amber/Green (RAG) Assessment for ease of planning reference. The RAG code refers broadly to the following categories and the process is set out in Figure 3-1.

- Green – WFD objectives will not be adversely affected. Growth can be accepted with no changes to the WRC infrastructure or permit required.
- Amber – in order to meet WFD objectives, changes to the discharge permit are required, and upgrades may be required to WRC infrastructure which may have phasing implications;
- Red - in order to meet WFD objectives changes to the discharge permit are required which are beyond the limits of what can be achieved with conventional treatment. An alternative solution needs to be sought.

Figure 3-1: RAG Assessment Process Diagram for Wastewater treatment capacity



3.2 Wastewater Treatment Assessment – Headroom Assessment

The assessment results are presented in this section and have been reported in the following order;

- Further detail on WRC catchments where growth can be accepted within the current permitted flow headroom have been reported together in Section 3.2.1;
- Further detail on those WRCs requiring a new discharge permit and hence a water quality assessment have been reported in Section 3.2.2.

3.2.1 WRC with Permitted Headroom

The volume of wastewater generated from growth in each WRC catchment was calculated for the proposed growth locations and compared to the treatment capacity at each WRC.

Table 3-1 details the WRC where existing permitted headroom is sufficient to accommodate all of the proposed growth and hence no infrastructure upgrades are required to deliver the proposed growth levels in these locations.

Growth in these catchments would not deteriorate water quality and hence there is no barrier to delivering the proposed growth levels. These catchments are Green in the RAG assessment and have not been assessed any further. Table 3-1 also includes information on how many additional dwellings could be connected before the headroom would be exceeded to inform potential variations to the spatial strategy.

Table 3-1: WRC with Permitted Headroom

WRC Catchment	Settlement Area	Current Permitted DWF (m^3/d)	Current Demand DWF (Q_{80}) (m^3/d)	Future 2033 DWF after Growth (m^3/d)	Headroom Assessment after Growth (2033)	
					Headroom Capacity (m^3/d)	Approx. Residual Housing Capacity[5]
Colchester	Colchester, Rowhedge, Stanway, Wivenhoe, East and West Garden Communities, Copford, Marks Tey	29,284	24,110	28,579	700	2,240
Earls Colne	Chappel, Wakes Colne	934	879	888	50	145
Eight Ash Green	Eight Ash Green, Fordham	650	504	564	85	270
Fingringhoe	Abberton, Fingringhoe	367	331	347	20	65
Great Tey	Great Tey	142	97	115	25	85
Layer-de-la-Haye	Layer-de-la Haye	380	219	235	145	460
Tiptree	Tiptree	2,400	1,909	2,220	180	575
West Bergholt	Great Horkesley, West Bergholt	1,430	1,277	1,344	85	275
West Mersea	West Mersea	2000	1,478	1,541	460	1,455

3.2.2 WRC without Permitted Headroom

The calculations of flow headroom capacity demonstrated that one WRC would not have sufficient headroom once all the growth within the WRC catchment is accounted for as detailed in Table 3-2.

[5] Based on an Occupancy rate of 2.1 and consumption rate of 150 l/h/d

Table 3-2: WRC without Permitted Headroom

WRC	Settlement Area	Current Permitted DWF (m^3/d)	Current Demand DWF (Q_{80}) (m^3/d)	Future 2033 DWF after Growth (m^3/d)	Headroom Assessment after Growth (2033)	
					Headroom Capacity (m^3/d)	Approx. Residual Housing Capacity[5]
Langham (East)	Langham, Boxted	420	616[6]	667	**-245**	**-785**

To ensure that the increase in permitted flow required to serve the proposed growth would not impact on downstream WFD requirements, water quality modelling has been undertaken for Langham (East) WRC listed in Table 3-2 to determine whether theoretically achievable quality conditions can be applied to a revised volumetric discharge permit in order to meet WFD objectives.

The results of the water quality modelling are provided in Section 3.3, with detailed results from the modelling provided in Appendix B.

[6] Current Demand DWF already exceeds the consented DWF for this WRC

3.3 Water Quality Modelling

A summary of the results and proposed infrastructure upgrades required for the Langham (East) WRC which has been identified as having no permitted headroom (Table 3-2). The following sub-headings are used;

- WFD Compliance (for which a sequence of calculations have been performed as detailed in Table 3-3),
- Upgrade Requirements and Phasing, and
- RAG Assessment.

Table 3-3: Sequence of water quality modelling calculations

Ref	Calculation Name	Calculation Detail	Reason for Calculation
C1	Limit deterioration to 10%	No deterioration from current *downstream quality + 10%* with future effluent flow[7]	To test whether future growth could cause deterioration in the current water quality downstream, allowing for a 10% exceedance of the current downstream Environmental Quality Standard (EQS)
C2	No deterioration (Current)	No deterioration from current *status* with current effluent flow	To confirm what quality condition is currently needed to avoid deterioration in the current status downstream with the current flow
C3	No deterioration (Future)	No deterioration from current *status* with future effluent flow[7]	To test whether future growth could cause deterioration in the current downstream status
C4	Achieve Good status (Current)	Achieving good ecological status with current effluent flow	To test what effluent quality would be needed to achieve good status with the current flow permit
C5	Achieve Good status (Future)	Achieving good ecological status with future effluent flow	To assess whether the future quality permit limits needed to achieve good status will be significantly more onerous and difficult to achieve than those currently needed (calculation C4)
C6	Load Standstill	Required future quality permits with future effluent flow[7]	To be used where the above calculations are not applicable such as for tidal discharges

The Environment Agency require 'no deterioration' calculations C1 and C3 for freshwater discharges to inform their hierarchical approach to the WFD 'no deterioration' targets used to identify indicative permits. This approach helps with consideration of the relative technical feasibility of ensuring 'no deterioration'.

3.3.1 Langham (East) WRC

The headroom assessment in Table 3-2 has demonstrated that Langham (East) WRC is already exceeding its current flow permit by approximately 195m^3/d. AWS have confirmed that the WRC has been operating close to its flow permit for a number of years. Therefore, the WRC does not have sufficient flow headroom under its current permit to accommodate the additional wastewater flow from growth.

Unless additional headroom can be made available in the WRC catchment, any growth draining to the WRC would result in the existing flow permit condition being exceeded further,, and by a total volume of 235m^3/d by the end of the plan period. Additional headroom can be made available through an application by AWS for a new or revised flow permit condition from the Environment Agency.

The following calculations have therefore used both the current measured discharge (as provided by AWS) and the future discharge as calculated within the WCS (current measured discharge plus additional flow from growth).

3.3.1.1 WFD Compliance

As Langham (East) WRC discharges to the freshwater River Stour, calculations C1 to C5 (Table 3-3) have been performed to check for compliance with the WFD objectives in terms of permit conditions for ammonia and phosphate. A load standstill calculation (C6) has been used to determine the future BOD permit conditions.

[7] Predicted for the WRC based on allocated future growth. Future effluent flow is based on an occupancy rate of 2.1 and consumption rate of 150 l/h/d

C1: Limit deterioration to 10%

Modelling has been undertaken to take account of the increased wastewater flows from the proposed growth, and allowing for a deterioration of up to 10% in the current downstream quality. In terms of phosphate, up to a 20% deterioration in downstream quality has been applied (in line with recommendation provided by the Environment Agency) instead because the upstream quality is already lower than a 10% deterioration.

The results showed that the discharge quality required would need to be beyond what is considered to be within the limits of conventional treatment for both ammonia and phosphate to limit deterioration in the River Stour to 10%.

It can be concluded that limiting deterioration to 10% cannot be achieved due to limitations in conventionally applied treatment technology. Therefore, the next step is to calculate what discharge quality is required to prevent a deterioration in status, and to determine whether this can be achieved with conventional treatment technology.

C2: No deterioration (Current)

A second phase of modelling has subsequently been undertaken to calculate what the required discharge quality is currently needed to avoid deterioration in status. This calculation is necessary since the flow permit is already being exceeded, and therefore the current discharge may require tightening of the quality conditions, before a similar calculation can be performed which includes growth.

The results from the modelling show that theoretically the quality conditions for both ammonia and phosphate on the current discharge permit require tightening in order to maintain the current status of the River Stour now (i.e. the quality conditions of the current discharge permit would cause a deterioration in ammonia and phosphate status, before taking into account any growth).

The results indicate that the ammonia discharge quality required now can be achieved within the limits of conventional treatment. The tightening of the ammonia quality condition would be in addition to an application by AWS for a new or revised flow permit condition from the Environment Agency.

The phosphate discharge quality required now cannot be achieved within the limits of conventional treatment.

C3: No deterioration (Future)

A similar calculation to C2, this calculation takes into account the increased wastewater flows from the proposed growth. The results demonstrate that the quality conditions for both ammonia and phosphate on a future discharge permit would require further tightening from the conditions calculated in calculation C2 in order to maintain the current status of the River Stour in the future (i.e. the quality conditions of the future discharge permit, which includes growth, would cause a deterioration in ammonia and phosphate status).

The results indicate that the ammonia discharge quality required in the future would be at the limit of conventional treatment for ammonia, but can be achieved.

The phosphate discharge quality required in the future cannot be achieved within the limit of conventional treatment for phosphate. It can be concluded that it is not growth that would cause a deterioration in phosphate status, but current limits in technology.

It should be noted that the addition of growth would not require significant tightening of the ammonia or phosphate permit conditions for either ammonia or phosphate compared to the conditions required for the current discharge.

C4 & C5: Achieve Good status (Current & Future)

This calculation considers whether growth could affect attainment of the future target status for the River Stour. In physico-chemical terms, this relates to a target of good for phosphate. Ammonia (currently at high status) would remain at the required level with the permit limit required for no deterioration.

The modelling has shown that future good status for phosphate cannot be achieved with the current discharge volumes using current conventional treatment technology. Therefore, it can be concluded that growth itself would not prevent future good status for phosphate from being achieved, but current limits in available technology.

C6: Load standstill

The results of the calculations show that the quality conditions for BOD on the revised discharge permit would need to be slightly tighter than the current condition to maintain the current BOD water quality downstream in the River Stour.

3.3.1.2 Upgrade Requirements and Phasing

Information provided by AWS confirms that the WRC currently has limited hydraulic capacity, and calculations as part of the WCS also demonstrate this. The onus is on AWS to maintain standards set within the WRCs environmental permit;

however housing trajectory information provided by Colchester Borough Council to inform this WCS indicates that no growth is planned within the WRC catchment until 2022.

AWS are currently preparing for Asset Management Plan 7 (AMP7)[8] which will outline their investment programme from April 2020 to 2025. AWS's approach to wastewater treatment asset management requires that sufficient certainty is given that the quantum of development will proceed before improvements to WRC assets can be justified and funding sought.

Information provided in this WCS represents the first stage of providing development information, and can be used by AWS to inform their investment programme (AMP7) to ensure the provision of additional capacity is planned and development is not delayed. Once funding has been confirmed, there will be a lead-in time for the necessary upgrades to be complete. It is considered there is sufficient time before development begins within the WRC catchment for AWS to plan their investment and to deliver the necessary upgrades.

Ammonia and BOD

There is a requirement to change the ammonia and BOD conditions on the current discharge permit immediately, before taking account of any growth, to ensure there is no deterioration in the current status. This is due to the flow condition on the current discharge permit already being exceeded and therefore the existing quality conditions on the permit may not be compliant with WFD objectives. When taking growth into account, an ammonia condition similar to that required pre-growth, and a tighter BOD condition, would be required. It has been determined that the ammonia permit condition would need to be equivalent to 1 mg/l, and the BOD permit condition tightened to 8 mg/l or less in order to maintain the existing status of the River Stour, both before and after growth. To achieve these tighter permit conditions, current conventional treatment technologies would be sufficient.

Process upgrades at Langham (East) WRC may be required, and the exact technical specification of any upgrade should be determined by AWS for the AMP7 asset planning period.

Phosphate

The theoretical quality condition required for phosphate on the current discharge permit, before taking account of any growth and to ensure no deterioration in current status, is considered to be marginally beyond the limits of conventional treatment. The results therefore indicate that either the WRC is treating better than would be expected with conventional treatment technologies, or the downstream monitoring point is at a distance sufficient to allow the river phosphate concentrations to be diluted from the point of discharge to an acceptable level at the downstream sampling point. When considering whether the required status at the point of discharge can be achieved, a phosphate limit beyond conventional treatment would be required irrespective of growth in order to ensure no deterioration.

In relation to achieving future good status for phosphate, a phosphate quality condition beyond the limits of conventional treatment would also be required, before taking account of any growth. Therefore it is not growth which would prevent future good status from being attained in the River Stour, but current limits in technology.

If the WRC can maintain the current level of treatment with the addition of growth, a flow solution will only be required to enable the WRC to be able to accept all wastewater flows. Should it not be possible to maintain the current level of treatment, a treatment solution (in addition to a flow solution) will also need to be agreed between the Environment Agency and AWS and confirmed prior to development coming forward in the WRC catchment (projected to be 2022).

A potential solution could include new treatment technology currently being trialled. There is currently a programme of phosphate reduction trials being undertaken by water companies in the UK, testing whether there are technologies that can reduce phosphate at WRCs to around 0.1 mg/l, with results due to be published in spring 2017.

3.3.1.3 RAG Assessment

The growth in the Langham (East) WRC catchment is given an **Amber** status on the basis that upgrades using currently available technology are likely to be required at the WRC to ensure the current discharge as well as future discharge (including growth) do not compromise the WFD objectives in terms of ammonia and BOD. The current discharge in terms of phosphate may require treatment technology beyond what is considered conventional technology to ensure the no deterioration WFD objective is met, and solutions need to be agreed between the Environment Agency and AWS.

[8] Investment programme from April 2020 to 2025

3.4 Ecological Appraisal

3.4.1 Introduction

There are twelve statutory and non-statutory designated sites that have been identified as potentially being connected to the Langham East WRC discharge. These are:

- Cattawade Marshes SSSI
- Hamford Water Ramsar site
- Hamford Water SAC
- Hamford Water SPA and potential SPA
- Hamford Water SSSI
- Landguard Common SSSI
- Landguard Common LNR
- Orwell Estuary SSSI
- Stour and Orwell Estuaries SPA
- Stour and Orwell Estuaries Ramsar
- Stour Estuary SSSI
- Wrabness LNR

All other designated sites identified within the Borough are remote from watercourses into which the WRC discharges treated effluent. The ecological background to the statutory designated sites including the details of the interest features and relevant condition assessments are provided in Appendix D.

3.4.2 Impact on Designated Sites

Table 3-2 identifies that the Langham (East) WRC does not have sufficient headroom capacity to accommodate the proposed increase in development within the WRC catchment.

This WRC therefore poses implications for downstream water quality (and thus ecology). It should be noted that Langham (East) WRC is already more than 40% in exceedance of its flow capacity even without the potential new development planned for its catchment in the Local Plan. However, the Local Plan development as currently distributed does exacerbate that situation slightly.

In addition, the RQP assessments indicate that, given the extent of exceedance expected, Langham East is unlikely to be able to achieve 'no deterioration downstream' within the limits of conventional treatment for phosphate.

3.4.2.1 Langham (East)

This WRC also discharges into Black Brook, entering the River Stour after 5.4km at the same point that Dedham WRC enters the River Stour. The discharge point is approximately 8km upstream of **Stour and Orwell Estuaries SPA and Ramsar** site, and **Cattawade Marshes SSSI**. In theory, due to the distances involved and the dynamic nature of the coastal and estuarine process within these designated sites, any WRC bi-products will be quickly and frequently diluted and dispersed, thus not impacting upon the designated features and sites.

The WRC's point of discharge is located 10.3km upstream from the **Stour Estuary SSSI,** 15.9km upstream of the **Wrabness LNR**, beyond this and towards the mouth of the Stour Estuary is the **Orwell Estuary SSSI, and Landguard Common SSSI and LNR**. Approximately 25km downstream and beyond the mouth of the Stour Estuary is **Hamford Water Ramsar site, SAC, SPA and SSSI,** and **Hamford Water pSPA.** At these further distances and due to the tidal nature of the designated sites, any effects of waste water discharge will have been sufficiently diluted to not impact upon the designated features of theses wildlife sites.

Langham (East) WRC is currently in exceedance of its existing flow headroom capacity by 47%. During the plan period an additional 160 dwellings are planned within the WRC's catchment, resulting in a 12% increase in the exceedance of headroom capacity. Nonetheless, any further increase in the headroom capacity exceedance without improvement to discharge quality will result in some further deterioration downstream and possibly exacerbate the existing potential impact upon Black Brook, the River Stour and (possibly) the Cattawade Marshes SSSI.

This assessment also identifies that BOD levels are in exceedance. However, the 'no deterioration assessment' identified that to maintain the current BOD status of 'Good', permit tightening will be required, but within limits of conventionally applied treatment processes. Therefore, it should be possible to deliver new housing within the catchment of Langham (East) WRC without an adverse effect on downstream water quality (and thus downstream ecology and designated sites) with respect to BOD.

It is important to ensure that planned development within the plan period does not result in a negative impact upon designated sites or riverine habitats. It is recommended that policy is included within the Local Plan to ensure that proposed development only comes forward within a WRC catchment which currently has available flow headroom, or it

can be guaranteed that the WRC will have permitted flow headroom for development which has a high level of certainty to come forward.

For phosphate and ammonia discharge quality conditions, a view must be taken in conjunction with AWS and the Environment Agency as to the significance of the impact of Local Plan development on the requirement for permit tightening, given that the majority of the permit tightening is required now (before growth). Whilst permit tightening can be technically achieved for ammonia, permit tightening for phosphate would require technology not currently considered to be conventional. It may be beneficial to include the requirement in the New Local Plan for infrastructure to be in place prior to the delivery of new development or the need for phased infrastructure (in line with the delivery of development or availability of new treatment technologies) to ensure that the WRC can not only accommodate the increased wastewater flow capacity, but also maintain current WFD status of receiving waterbodies.

This may result in a conclusion that the overall exceedance in discharge volumes and phosphate treatment means that no further housing should be permitted within this catchment without a new treatment solution due to the potential for effects on downstream ecology of Black Brook and (possibly) the River Stour and Cattawade Marshes SSSI.

3.4.3 Impacts on Ecology outside Designated Sites

Whilst the above assessment is primarily focused on the impact on ecologically designated sites, the following section discusses ecology outside of designated sites. The limitations of a WCS report make it impossible for such a discussion to be exhaustive or spatially very specific.

In addition to impacts on designated sites, a range of other UK or Essex BAP species or otherwise protected/notable species that are found in Essex can be affected by wastewater discharge. These include:

- Water vole (protected through Wildlife & Countryside Act 1981 and a UK BAP species)
- Grass snake (partially protected through Wildlife & Countryside Act 1981)
- Common toad (UK BAP species)
- Great crested newt (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK BAP species)
- Birds such as bittern, kingfisher (protected through Wildlife & Countryside Act 1981 and a UK BAP species), lapwing and snipe; and
- Otter (legally protected through Conservation of Habitats & Species Regulations 2010, Wildlife & Countryside Act 1981 and a UK/ Essex BAP species).

Similarly important habitats (all listed in the Essex BAP) include:

- Floodplain and coastal grazing marsh
- Reedbeds
- Coastal saltmarsh
- Rivers & streams

All of these habitats and species are present (or possibly present) in Colchester Borough.

It is not possible within the scope of this commission to undertake a detailed investigation and evaluation of the impacts of the changes in water quality/flow and infrastructure to be delivered under the water cycle study on wildlife generally, since it would be necessary to undertake detailed species surveys of each watercourse and utilise detailed flow and quality data/modelling which has not been available for this commission for most watercourses.

3.5 Impact of Garden Communities

The two garden communities proposed, East of Colchester and West of Colchester, represent a significant proportion of Colchester Borough Council's future growth during the plan period (3,000 dwellings by 2033). It has been agreed between Colchester Borough Council and AWS that the assumption to be applied in the WCS assessment is to assume Colchester WRC will serve both garden communities.

Colchester WRC has sufficient volumetric headroom (indicated in Table 3-1) under the current permit to accept the additional wastewater flow from growth in both garden communities proposed within the plan period (3,000 dwellings by 2033). However, significant growth at both garden communities is expected to continue beyond the plan period and has not been assessed within this WCS.

Table 3-4: Number of dwellings per Garden Community

Garden Community	Growth up to 2033 (in Colchester's new Local Plan)	Growth up to 2033 (in other local authority Local Plan)	Growth beyond 2033	Total dwellings to be delivered	Potential site capacity
East of Colchester	1,650	1,250 (Tendring District Council)	0	2,900	3,000
West of Colchester	1,350	0	2,500	3,850	7,500
Assessed in this WCS?	Yes	No			

In addition to the significant future growth expected at both garden communities as detailed in Table 3-4, both garden communities also encompass other local WRC catchments which discharge to local watercourses. These WRC discharges form an essential component of the flow in their respective receiving watercourses, which is required to support the ecological habitats and species associated with the watercourses. However, the extent of infrastructure required and the associated cost to connect the garden communities to Colchester WRC could potentially undermine the viability of maintaining the local WRCs (i.e. it would be more cost effective to close the local WRCs and divert their wastewater flows to Colchester WRC via the new infrastructure).

Although these local WRCs have not been modelled as part of this assessment, comment provided by AWS on the WCS stated that significant investment would be required to upgrade and enable these local WRCs to serve growth within the garden communities and thereby maintaining their viability. This approach may be more expensive in the short term, but could prove to be more sustainable in the longer term in terms of balancing environmental benefits with cost.

The construction of a new package WRC in the next Asset Management Plan (AMP) five year cycle (2020 – 2025) is also considered an option to serve and accept wastewater flows from the West of Colchester garden community (1,350 dwellings within the plan period, with the potential for a further 2,500 dwellings), rather than directing wastewater to Colchester WRC.

Table 3-5 outlines the broad options which could be considered by AWS and the Environment Agency to deal with the additional flow from the garden community growth. The 'headline' benefits and drawbacks for each option have also been provided.

Table 3-5: Garden community growth wastewater treatment broad options

Option	Benefits	Drawbacks
All garden community growth to be served by Colchester WRC	• Lower cost due to economy of scales upgrading existing assets and treating large volume of wastewater. • Coastal discharge likely to require a less stringent discharge permit.	• Infrastructure cost undermining the viability of local WRCs whose discharge is essential component to flow in local watercourses. • Loss of treated wastewater as a water resource to coastal discharge.
Upgrade existing local WRCs to serve garden community growth	• Long term sustainability, balance between cost and environmental requirements. • Maintain/improve flow conditions in local watercourses.	• High cost due to significant upgrades required to treatment processes and flow capacity at a number of local WRCs. • Fluvial discharges likely to require tight discharge permit conditions due to nature of small watercourses.

Construction of new WRC to serve West of Colchester garden community growth. East of Colchester garden community served by Colchester WRC.	• Additional headroom made available at Colchester WRC. • Potential use of treated wastewater to contribute to local watercourse flow and replenish water resources	• High cost associated with construction of new WRC. • Suitable location of a new WRC requires detailed investigation.

Further consultation with AWS should be held to determine the necessity, exact requirements and cost associated with each option detailed in Table 3-5 to deal with the additional wastewater flows from the garden communities as the masterplanning and timeline for the communities develops.

3.6 Wastewater Summary

Table 3-6 provides a summary of the RAG assessment of the Langham (East) WRC.

Table 3-6: Wastewater treatment summary

WRC	Watercourse	Is Headroom Available?	Is a quality permit update required and technically feasible?	Solutions Available?
Langham (East)	River Stour	No	BOD and ammonia permit conditions require tightening, technically feasible. Phosphate permit condition also requires tightening, not technically feasible.	Emerging treatment technology, but exact solution to be agreed and confirmed between the Environment Agency and AWS.

4 Water Supply Strategy

4.1 Introduction

The AWS Water Resource Management Plan 2015[9] (WRMP) and the updated Environment Agency Essex Catchment Abstraction Management Strategy (CAMS)[10], published in February 2013, have been used to determine the available water resource in Colchester Borough, whether it can accommodate the demand from the proposed new growth and consider how water efficiency can be further promoted and delivered for new homes beyond that which is planned for delivery in AWS WRMP.

In reviewing the AWS 2015 WRMP and through liaison with AWS it has been established that the growth figures assessed for this WCS update are catered for in the 2040 prediction of demand in the relevant Planning Zones under average conditions within the WRMP.

4.2 Catchment Management Strategies (CAMS)

An assessment of the existing environmental baseline with respect to locally available resources in the aquifers and the main river systems has been completed based on the Environment Agency's CAMS. Colchester Borough Council falls within the Colne and Tendring Area of the Essex CAMS.

The Environment Agency manages water resources at the local level through the use of CAMS. 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 which indicates:

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

The categories of resource availability status are shown in Table 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 4-1: CAMS water resource availability status categories

Indicative Resource Availability Status	License Availability
Water available for licensing	There is more water than required to meet the needs of the environment. New licences can be considered depending on local and downstream impacts.
Restricted water available for licencing	Full Licensed flows fall below the Environmental Flow Indictors (EFIs). If all licensed water is abstracted there will not be enough water left for the needs of the environment. No new consumptive licences would be granted. It may also be appropriate to investigate the possibilities for reducing fully licensed risks. Water may be available if you can 'buy' (known as licence trading) the entitlement to abstract water from an existing licence holder.
No water available for licencing	Recent actual flows are below the EFI. This scenario highlights water bodies where flows are below the indicative flow requirement to help support Good Ecological Status (as required by the Water Framework Directive (Note: we are currently investigating water bodies that are not supporting GES / GEP). No further consumptive licences will be granted. Water may be available if you can buy (known as licence trading) the amount equivalent to recently abstracted from an existing licence holder.

[9] Anglian Water Services, 2015. Final Water Resources Management Plan 2014.
http://www.anglianwater.co.uk/_assets/media/WRMP_2015.pdf
[10] Essex Abstraction Licensing Strategy, February 2013.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/289840/LIT_7740_6e1970.pdf

The classification for each of the surface waters and groundwater bodies (Water Resource Management Units) in the Colchester area is summarised in Table 4-2.

Table 4-2: CAMS resource availability classification

River – WRMU	Surface Water (flow exceedance scenarios)				Groundwater
	Q30	Q50	Q70	Q95	
River Colne (Assessment Point 9 (AP9))					Resource available at least 30% of the time. Presumption against new groundwater abstractions
Salary Brook (AP10)					Resource available at least 50% of the time. Applications for groundwater abstractions will be considered on a case by case basis depending on scale and impact on surface water
Roman River/Layer Brook (AP11)					Resource available at least 30% of the time Presumption against new groundwater abstractions
Sixpenny Brook (AP12)					Resource available at least 50% of the time Applications for groundwater abstractions will be considered on a case by case basis depending on scale and impact on surface water
Tenpenny Brook (AP13)					Resource available at least 50% of the time Applications for groundwater abstractions will be considered on a case by case basis depending on scale and impact on surface water

The majority of rivers are defined as having no water available for licensing during periods of low flows (Q70 and Q95). In the case of groundwater, applications for groundwater abstractions will be considered on a case by case basis, depending on scale and impact on surface water.

This analysis indicates that there is potential for local abstractions on the Salary Brook and Tenpenny Brook. This may be beneficial to supplying water resources to the proposed University Garden Settlement.

4.2.1 Water Resource Planning

Water companies have historically undertaken medium to long term planning of water resources in order to demonstrate that a there is a long-term plan for delivering sustainable water supply within its operational area to meet existing and future demand.

As of 2007, it became a statutory requirement for water companies to prepare and maintain WRMPs which demonstrate how water companies are managing the balance between available supply and future demand over a 25 year plan. These plans are subject to consultation and approval by the Secretary of State every five years, but must be reviewed on a yearly basis.

WRMPs are a key document for a WCS as they set out how demand for water from growth within a water company's supply area can be met, taking into account the need to for the environment to be protected. As part of the statutory approval process, the plans must be approved by both the Environment Agency and Natural England (as well as other regulators) and hence the outcomes of the plans can be used directly to inform whether growth levels being assessed within a WCS can be supplied with a sustainable source of water supply.

Water companies manage available water resources within key zones, called Water Resource Zones (WRZ). These zones share the same raw resources for supply and are interconnected by supply pipes, treatment works and pumping stations. As such the customers within these zones share the same available 'surplus of supply' of water when it is freely available; but also share the same risk of supply when water is not as freely available during dry periods (i.e. deficit of supply). Water companies undertake resource modelling to calculate if there is likely to be a surplus of available water or a deficit in each WRZ by 2040, once additional demand from growth and other factors such as climate change are taken into account.

4.3 Demand for Water

Likely increases in demand in the study area have been calculated using five different water demand projections based on different rates of water use for new homes that could be implemented through potential future policy. Employment growth has also been accounted for and based on the assumption of 928 jobs per year[11] throughout the plan period, with a consumption rate of 16l litres per job per day (l/job/d).

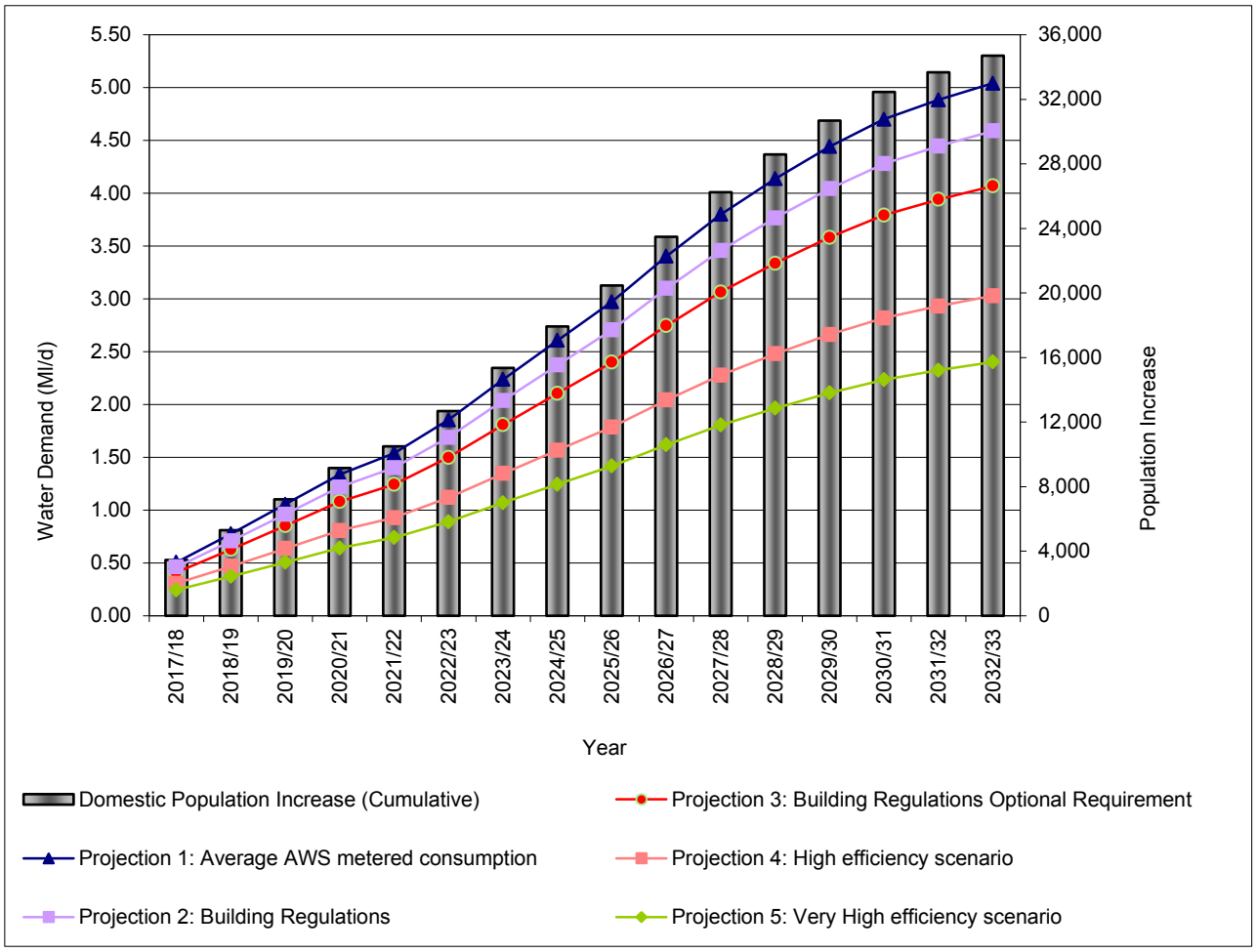
The projections were derived as follows:

- **Projection 1** – Average AWS metered consumption – New homes would use 138 l/h/d, this reflects the planning consumption used by AWS to maintain security of supply;
- **Projection 2** – Low Scenario (Building Regulations) – New homes would conform to (and not use more than) Part G of the Building Regulations requirement of 125 l/h/d;
- **Projection 3** – Medium Scenario (Building Regulations Optional Requirement) - Only applies where a condition that the new home should meet the optional requirement is imposed as part of the process of granting planning permission. Where it applies, new homes would conform to (and not use more than) Part G of the Building Regulations optional requirement of 110 l/h/d;
- **Projection 4** – High Efficiency Scenario – New homes would achieve 80 l/h/d (to reflect the now superseded Codes for Sustainable Homes Level of 5 or 6); and,
- **Projection 5** – Very High Efficiency Scenario – New homes would include both greywater recycling and rainwater harvesting reducing water use to a minimum of 62 l/h/d.

Using these projections, the increase in demand for water could range between 2.40 Ml/d and 5.04 Ml/d by 2033. The projections are shown in Figure 4-1.

[11] as provided by Colchester Borough Council from latest Objectively Assessed Need.

Figure 4-1: Range of water demands across plan period in Colchester depending on efficiency levels of new homes



4.3.1 Planned Water Availability Summary

The AWS 2015 WRMP covers the planning period to 2040 and has been used to summarise water availability to meet the projected demand for Colchester Borough Council.

In the previous AWS 2010 WRMP, Colchester Planning Zone (PZ56) was considered to be located within WRZ10, East Suffolk and Essex. Since then, AWS has reviewed their WRZ boundaries in line with the Environment Agency definition that a WRZ is the "largest possible zone in which customers share the same risk of a resource shortfall". The review was based upon various WRZ attributes including scale, connectivity, sources and transfers etc. In response to this assessment it was determined that the East Suffolk and Essex WRZs should be split into three independent Resource Zones (RZs): East Suffolk; Central Essex; and South Essex. Consequently, the Borough of Colchester is now located within the South Essex RZ.

The South Essex RZ is supplied through a combination of sources, including groundwater from the underlying chalk strata and surface water abstraction from the River Colne which is stored at Ardleigh Reservoir. Ardleigh Reservoir is a shared resource with Affinity Water.

The conclusions on available water supply from the AWS 2015 WRMP can be used directly in this WCS to inform and support the development proposed within Colchester Borough Council's new Local Plan.

Forecasting completed for the AWS 2015 WRMP indicates that, without new measures, the South Essex RZ will be in deficit under dry year annual average by 1.02 Ml/d at the end of AMP10 (2039-2040). This deficit is driven by both a growth in household demand and target headroom requirements. A deficit is not apparent for the dry year critical period equivalent. The total number of household customers within the resource zone which were billed on the basis of measured supplies was 76%.

4.3.1.1 AWS Supply-Demand Strategy

AWS has identified a number of schemes which could be selected to benefit the South Essex RZ and will help to reduce the supply-demand deficit. The options are as follows:

- SE1 Colchester water reuse: Effluent from Colchester WRC would be treated to an extremely high (near potable) standard and discharged to the River Colne to supplement river flows and permit increased abstraction. A new pipeline and pumping station would require additional treatment capacity.
- SE2 East Suffolk RZ Transfer (12 Ml/d): This option provides for the transfer of 12 Ml/d of water from Ipswich in the East Suffolk RZ to Colchester via a new 22km long pipeline
- SE4 Amendment to Ardleigh agreement: Resources in the Colchester area shared with Affinity Water. This option would increase the Anglian Water share of the available resource.
- SE6 South Essex RZ groundwater development: This option provides for the utilisation of an existing licensed borehole in the Colchester area. New treatment facilitates would be required.
- SE7 Ardleigh reservoir extension: An extension to an existing reservoir utilising disuses mineral abstraction pits to provide additional storage. Additional treatment capacity and transfer pipelines would also be required; and,
- SE8 East Suffolk RZ transfer (2Ml/d): This option is similar to option SE2 above but requires a smaller pipeline. These two options (in addition with ES10 South Essex RZ transfer to East Suffolk RZ) are mutually exclusive because only one of the transfer options would be constructed.

SE2 and SE8 utilise the surplus apparent within the East Suffolk RZ during the beginning of the forecasting period. However, once these resources become depleted, further resources will be required to supply the transfer, as described within Anglian WRMP within the East Suffolk RZ summary.

AWS have identified their preferred plan for the South Essex RZ as outlined in Table 4-3:

Table 4-3: South Essex RZ – Preferred Plan

Scheme Type	AMP6 (2015-20)	AMP7 (2020-25)	AMP8 (2025-30)	AMP9 (2030-35)	AMP10 (2035-40)	South Essex RZ Residual Deficit (2039-40)
Resources side	-	-	-	SE4 – Amendment to Ardleigh Agreement	-	0 Ml/d
Distribution side	Transfers out of South Essex RZ to support Central Essex RZ and East Suffolk RZ: • CE1 – South Essex RZ transfer to Central Essex RZ • ES10 – South Essex RZ transfer to East Suffolk RZ.	-	-	-	-	
Customer (Demand) side	Water efficiency plan (Section 4.3.2): • Approx. 9,000 water efficiency audits • Estimated 4,000 customers will opt onto metered billing • Leakage reduction	-	-	-	-	

The preferred plan assumes:

- Continuation of the current 70/30 arrangement with Affinity Water to trade the resources of Ardleigh reservoir;
- The availability of an option to trade 80/20 with Affinity Water in AMP9; and
- That the deployable output of the Ardleigh WTW can be maintained at the 36Ml/d currently assumed.

4.3.2 Water Efficiency Plan

As well as providing additional supply resource, it is important to ensure that the existing resources are used as efficiently as possible to reduce demand. AWS is planning a series of demand management measures and a number of improvements to existing infrastructure and resources across the South Essex RZ. The majority of these measures will

be undertaken in AMP6 (2019-2020). Lowering water consumption levels is considered to be a priority in offsetting resource development.

Proposed demand management measures across the South Essex RZ include:

- Completing water efficiency audits (AWS aim to complete ~9,000 water efficiency audits in the South Essex RZ);
- Water metering (AWS expect 4,000 customers will opt in for metered billing in the South Essex RZ);
- Leakage reduction;
- Mitigating drought risk (increasing environmental awareness).

There are several key drivers for ensuring that water use in the development plan period is minimised as far as possible through the adoption of water efficiency policy. This WCS therefore includes an assessment of the feasibility of achieving a 'water neutral' position after growth across the Borough. This is set out in the following subsections.

4.4 Drivers and Justification for Water Efficiency

4.4.1 Water Stress

In 2013, the AWS supply area was classified by the Environment Agency as an 'Area of serious water stress'[12] based on a 'Water Exploitation Index' as derived by the European Environment Agency. Part of this classification is based on climate change effects as well as increases in demand driven by Local Plan growth targets. This creates a very strong driver for new homes in the next 25 years to be made as efficient as economically possible to safeguard the future resources to be made available by AWS in the study area.

4.4.2 Managing Climate Change and Availability of Water

In their Strategic Direction Statement[13], AWS state that climate change is the biggest single risk facing their business over the next 25 years. Customers expect AWS to provide a continuous supply of water, but the resilience of the supply systems have the potential to be affected by the impact of climate change with severe weather-related events, such as flooding or an 'outage' incident at a source works supplying one of the major centres of population in the region.

In their 2015 WRMP, AWS highlight that over the planning period the key water resources challenges they face are from the impacts of growth and climate change. Overall, AWS predict their supply-demand balance could be at risk from adverse changes which may be as large as approximately 50% of their 2011/12 Distribution Input.

It is predicted that climate change will further reduce the available water resources in Colchester as rainfall patterns change to less frequent, but more extreme, rainfall events in the summer months, and winter rainfall patterns become more frequent and intense.

AWS reported that the changes most significant for managing water resources in their supply area are:

- the increase in rainfall in the winter;
- reduction in the summer rainfall; and
- an increase in summer temperatures that will reduce the length of the winter recharge season and potentially increase the demand for water.

At a strategic level, AWS highlighted that it will be important to store more run-off from winter rainfall and to enhance the natural groundwater recharge.

4.4.2.1 Impact on Supplies

AWS have undertaken analysis of the impacts of climate change on the future availability of their water resources on both their groundwater and surface water sources, and incorporated these results into their assessment of deployable output.

The analysis involved processing median, best and worst case scenarios through a number of recognised climate change models, for the groundwater and surface water sources in the WRZs considered the most vulnerable to the

[12] Environment Agency (2013). Water Stressed Areas – Final Classification. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/244333/water-stressed-classification-2013.pdf
[13] Anglian Water (2007) Strategic Direction Statement 2010 - 2035

potential impacts of climate change on source yield. The results identified a more significant impact on surface water source yield (reservoir and direct intake) than for groundwater. The modelling results also indicated that in some cases potential groundwater yield could increase, as the climate change scenarios not only predict higher temperatures but increased periods of prolonged and heavy rainfall.

The impact of a worst case climate change scenario on water resources over the plan period within the South Essex RZ is estimated at a decrease of 3.6 Ml/d by 2040.

4.4.2.2 Impact on Demand

The main impact of climate change on demand is related to periods of extremely hot and dry weather that will increase the peak demand for water. AWS have accounted for the impact on the peak demand and the longer duration effect of a dry year through applying factors to the household and non-household water consumption rate in their supply-demand modelling. The effect of peak demand varies between WRZ due to factors such as the location of holiday resorts and heavy industry and socio-economic factors reflected in the type and age of housing stock and customers' behaviour.

Although AWS have planned for the anticipated impacts of climate change, the view of AWS and other water companies is that, in order to manage the effects of climate change effectively, the single most cost effective step in water resources climate change resilience is to manage demand downwards. The reduction in demand will also help to reduce carbon emissions which aids in reducing impacts of climate change. Planning policy has a significant role to play in helping to achieve this.

For the South Essex RZ, climate change impacts upon demand are considered to be marginal and equivalent to approximately a 2% increase across the forecast period.

4.5 Water Neutrality

4.5.1 What is Water Neutrality?

Water neutrality is a concept whereby the total demand for water within a planning area after development has taken place is the same (or less) than it was before development took place[14]. If this can be achieved, the overall balance for water demand is 'neutral', and there is considered to be no net increase in demand as a result of development. In order to achieve this, new development needs to be subject to planning policy which aims to ensure that where possible, houses and businesses are built to high standards of water efficiency through the use of water efficient fixtures and fittings, and in some cases rainwater harvesting and greywater recycling.

It is theoretically possible that neutrality can be achieved within a new development area, through the complete management of the water cycle within that development area. In addition to water demand being limited to a minimum, it requires:

- All wastewater to be treated and re-used for potable consumption rather than discharged to the environment;
- Maximisation of rainwater harvesting (in some cases complete capture of rainfall falling within the development) for use in the home; and,
- Abstraction of local groundwater or river flow storage for treatment and potable supply.

Achieving 'total' water neutrality within a development remains an aspirational concept and is usually only considered for an eco-town or eco-village type development, due to the requirement for specific catchment conditions to supply raw water for treatment and significant capital expenditure. It also requires specialist operational input to maintain the systems such as wastewater re-use on a community scale. Total neutrality for a single development site is yet to be achieved in the UK.

For the majority of new development, in order for the water neutrality concept to work, the additional demand created by new development needs to be offset in part by reducing the demand from existing population and employment. Therefore, a 'planning area' needs to be considered where measures are taken to reduce existing or current water demand from the current housing and employment stock. The planning area in this case is considered to be Colchester Borough Council as a whole.

[14] Water Neutrality is defined more fully in the Environment Agency report 'Towards water neutrality in the Thames Gateway' (2007)

4.5.2 Twin-Track Approach

Attainment of water neutrality requires a 'twin track' approach whereby water demand in new development is minimised as far as possible, whilst at the same time taking measures, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available[15]. Generally, these measures fall into two categories due to cost and space constraints, as those that should be installed in new developments and those which could be retrofitted. Appendix C provides more detail on the different types of device or system along with the range of efficiency savings they could deliver.

4.5.3 Achieving Total Neutrality – is it feasible?

When considering neutrality within an existing planning area, it is recognised by the Environment Agency[16] that achievement of total water neutrality (100%) for new development is often not possible, as the levels of water savings required in existing stock may not be possible for the level of growth proposed. A lower percentage of neutrality may therefore be a realistic target, for example 50% neutrality.

This WCS therefore considers four water neutrality targets and sets out a 'pathway' for how the most likely target (or level of neutrality) can be achieved. The pathway concept is discussed in more detail in Appendix C, and highlights the importance of developing local policy in the Colchester Borough for delivering aspirations like water neutrality as well as understanding the additional steps required beyond 'business as usual' required to achieve it.

4.5.4 Water Neutrality Scenarios

Four water neutrality targets have been proposed and assessed. Each target moves beyond the Business as Usual scenario, which is considered to be:

- 125 l/h/d for all new homes[17];
- No mandatory efficiency target for non-domestic property; and
- Continued meter installation in existing homes as planned in AWS' WRMP up to 2040.

The existing level of metering within the AWS South Essex RZ is 82%. AWS' future target for meter penetration[18] on domestic water meters in the South Essex RZ is 97% by 2040.

The water neutrality scenarios have been developed based on the following generic assumptions. For clarity, Colchester Borough Council has been considered as a whole when assessing the scenarios:

4.5.4.1 Very High Scenario

The scenario has been developed as a context to demonstrate what is required to achieve the full aspiration of water neutrality. In reality, achieving 100% meter penetration across the Borough is unlikely, due to a proportion of existing properties which either have complicated plumbing or whose water is supplied by bulk (i.e. flats), making it difficult for meter installation.

The key assumptions for this scenario are that water neutrality is achieved; however it is considered as aspirational only as it is unlikely to be feasible based on:

- Existing research into financial viability of such high levels of water efficiency measures in new homes; and,
- Uptake of retrofitting water efficiency measures considered to be at the maximum achievable (33%) in the Borough.
- It would require:
  - A significant funding pool and a specific joint partnership 'delivery plan' to deliver the extremely high percentage of retrofitting measures required;
  - Strong local policy within the Local Plan on restriction of water use in new homes on a Borough scale which is currently unprecedented in the UK; and

[15] Source: Water Efficiency in the South East of England, Environment Agency, April 2007.
[16] Environment Agency (2009) *Water Neutrality, an improved and expanded water management definition*
[17] Building regulations Part G Requirement
[18] proportion of properties within the AWS supply area which have a water meter installed

- All new development to include water recycling facilities across the Borough which is currently limited to small scale development in the UK.

4.5.4.2 High Scenario

The key assumptions for this scenario are that a high water neutrality percentage[19] is achieved but requires significant funding and partnership working, and adoption of new local policy which is currently unprecedented in the UK.

It would require:

- Uptake of retrofitting water efficiency measures to be very high (30%) in relation to studies undertaken across the UK; and,
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.
- It is considered that, despite being at the upper scale of percentage uptake of retrofitting measures, it is technically and politically feasible to obtain this level of neutrality if a fully funded joint partnership approach could be developed.

4.5.4.3 Medium Scenario

The key assumptions for this scenario are that the water neutrality percentage[20] achieved is at least 50% of the total neutrality target and would require funding and partnership working, and adoption of new local policy which has only been adopted in a minimal number of Local Plans in the UK.

It would require:

- Uptake of retrofitting water efficiency measures to be reasonably high (25%) in the Borough; and,
- A significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures required.
- It is considered that it is technically and politically feasible to obtain this level with a relatively modest funded joint partnership approach and with new developers contributing relatively standard, but high spec water efficient homes.

4.5.4.4 Business as Usual / Low Scenario

The key assumptions for this scenario are that the water neutrality percentage[21] achieved is low and that all new homes are built to Building Regulations standard of 125 l/h/d, but would require small scale level of funding and partnership working, and adoption of new local policy which is likely to be easily justified and straightforward for developers to implement.

It would require:

- Uptake of retrofitting water efficiency measures to be fairly low (15%); and,
- A relatively small funding pool and a partnership working not moving too far beyond 'business as usual' for stakeholders.

It is considered that it is technically and politically straightforward to obtain this level with a small funded joint partnership approach and with new developers contributing standard, but water efficient homes with a relative low capital expenditure.

4.5.5 Neutrality Scenario Assessment Results

To achieve total water neutrality, the demand post growth must be the same as, or less than existing demand. Based on estimates of population size, existing demand in Colchester Borough was calculated to be 22.7 Ml/d.

For each neutrality option and scenario, an outline of the required water efficiency specification was developed for new houses, combined with an estimate of the savings that could be achieved through metering and further savings that

[19] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue
[20] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue
[21] WN percentage refers to the percentage of water use savings made by various measures against the total new demand if the business as usual demand were to continue

could be achieved via retrofitting of water efficient fixtures and fittings in existing property. This has been undertaken utilising research undertaken by groups and organisations such as Waterwise, UKWIR[22], the Environment Agency and Ofwat to determine realistic and feasible efficiency savings as part of developer design of properties, and standards for non-residential properties (Appendix C).

Additional projections have also been provided, incorporating the effect of retrofitting existing properties with water efficient fixtures and fittings. These projections are described as;

- **Projection 2b** – Low Scenario (Building Regulations and Retrofit of Existing Properties) – New homes would conform to (and not use more than) Part G of the Building Regulations requirement of 125 l/h/d along with a percentage of existing homes being retrofit with water efficient fixtures and fittings;
- **Projection 3b** – Medium Scenario (Building Regulations Optional Requirement and Retrofit of Existing Properties) - New homes would conform to (and not use more than) Part G of the Building Regulations optional requirement of 110 l/h/d with a percentage of existing homes retrofitted with water efficient fixtures and fittings;

For each neutrality scenario, total demand was then calculated at three separate stages for housing as follows:

- Stage 1 – Total demand post growth without any assumed water efficiency retrofitting for the differing levels of water efficiency in new homes;
- Stage 2 – Total demand post growth with effect of metering applied for the differing levels of water efficiency in new homes; and,
- Stage 3 – Total demand post growth with metering and water efficient retrofitting applied to existing homes for the differing levels of water efficiency in new homes. The results are provided in

[22] UKWIR – The United Kingdom Water Industry Research group, attended and part funded by all major UK water companies

– Table 4-4. If neutrality is achieved, the result is displayed as green. If it is not, but is within 5%, it is displayed as amber, and red if neutrality above the 5% threshold is not achieved.. The percentage of total neutrality achieved per scenario is also provided.

Table 4-4: Results of the Neutrality Scenario Assessments

Neutrality Scenario	New Homes demand projections	Consumption rate (l/h/d)	% of existing properties to be retrofitted	Demand from Growth (Ml/d)	Total demand post growth* (Ml/d)	Total demand after metering effect (Ml/d)	Total demand after metering & retrofitting (Ml/d)	% Neutrality Achieved
Baseline	Projection 1: Average metered consumption	138	0	5.04	27.76	**27.16**	**27.16**	12%
Low	Projection 2a: Building Regulations	125	0	4.59	27.31	**26.71**	**26.71**	21%
	Projection 2b: Building Regulations + Retrofitting	125	15	4.59	27.31	**26.71**	**26.35**	28%
Medium	Projection 3a: Building Regulations optional requirement	110	0	4.07	26.78	**26.19**	**26.19**	31%
	Projection 3b: Building Regulations optional requirement + Retrofitting	110	25	4.007	26.78	**26.19**	**24.90**	57%
High	Projection 5: High efficiency scenario	80	30	3.03	25.74	**25.05**	**22.86**	97%
Very High	Projection 6: Very High efficiency scenario	62	33	2.40	25.12	**24.43**	**22.01**	100%

* prior to demand management for existing housing stock

The results show that total neutrality is only achieved by applying the Very High WN scenario, requiring new homes to use water at a rate of 62 l/h/d respectively. The Medium WN scenario would give a minimum of 31% neutrality which would require only new homes to be designed to use water at a rate of 110 l/h/d (Projection 3a). A further 26% neutrality (up to 57%) could be achieved through retrofitting 25% of the existing housing stock with water efficiency fittings equivalent to the optional requirement standard.

4.5.6 Delivery Requirements – Technological

The details of what is required technologically from each scenario in terms of new build are included in Table 4-5.

Table 4-5: Details of new build specification required to meet each water use target

Component	138 l/h/d Standard Home	Building Regulations 125 l/h/d	Building Regulations Optional Target 110 l/h/d	High 80 l/h/d	62 l/h/d (water recycling)
Toilet flushing	28.2	18.7 **b**	12.3 **d**	12.3 **d**	12.3 **d**
Taps	24.1 **a**	22.7 **a**	20.5 **a**	15.3 **a**	15.3 **a**
Shower	43.7	39.8	31.8	23.9	23.9
Bath	18.5 **c**	18.5 **c**	17.0 **f**	14.5 **h**	14.5 **h**
Washing Machine	15.6	15.6	15.6	15.6	15.6
Dishwasher	4.1	4.1	4.1	4.1	4.1
Recycled water				-13.4 **e**	-26.8 **g**
External Use	5	5	5	0	0
Total per head	139.3	124.4	106.3	77.3	63.9
Total per household	292.4	261.3	223.3	162.4	134.2

- **a** Combines kitchen sink and wash hand basin
- **b** 6/4 litre dual-flush toilet (f) recycled water
- **c** 185 litre bath
- **d** 4/2.6 litre dual flush toilet
- **e** Rainwater harvesting for external and toilet use
- **f** 170 litre bath
- **g** Rainwater/greywater harvesting for toilet, external and washing machine
- **h** 145 litre bath

More detail on the specific measures required under each scenario can be found in Appendix C.

4.5.7 Financial Cost Considerations

There are detailed financial and sustainability issues to consider in deciding on a policy for water neutrality. Whilst being water efficient is a key consideration of this study, due to the wider vision for sustainable growth in the Borough, reaching neutrality should not be at the expense of increasing energy use and potential increasing the carbon footprint of development

It is also important to consider that through using less water, more water efficient homes require less energy to heat water, hence there are energy savings. These elements are broken down in more detail in Appendix C.

The financial cost of delivering the technological requirements of each neutrality scenario have been calculated from available research and published documents. Summary tables below should be reviewed with Appendix C.

4.5.8 Neutrality Score Costs

Using the information compiled, the financial costs per neutrality scenario has been calculated and are included in Table 4-6. It should be noted that these are only estimate costs.

Table 4-6: Estimated Cost of Neutrality Scenarios

Neutrality Scenario	New Homes		Existing Properties					Costs Summary		
	No.	Efficiency cost	No. to be metered	Metering cost	Population Retrofit %	No. to retrofit	Retrofit cost	Developer	Non developer	Total
Low	16,144	-	1,960	£ 979,788	15%	11,758	£ 587,873	-	£ 1,567,660	£ 1,567,660
Medium	16,144	£ 145,296	1,960	£ 979,788	25%	19,596	£ 3,821,171	£ 145,296	£ 4,800,959	£ 4,946,255
High	16,144	£ 43,540,368	1,960	£ 979,788	30%	23,515	£ 5,173,278	£ 43,540,368	£ 6,153,066	£ 49,693,434
Very High	16,144	£ 66,141,968	1,960	£ 979,788	38%	25,866	£ 5,690,606	£ 66,141,968	£ 6,670,393	£ 72,812,361

4.5.9 Preferred Strategy – Delivery Pathway

The assessment of water neutrality in this WCS has been undertaken to demonstrate whether moving towards neutrality is feasible and what the cost, and technological implications might be to get as close to neutrality as possible.

To achieve any level of neutrality, a series of policies, partnership approaches and funding sources would need to be developed. This WCS has assumed a 'medium' scenario would be favoured and sets out what would be required to support this strategy. This 'medium' WN scenario would allow a WN target of between 31 and 6049% to be reached if all the households that remain unmetered in 2040 are additionally metered. The medium scenario is considered to require a significant funding pool and a specific joint partnership 'delivery plan' to deliver the high percentage of retrofitting measures, as well as the adoption of new local policy within the Local Plan on restriction of water use in new homes on a Borough scale which goes beyond that seen generally in the UK.

It is considered that it is technically and politically feasible to obtain this level with a relatively modest funded joint partnership approach and with new developers contributing relatively standard, but high spec water efficient homes.

Depending on the success of the first step to neutrality, higher WN scenarios could be aspired to by further developing policies and partnership working to deliver greater efficiencies.

4.5.10 Delivery Requirements – Policy

In order to meet the medium water neutrality target scenario given above, specific planning policy will be required and recommendations are presented in Section 6.

When considering planning applications for new development (regardless of size), the planning authority and statutory consultees should consider whether the proposed design of the development has incorporated water efficiency measures, including (but not necessarily limited to) garden water butts, low flush toilets, low volume baths, aerated taps, and water efficient appliances sufficient to meet 110l/h/d.

Undertaking retrofitting and water audits must work in parallel with the promotion and education programme. Further recommendations on how to achieve it are included in Section 4.5.11 below, including recommended funding mechanisms.

4.5.11 Delivery Requirements – Partnership Approaches

Housing association partners should be targeted with a programme of retrofitting water efficient devices, to showcase the policy and promote the benefits. This should be a collaborative scheme between Colchester Borough Council, AWS and Waterwise. In addition, RWH/GWR schemes could be implemented into larger council owned and maintained buildings, such as schools or community centres. RWH could be introduced to public toilets.

A programme of water audits should be carried out in existing domestic and non-domestic buildings, again showcased by Council owned properties, to establish water usage and to make recommendations for improving water efficiency measures. The water audits should be followed up by retrofitting water efficient measures in these buildings, as discussed above. In private non-domestic buildings water audits and retrofitting should be funded by the asset owner, the cost of this could be offset by the financial savings resulting from the implementation of water efficient measures. Funding options for domestic properties are discussed above.

In order to ensure the uptake of retrofitting water efficient devices for non-council properties, Colchester Borough Council should implement an awareness and education campaign, which could include the following:

- working with AWS to help with its water efficiency initiative, which has seen leaflets distributed directly to customers and at events across the region each year;
- a media campaign, with adverts/articles in local papers and features on a local news programme;
- a media campaign could be supplemented by promotional material, ranging from those that directly affect water use e.g. free cistern displacement devices, to products which will raise awareness e.g. fridge magnets with a water saving message;
- encouraging developers to provide new residents with 'welcome packs', explaining the importance of water efficiency and the steps that they can take to reduce water use;
- working with retailers to promote water efficient products, possibly with financial incentives as were undertaken as part of the Preston Water Initiative[23];

[23] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

- carrying out educational visits to schools and colleges, to raise awareness of water efficiency amongst children and young adults;
- working with neighbourhood trusts, community groups and local interest groups to raise awareness of water efficiency; and,
- carrying out home visits to householders to explain the benefits of saving water, this may not be possible for the general population of Colchester Borough Council, but rather should be used to support a targeted scheme aimed at a specific residential group, as was carried out for the Preston Water Initiative.

4.5.11.1 Responsibility

The recommendations above are targeted at Colchester Borough Council and AWS, as these are the major stakeholders, although the Environment Agency and other statutory consultees can also influence future development to ensure the water neutrality target is achieved.

It is therefore suggested that responsibility for implementing water efficiency policies be shared as detailed in Table 4-7.

Table 4-7 Responsibility for implementing water efficiency

Responsibility	Responsible stakeholder
Ensure planning applications are compliant with the recommended policies	Colchester BC
Fitting water efficient devices in accordance with policy	Developers
Provide guidance and if necessary enforce the installation of water efficient devices through the planning application process	Colchester BC
Ensure continuing increases in the level of water meter penetration	AWS
Retrofit devices within council owned housing stock	Colchester BC
Retrofit devices within privately owned housing stock (via section 106 agreements)	Developers
Promote water audits and set targets for the number of businesses that have water audits carried out. Allocate a specific individual or team within the local authority to be responsible for promoting and undertaking water audits and ensuring the targets are met. The same team or individual could also act as a community liaison for households (council and privately owned) and businesses where water efficient devices are to be retrofitted, to ensure the occupants of the affected properties understand the need and mechanisms for water efficiency.	Colchester BC
Educate and raise awareness of water efficiency	Colchester BC and AWS

A major aim of the education and awareness programme, as outlined by Policy Recommendation WS5, is to change peoples' attitude to water use and water saving and to make the general population understand that it is everybody's responsibility to reduce water use. Studies have shown that the water efficiencies in existing housing stock achieved by behavioural changes, such as turning off the tap while brushing teeth or reducing shower time, can be as important as the installation of water efficient devices.

4.5.11.2 Retrofitting funding options

Water companies are embarking on retrofit as part of their response to meeting OFWAT's mandatory water efficiency targets. These programmes are funded out of operational expenditure. If a company has, or is forecasting, a supply-demand deficit over the planning period, water efficiency programmes can form part of a preferred option(s) set to overcome the deficit. However, these options are identified as part of the company's water resource management plans and will have to undergo a cost-benefit analysis.

Colchester Borough Council could consider developer contributions to through S106 agreements.

Section 106 (S106) of the Town and Country Planning Act 1990[24] allows an authority to enter into a legally-binding agreement or planning obligation with a landowner in association with the granting of planning permission, known as a Section 106 Agreement. These agreements are a way of delivering or addressing matters that are necessary to make a development acceptable in planning terms. They are increasingly used to support the provision of services and infrastructure, such as highways, recreational facilities, education, health and affordable housing.

However, there are considerable existing demands on developer contributions and it is unlikely that all of the retrofitting required in Colchester Borough Council could be funded through this mechanism; they therefore need to look beyond developer contributions, possibly to the water companies, for further funding sources. Some councils offer council tax rebates to residents who install energy efficient measures (rebates jointly funded by the Council and Energy Company)[25]. Colchester Borough Council should consider a similar scheme, although this would require the agreement of AWS.

4.5.11.3 Retrofitting monitoring

During delivery stage, it will be important to ensure sufficient monitoring is in place to track the effects of retrofitting on reducing demand form existing housing stock. The latest research shows that retrofitting can have a significant beneficial effect and can be a cost effective way of managing the water supply-demand balance[26]. However, it is acknowledged that savings from retrofitting measures do diminish with time. This means that a long-term communication strategy is also needed to accompany any retrofit programme taken forward. This needs to be supported by monitoring, so that messages can be targeted and water savings maintained in the longer-term. The communication and monitoring message also applies to new builds to maintain continued use of water efficient fixtures and fittings.

[24] http://www.legislation.gov.uk/ukpga/1990/8/contents
[25] Cambridge (and surrounding major growth areas) WCS Phase 2, Halcrow, 2010
[26] Waterwise (2011): Evidence base for large-scale water efficiency, Phase II Final report

5 Preferred Area Assessment

5.1 Introduction

Following the assessment of wastewater treatment capacity and water resources, this section of the WCS addresses infrastructure capacity issues, flood risk, surface water management and SuDS suitability for each of the major development sites (sites containing more than 10 dwellings). The results are presented for each of the new Local Plan Preferred Sites in Appendix E.

5.2 Preferred Sites Assessment Methodologies

5.2.1 Wastewater Network

The wastewater strategy to cater for growth requires an assessment of the capacity of the wastewater network (sewer system) to accept and transmit wastewater flows from the new development to the WRC for treatment.

The capacity of the existing sewer network is an important consideration for growth, as in some cases the existing system is already at, or over its design capacity. Further additions of wastewater from growth can result in sewer flooding in the system (affecting property or infrastructure) or can increase the frequency with which overflows to river systems occur, resulting in ecological impact and deterioration in water quality.

As the wastewater undertaker for the study area, AWS has a general duty under Section 94 of the Water Industry Act 1991 to provide effectual drainage which includes providing additional capacity as and when required to accommodate planned development. However this legal requirement must also be balanced with the price controls as set by the regulatory body OFWAT which ensure AWS has sufficient funds to finance its functions, and at the same time protect consumers' interests. The price controls affect the bills that customers pay and the sewerage services consumers receive, and ultimately ensure wastewater assets are managed and delivered efficiently.

Consequently, to avoid potential inefficient investment AWS generally do not provide additional capacity until there is certainty that the development is due to commence. Where development proposals are likely to require additional capacity upgrades to accommodate new development flows, it is highly recommended that potential developers contact AWS as early as possible to confirm flow rates and intended connection points. This will ensure the provision of additional capacity is planned into AWS's investment programme to ensure development is not delayed.

AWS have undertaken an internal assessment of the capacity of the network system using local operational knowledge.

The results are presented for each of the Preferred Sites in Appendix E. A RAG assessment has been undertaken; a key indicating the coding applied to each assessment is provided in Table 5-1.

Table 5-1: Key for wastewater network RAG assessment

Development is likely to be possible without upgrades	**Pumping station or pipe size may restrict growth, or non-sewered areas, where there is a lack of infrastructure; a pre-development enquiry is recommended before planning permission is granted**	**There is limited capacity in the network, hence solution required to prevent further CSO discharges or sewer flooding**

5.2.2 Water supply

In addition to available water resources, there is a requirement to consider whether there is the infrastructure capacity to move water to where the demand will increase.

AWS have undertaken an assessment of the capacity of the water supply system using local operational knowledge. A RAG assessment has been undertaken; a key indicating the coding applied to each assessment is provided in Table 5-2

Table 5-2: Key for water supply network RAG assessment

Capacity available to serve the proposed growth	Infrastructure and/or treatment upgrades required to serve proposed growth or diversion of assets may be required	Major constraints to the provision of infrastructure and/or treatment to serve proposed growth

5.2.3 Flood Risk

5.2.3.1 Fluvial

The flood risk to each of the Preferred Sites has been considered using the Environment Agency Flood Maps for Planning. The percentage of development site area within each Flood Zone has been provided. The Colchester Strategic Flood Risk Assessment (SFRA) has also been used to help identify the risk of fluvial flooding at the preferred sites.

5.2.4 Main Rivers

Under the Water Resources Act, the Environment Agency is the consenting Authority for main rivers, and any works in, over, under or near a main river or a flood defence will need consent. A main river is a watercourse that is shown on a main river map and includes any structure or appliance for controlling or regulating the flow of water into, in or out of the channel.

Developers need to obtain Environment Agency consent to ensure that their activities do not cause or make existing flood risk worse, interfere with Environment Agency work, and do not adversely affect the local environment, fisheries or wildlife.

5.2.4.1 Policy recommendations:

- Watercourses should not be culverted or straightened, as these activities cause deterioration of their quality;
- Where watercourses have in the past been culverted or straightened, reinstatement to a more natural landscape should form part of the development;
- Each development should enhance the quality of the local watercourse,
- A minimum easement of 8 meters from the top of bank of a main river is required to allow maintenance of the watercourse. Where possible a larger easement should be provided.

6 Water Cycle Strategy Recommendations and Policy

The following policy recommendations are made and should be considered by Colchester Borough Council to ensure that the Colchester Local Plan considers potential limitations (and opportunities) presented by the water environment and water infrastructure on growth, and phasing of growth.

6.1 Policy Recommendations Overview

6.1.1 Wastewater

WW1 – Development Phasing –Langham (East) WRC
A solution is required to enable the WRC to be able to accept all wastewater flows. An additional solution to upgrade the treatment processes at the WRC with treatment technology beyond what is currently considered conventional may also be required. The preferred solution should be agreed between the Environment Agency and AWS. Both solutions should be confirmed prior to development coming forward in the WRC catchment (projected to be 2022).

WW2 – Development and Sewerage Network
Development at sites indicated in the WCS to have potentially limited sewer network capacity (shown as Amber) should be subject to a pre-development enquiry with AWS to determine if upgrades are needed prior to planning permission being granted.

WW3 – Development of Garden Communities
Integrated water management studies (IWMS) should be undertaken for both the West of Colchester and East of Colchester garden communities to assess the wastewater and water resource demand that this housing and employment growth will place on existing infrastructure and the environment. The IWMS should consider means by which water can be re-used on site to minimise demand for potable water and increasing the loss of this water as wastewater via discharge to Colchester WRCs coastal outfall. Discussion should be had with AWS about the potential options to serve the garden communities.

6.1.2 Water Supply

WS1 – Water Efficiency in new homes
In order to move towards a more 'water neutral position' and to enhance sustainability of development coming forward, a policy should be developed that ensures all housing is as water efficient as possible, and that new housing development should go beyond Building Regulations, ideally to 110 l/h/d. Non-domestic buildings should as a minimum reach 'Good' BREEAM status.

WS2 – Water Efficiency Retrofitting
In order to move towards a more 'water neutral position', a policy could be developed to carry out a programme of retrofitting and water audits of existing dwellings and non-domestic buildings with the aim to move towards delivery of 25% of the existing housing stock with easy fit water savings devices

WS3 – Water Efficiency Promotion
In order to move towards a more 'water neutral position', a policy could be developed to establish a programme of water efficiency promotion and consumer education, with the aim of behavioural change with regards to water use.

6.1.3 Surface Water Management and Flood Risk

SWM1 – Sewer Separation
Developers should ensure foul and surface water from new development and redevelopment are kept separate. Where sites which are currently connected to combined sewers are redeveloped, the opportunity to disconnect surface water and highway drainage from combined sewers must be taken.

SWM2 – SuDS and Green Infrastructure
Developers should ensure linkage of SuDS to green infrastructure to provide environmental enhancement and amenity, social and recreational value. SuDS design should maximise opportunities to create amenity, enhance biodiversity, and contribute to a network of green (and blue) open space.

SWM3 – SuDS and Water Efficiency
Developers should ensure linkage of SuDS to water efficiency measures where possible, including rainwater harvesting.

SWM4 – Linkages to SWMP, SuDS Handbook, SFRA
Developers should ensure SuDS design supports the findings and recommendations of the Colchester Surface Water Management Plan (SWMP), the SuDS Manual (the CIRIA SuDS Manual) and Colchester Borough Council's SFRA and Essex County Council's Sustainable Drainage Systems Design Guide (2014).

SWM5 – Water Quality Improvements
Developers should ensure, where possible, that discharges of surface water are designed to deliver water quality improvements in the receiving watercourse or aquifer where possible to help meet the objectives of the Water Framework Directive.

6.1.4 Ecology

ECO1 – Biodiversity Enhancement
It is recommended that the Colchester Borough Council include a policy within its Local Plan which commits to seeking and securing (through planning permissions etc.) enhancements to aquatic biodiversity in Colchester Borough Council through the use of SuDS (subject to appropriate project-level studies to confirm feasibility including environmental risk and discussion with relevant authorities).

6.2 Further Recommendations

6.2.1 Stakeholder Liaison

It is recommended that key partners in the WCS maintain regular consultation with each other as development proposals progress.

6.2.2 WCS Periodic Review

The WCS should remain a living document, and (ideally) be reviewed on a bi-annual basis as development progresses and changes are made to the various studies and plans that support it; these include:

- five yearly reviews of AWS' WRMP (the next full review is due in 2019, although interim reviews are undertaken annually); and,
- Periodic review 2019 (PR19) (AWS' business plan for AMP7 – 2020 to 2025).

Appendix A. Updated Planning Policies and Guidance

Directive/Legislation/Guidance	Description
Bathing Waters Directive 76/160/EEC	To protect the health of bathers and maintain the aesthetic quality of inland and coastal bathing waters. Sets standards for variables and includes requirements for monitoring and control measures to comply with standards for bacterial levels within designated bathing waters.
Birds Directive 2009/147/EC	Provides for the designation of Special Protection Areas.
Eel Regulations 2009	Provides protection to the European eel during certain periods to prevent fishing and other detrimental impacts.
Environment Act 1995	Sets out the role and responsibility of the Environment Agency.
Environmental Protection Act 1990	Integrated Pollution Control (IPC) system for emissions to air, land and water.
Flood & Water Management Act 2010	The Flood and Water Management Act 2010 is the outcome of a thorough review of the responsibilities of regulators, local authorities, water companies and other stakeholders in the management of flood risk and the water industry in the UK. The Pitt Review of the 2007 flood was a major driver in the forming of the legislation. Its key features relevant to this WCS are: • To give the Environment Agency an overview of all flood and coastal erosion risk management and unitary and county councils the lead in managing the risk of all local floods. • To encourage the uptake of sustainable drainage systems by removing the automatic right to connect to sewers. • To widen the list of uses of water that water companies can control during periods of water shortage, and enable Government to add to and remove uses from the list. • To enable water and sewerage companies to operate concessionary schemes for community groups on surface water drainage charges. • To make it easier for water and sewerage companies to develop and implement social tariffs where companies consider there is a good cause to do so, and in light of guidance that will be issued by the SoS following a full public consultation.
Future Water, February 2008	Sets the Government's vision for water in England to 2030. The strategy sets out an integrated approach to the sustainable management of all aspects of the water cycle, from rainfall and drainage, through to treatment and discharge, focusing on practical ways to achieve the vision to ensure sustainable use of water. The aim is to ensure sustainable delivery of water supplies, and help improve the water environment for future generations.
Groundwater Directive 80/68/EEC	To protect groundwater against pollution by 'List 1 and 2' Dangerous Substances.
Habitats Directive 92/44/EEC and Conservation of Habitats & Species Regulations 2010	To conserve the natural habitats and to conserve wild fauna and flora with the main aim to promote the maintenance of biodiversity taking account of social, economic, cultural and regional requirements. In relation to abstractions and discharges, can require changes to these through the Review of Consents (RoC) process if they are impacting on designated European Sites. Also the legislation that provides for the designation of Special Areas of Conservation provides special protection to certain non-avian species and sets out the requirement for Appropriate Assessment of projects and plans likely to have a significant effect on an internationally designated wildlife site.
Land Drainage Act 1991	Sets out the statutory roles and responsibilities of key organisations such as Internal Drainage Boards, local authorities, the Environment Agency and Riparian owners with jurisdiction over watercourses and land drainage infrastructure.
Making Space for Water, 2004	Outlines the Government's strategy for the next 20 years to implement a more holistic approach to managing flood and coastal erosion risks in England. The policy aims to reduce the threat of flooding to people and property, and to deliver the greatest environmental, social and economic benefit.

National Planning Policy Framework	Planning policy in the UK is set by the National Planning Policy Framework (NPPF). The NPPF revokes most of the previous Planning Policy Statements and Planning Policy Guidance. The accompanying NPPF Technical Guidance has also been superseded by the revised NPPF PPG published as an on-line resource in 2014. NPPF advises local authorities and others on planning policy and operation of the planning system. A WCS helps to balance the requirements of various planning policy documents, and ensure that land-use planning and water cycle infrastructure provision is sustainable.
Pollution Prevention and Control Act (PPCA) 1999	Implements the IPPC Directive. Replaces IPC with a Pollution Prevention and Control (PPC) system, which is similar but applies to a wider range of installations.
Ramsar Convention	Provides for the designation of wetlands of international importance
Urban Waste Water Treatment Directive (UWWTD) 91/271/EEC	This Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. Its aim is to protect the environment from any adverse effects caused by the discharge of such waters.
Water Act 2003	Implements changes to the water abstraction management system and to regulatory arrangements to make water use more sustainable.
Water Framework Directive (WFD) 2000/60/EC	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 or by 2027 if there are grounds for derogation. The WFD, for the first time, combines water quantity and water quality issues together. An integrated approach to the management of all freshwater bodies, ground waters, estuaries and coastal waters at the river basin level has been adopted. It effectively supersedes all water related legislation which drives the existing licensing and permitting framework in the UK. The Environment Agency is the body responsible for the implementation of the WFD in the UK. The Environment Agency have been supported by UKTAG[27], an advisory body which 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[28].
Natural Environment & Rural Communities Act 2006	Covering Duties of public bodies – recognises that biodiversity is core to sustainable communities and that Public bodies have a statutory duty that states that "every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity
Water Resources Act 1991	Protection of the quantity and quality of water resources and aquatic habitats. Parts have been amended by the Water Act 2003. Also sets out flood defence responsibilities of the Environment Agency for main rivers
Wildlife & Countryside Act 1981 (as amended)	Legislation that provides for the protection and designation of SSSIs and specific protection for certain species of animal and plant among other provisions.

[27] 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.
[28] UK Environmental Standards and Conditions (Phase I) Final Report, April 2008, UK Technical Advisory Group on the Water Framework Directive.

Appendix B. WRC Capacity Assessment Results

B.1 Modelling assumptions and input data

Several key assumptions have been used in the water quality and permit modelling as follows:

- the wastewater generation per new household is based on an assumed Occupancy Rate (OR) of 2.1 people per house and an average consumption of 150 l/h/d (as set out in Section 1.6);
- WRC current flows were taken as the current measured dry weather flow (DWF) (Q_{80}). Future 2033 flows were calculated by adding the volume of additional wastewater generated by new dwellings (using an OR of 2.1, a consumption value of 150l/h/d n) to the current permitted DWF value;
- River flow data for the RQP modelling has been provided by the Environment Agency – data was provided as mean flow and Q95.
- The Environment Agency provided the most up to date WFD status.

Details are provided below along with the full results and outputs from the water quality modelling in Tables B2.1 and B2.2.

- For the purposes of this study, the limits of conventionally applied treatment processes are considered to be:
- 5mg/l for BOD;
- 1mg/l for Ammoniacal-N; and
- 0.5mg/l for Phosphate.

B.2 Assessment techniques

Modelling of the quality permits required to meet the two WFD requirements has been undertaken, using RQP 2.5 (River Quality Planning), the Environment Agency's software for calculating permit conditions. The software is a monte-carlo based statistical tool that determines what statistical quality is required from discharges in order to meet defined downstream targets, or to determine the impact of a discharge on downstream water quality compliance statistics.

The first stage of the modelling exercise was to establish the discharge permit standards that would be required to meet 'No Deterioration'. This would be the discharge permit limit that would need to be imposed on AWS at the time the growth causes the flow permit to be exceeded. No deterioration is an absolute requirement of the WFD and any development must not result in a decrease in quality downstream from the current status. The Environment Agency require two parts to the 'No Deterioration' assessment to inform their hierarchical approach to the WFD 'no deterioration' targets used to identify indicative permits. This approach helps with consideration of the relative technical feasibility of ensuring 'no deterioration'.

The second stage was to establish the discharge permit standards that would be required to meet future Good Status under the WFD in the downstream waterbody. This assessment was only carried out for WRCs discharging to waterbodies where the current status is less than Good (i.e. currently Moderate, Poor or Bad). This would be the discharge permit standard that may need to be applied in the future, subject to the assessments of 'technical feasibility' and 'disproportionate cost. Such assessments would be carried out as part of the formal Periodic Review process overseen by OFWAT in order to confirm that the proposed improvement scheme is acceptable.

Step 1 – 'No Deterioration' – C1, C2 and C3
Calculations were undertaken to first determine if deterioration can be limited to 10% of the current downstream quality. If this was not achievable within current limits of technology, the second step determines if the receiving watercourse can maintain no deterioration downstream from the current status with the proposed growth within limits of conventional treatment technology, and what permit limits would be required.

Ref	Calculation Name	Calculation Detail	Reason for Calculation
C1	Limit deterioration to 10%	No deterioration from current *downstream quality + 10%* with future effluent flow	To test whether future growth could cause deterioration in the current water quality downstream, allowing for a 10% exceedance of the current downstream Environmental Quality Standard (EQS)
C2	No deterioration (Current)	No deterioration from current *status* with current effluent flow	To confirm what effluent quality is currently needed to avoid deterioration in the current status downstream with the current flow permit
C3	No deterioration (Future)	No deterioration from current *status* with future effluent flow	To test whether future growth could cause deterioration in the current downstream status
C6	Load Standstill	Required future quality permits with future effluent flow	To be used where the above calculations are not applicable such as for tidal discharges

If 'No Deterioration' could be achieved, then a proposed discharge permit standard was calculated which will be needed as soon as the growth causes the WRC flow permit to be exceeded, see Table B1.

Step 2 – Meeting Future 'Good' Status – C4 and C5
For all WRC where the current downstream quality of the receiving watercourse is less than good, a calculation was undertaken to determine if the receiving watercourse could achieve future 'Good Status', with the proposed growth within limits of conventional treatment technology and what permit limits would be required to achieve this.

The assessment of attainment of future 'Good Status' assumed that other measures will be put in place to ensure 'Good Status' upstream, so that the modelling assumed upstream water quality is at the midpoint of the 'Good Status' for each element and set the downstream target as the lower boundary of the 'Good Status' for each element.

If 'Good' could be achieved with growth with permits achievable within the limits of conventional treatment, then a proposed discharge permit standard which may be needed in the future has been given in Table B2.

If the modelling showed that the watercourse could not meet future 'Good' status with the proposed growth within limits of conventional treatment technology, a further assessment step three was undertaken.

Ref	Calculation Name	Calculation Detail	Reason for Calculation
C4	Achieve Good status (Current)	Achieving good ecological status with current effluent flow	To test what effluent quality would be needed to achieve good status with the current flow permit
C5	Achieve Good status (Future)	Achieving good ecological status with future effluent flow	To assess whether the future quality permit limits needed to achieve good status will be significantly more onerous and difficult to achieve than those currently needed (calculation 4)

Step 3 – Is Growth the Factor Causing failure to meet future 'Good Status'?
In order to determine if it is growth that is causing the failure to attain future 'Good Status' downstream, the modelling in step 2 was repeated, but without the growth in place (i.e. using current flows) as a comparison.

If the watercourse could not meet 'Good Status' without growth (assuming the treatment standard were improved to the limits of conventional treatment technology), then it is not the growth that would be preventing future 'Good Status' being achieved and the 'No Deterioration' permit standard given in Table B1. (Step 1) above would be sufficient to allow the proposed growth to proceed.

If the watercourse could meet 'Good Status' without growth, then it is the growth that would be preventing future 'Good Status' being achieved. Therefore consideration needs to be given to whether there are alternative treatment options that would prevent the future failure to attain 'Good Status'. The methodology is designed to look at the impact of proposed growth alone, and whether the achievement of 'Good Status' will be compromised. It is important that AWS have an understanding of what permits may be necessary in the future. The RBMP and Periodic Review planning processes will deal with all other issues of disproportionate costs.

B.3 Assessment Tables

'NO DETERIORATION' ASSESSMENT - December 2016

	Langham (East) WRC	
	Ammonia	**Phosphate**
River Downstream of Discharge	Stour (Lamarsh - R. Brett)	
No Deterioration target	**High**	**Moderate**
River quality target (90%ile or AA)	**0.30**	**0.23**
LCT	1	0.5
(C1) Discharge Quality Required (+10%)		
Future DWF (m3/day)	**667**	
Permit limits (95%ile or AA)	7	-
Current D/S quality **+10%** (90%ile or AA)	0.08	0.16
Effluent quality required to avoid deterioration from current D/S quality (+10%) (95%ile or AA)	**0.14**	**0.21**
Can more than a 10% deterioration in current D/S quality be avoided?	No - would require an effluent quality which cannot be achieved with current treatment technology	No - would require an effluent quality which cannot be achieved with current treatment technology
(C2) Current DWF Permit		
Current DWF (m3/day)	**616**	
Permit limits (95%ile or AA)	7	-
Current effluent quality (95%ile or AA)	**1.05**	**0.46**
(C3) Discharge Quality Required		
Future DWF (m3/day)	**667**	
Effluent quality required to avoid deterioration from current status (95%ile or AA)	**1.00**	**0.44**
Will Growth prevent WFD objective of 'No Deterioration' from being achieved ?	No - current effluent quality would need to be improved and can be achieved with current treatment technology. The future effluent quality could also be achieved with current treatment technology.	No - would require an effluent quality which cannot be achieved with current treatment technology. It is not growth that would cause a deterioration in status, but current limits in technology.

'IMPROVEMENT TO GOOD STATUS' ASSESSMENT - December 2016

	Langham (East) WRC	
	Ammonia	**Phosphate**
River Downstream of Discharge		
WFD Status target	N/A	Good
River quality target (90-percentile or AA)	N/A	**0.08**
(C4) Discharge Quality Required - Current		
Current DWF (m3/day)	**616**	
Effluent quality required (95%ile or AA)	N/A	**0.15**
(C5) Discharge Quality Required - Future		
Future DWF (m3/day)	**667**	
Effluent quality required (95%ile or AA)	N/A	**0.15**
Will Growth prevent WFD Good Status from being achieved ?	N/A	No - it is not growth preventing the future target status from being achieved, but current limits in technology.

Key to 'Effluent Quality Required'
Green Value – no change to current permit required
Amber Value – Permit tightening required, but within limits of conventionally applied treatment processes
Red Value – not achievable within limits of conventionally applied treatment processes

Appendix C. Water Neutrality

Water Neutrality is defined in Section 4, and the assumptions used outlined in Section 1.6. This appendix provides supplementary information and guidance behind the processes followed.

C.1 Twin-Track Approach

Attainment of water neutrality requires a 'twin track' approach whereby water demand in new development is minimised as far as possible. At the same time measures are taken, such as retrofitting of water efficient devices on existing homes and business to reduce water use in existing development.

In order to reduce water consumption and manage demand for the limited water resources within the study area, a number of measures and devices are available[29], including:

- cistern displacement devices;
- flow regulation;
- greywater recycling;
- low or variable flush replacement toilets;
- low flow showers;
- metering;
- point of use water heaters;
- pressure control;
- rainwater harvesting;
- variable tariffs;
- low flows taps;
- water audits;
- water butts;
- water efficient garden irrigation; and,
- water efficiency promotion and education.

The varying costs and space and design constraints of the above mean that they can be divided into two categories, measures that should be installed for new developments and those which can be retrofitted into existing properties. For example, due to economies of scale, to install a rainwater harvesting system is more cost effective when carried out on a large scale and it is therefore often incorporated into new build schools, hotels or other similar buildings. Rainwater harvesting is less well advanced as part of domestic new builds, as the payback periods are longer for smaller systems and there are maintenance issues. To retrofit a rainwater harvesting system can have very high installation costs, which reduces the feasibility of it.

However, there are a number of the measures listed above that can be easily and cheaply installed into existing properties, particularly if part of a large campaign targeted at a number of properties. Examples of these include the fitting of dual-flush toilets and low flow showers heads to social housing stock, as was successfully carried out in Preston by Reigate and Banstead Council in conjunction with Sutton and East Surrey Water and Waterwise[30].

C.2 The Pathway Concept

The term 'pathway' is used here as it is acknowledged that, to achieve any level of neutrality, a series of steps are required in order to go beyond the minimum starting point for water efficiency which is currently mandatory for new development under current and planned national planning policy and legislation.

There are no statutory requirements for new housing to have a low water use specification as previous government proposals to make different levels compulsory have been postponed pending government review. For non-domestic development, there is no statutory requirement to have a sustainability rating with the Building Research Establishment Environmental Assessment Method (BREEAM), only being mandatory where specified by a public body in England such as:

- Local Authorities incorporating environmental standards as part of supplementary planning guidance;
- NHS buildings for new buildings and refurbishments;

[29] Water Efficiency in the South East of England, Environment Agency, April 2007.
[30] Preston Water Efficiency Report, Waterwise, March 2009, www.waterwise.org.uk

- Department for Children, Schools and Families for all projects valued at over £500K (primary schools) and £2million (secondary schools);
- English Partnerships (now incorporated into the Homes and Communities Agency) for all new developments involving their land; and,
- Office of Government Commerce for all new buildings;

Therefore, other than potential local policies delivered through a Local Plan, the only water efficiency requirements for new development are through the Building Regulations[31] where new homes must be built to specification to restrict water use to 125l/h/d or 110l/h/d where the optional requirement applies. However, the key aim of the Localism Act is to decentralise power away from central government towards local authorities and the communities they serve. It therefore creates a stronger driver for local authorities to propose local policy to address specific local concerns. New local level policy is therefore key to delivering aspirations such as water neutrality and the Localism Act provides the legislative mechanism to achieve this in Colchester Borough Council.

In addition to the steps required in new local policy, the use of a pathway to describe the process of achieving water neutrality is also relevant to the other elements required to deliver it, as it describes the additional steps required beyond 'business as usual' that both developers and stakeholders with a role (or interest) in delivering water neutrality would need to take, for example:

- the steps required to deliver higher water efficiency levels on the ground (for the developers themselves); and,
- the partnership initiative that would be required beyond that normally undertaken by local authorities and water companies in order to minimise existing water use from the current housing and business stock.

Therefore, the pathway to neutrality described in this section of the WCS requires a series of steps covering:

- technological inputs in terms of physically delivering water efficiency measures on the ground;
- local planning policies which go beyond national guidance; and,
- partnership initiatives and partnership working.

The following sections outline the types of water efficiency measures which have been considered in developing the technological pathway for the water neutrality target scenarios.

C.3 Improving Efficiency in Existing Development

C.3.1 Metering

The installation of water meters in existing housing stock has the potential to generate significant water use reductions because it gives customers a financial incentive to reduce their water consumption. Being on a meter also encourages the installation and use of other water saving products, by introducing a financial incentive and introducing a price signal against which the payback time of new water efficiency measures can be assessed. Metering typically results in a 5-10 per cent reduction from unmetered supply, which equates to water savings of approximately 50l per household per day, assuming an occupancy rate of 2.3[32] for existing properties.

In 2009, DEFRA instructed Anna Walker (the Chair of the Office of Rail Regulation) to carry out an independent review of charging for household water and sewerage services (the Walker view)[33]. The typical savings in water bills of metered and unmetered households were compared by the Walker review, which gives an indication of the levels of water saving that can be expected (see Table C-1).

Table C-1: Change in typical metered and unmetered household bills

2009-10 Metered	2009-10 Unmetered	2014-15 Metered	2014-15 Unmetered	% change Metered	% change Unmetered
348	470	336	533	-3	13

C.3.2 Low or Variable Flush Toilets

[31] Part G of the Building Regulations
[32] 2.3 is used for existing properties and new properties. This figure was agreed with STW prior to the assessment
[33] Independent Walker Review of Charging and Metering for Water and Sewerage services, DEFRA, 2009, http://www.defra.gov.uk/environment/quality/water/industry/walkerreview/

Toilets use about 30 per cent of the total water used in a household[34]. An old style single flush toilet can use up to 13 litres of water in one flush. New, more water-efficient dual-flush toilets can use as little as 2.6 litres[35]per flush. A study carried out in 2000 by Southern Water and the Environment Agency[36] on 33 domestic properties in Sussex showed that the average dual flush saving observed during the trial was 27 per cent, equivalent to a volumetric saving of around 2.6 litres per flush. The study suggested that replacing existing toilets with low or variable flush alternatives could reduce the volume of water used for toilet flushing by approximately 27 per cent on average.

C.3.3 Cistern Displacement Devices

These are simple devices which are placed in the toilet cistern by the user, which displace water and therefore reduce the volume that is used with each flush. This can be easily installed by the householder and are very cheap to produce and supply. Water companies and environmental organisations often provide these for free.

Depending on the type of devices used (these can vary from a custom made device, such bag filled with material that expands on contact with water, to a household brick) the water savings can be up to 3 litres per flush.

C.3.4 Low Flow Taps and Showers

Flow reducing aerating taps and shower heads restrict the flow of water without reducing water pressure. Thames Water estimates that an aerating shower head can cut water use by 60 per cent with no loss of performance[37].

C.3.5 Pressure Control

Reducing pressure within the water supply network can be an effective method of reducing the volume of water supplied to customers. However, many modern appliances, such as Combi boilers, point of use water heaters and electric showers require a minimum water pressure to function. Careful monitoring of pressure is therefore required to ensure that a minimum water pressure is maintained. For areas which already experience low pressure (such as those areas with properties that are included on a water company's DG2 Register) this is not suitable. Limited data is available on the water savings that can be achieved from this method.

C.3.6 Variable tariffs

Variable tariffs can provide different incentives to customers and distribute a water company's costs across customers in different ways.

The Walker review assessed variable tariffs for water, including:

- rising block tariff;
- a declining block tariff;
- a seasonal tariff; and,
- time of day tariff.

A rising block tariff increases charges for each subsequent block of water used. This can raise the price of water to very high levels for customers whose water consumption is high, which gives a financial incentive to not to consume additional water (for discretionary use, for example) while still giving people access to low price water for essential use.

A declining block tariff decreases charges for each subsequent block of water used. This reflects the fact that the initial costs of supply are high, while additional supply has a marginal additional cost. This is designed to reduce bills for very high users and although it weakens incentives for them to reduce discretionary water use, in commercial tariffs it can reflect the economies of scale from bulk supplies.

A seasonal tariff reflects the additional costs of summer water supply and the fact that fixed costs are driven largely by the peak demand placed on the system, which is likely to be in the summer.

Time-of-day tariffs have a variable cost per unit supply according to the time of the day when the water is used; this requires smart meters. This type of charging reflects the cost of water supply and may reduce an individual household's bill; it may not reduce overall water use for a customer.

C.3.7 Water Efficient Appliances

[34] http://www.waterwise.org.uk/reducing_water_wastage_in_the_uk/house_and_garden/toilet_flushing.html
[35] http://www.lecico.co.uk/
[36] The Water Efficiency of Retrofit Dual Flush Toilets, Southern Water/Environment Agency, December 2000
[37] http://www.thameswater.co.uk/cps/rde/xchg/corp/hs.xsl/9047.htm

Washing machines and dishwashers have become much more water efficient over the past twenty years; whereas an old washing machine may use up to 150 litres per cycle, modern efficient machines may use as little as 35 litres per cycle. An old dishwasher could use up to 50 litres per cycle, whereas modern models can use as little as 10 litres. However, this is partially offset by the increased frequency with which these are now used. It has been estimated[38] that dishwashers, together with the kitchen tap, account for about 8-14 per cent of water used in the home.

The Water Efficient Product Labelling Scheme provides information on the water efficiency of a product (such as washing machines) and allows the consumer to compare products and select the efficient product. The water savings from installation of water efficient appliances therefore vary, depending on the type of machine used.

C.3.8 Non-Domestic Properties

There is also the potential for considerable water savings in non-domestic properties; depending on the nature of the business water consumption may be high e.g. food processing businesses. Even in businesses where water use is not high, such as B1 Business or B8 Storage and Distribution, there is still the potential for water savings using the retrofitting measures listed above. Water audits are useful methods of identifying potential savings and implementation of measures and installation of water saving devices could be funded by the asset owner; this could be justified by significant financial savings which can be achieved through implementation of water efficient measures. Non-domestic buildings such as warehouses and large scale commercial (e.g. supermarkets) property have significant scope for rainwater harvesting on large roof areas.

C.3.9 Water Efficiency in New Development

The use of efficient fixtures and fittings as described in above also apply to the specification of water use in the building of new homes. The simplest way of demonstrating the reductions that use of efficient fixtures and fitting has in new builds is to consider what is required in terms of installation of the fixtures and fittings at different ranges of specification to ensure attainment of building regulation and building regulation optional water use requirements. Part G of The Building Regulations 2010 has been used to develop these figures. For 80l/h/d and 62l/h/d houses, The Building Regulations Water Efficiency Calculator has been used in association with the Department of Communities and Local Government – Housing Standard Review (September 2014). These are shown below in Table C-2.

Table C-2: Summary of water savings borne by water efficiency fixtures and fittings

Component	125 l/h/d Building Regulations	110 l/h/d Building Regulations Optional Requirement	80 l/h/d	62 l/h/d
Toilet flushing	18.7 **b**	12.3 **d**	12.3 **d**	12.3 **d**
Taps	22.7 **a**	20.5 **a**	15.3 **a**	15.3 **a**
Shower	39.8	31.8	23.9	23.9
Bath	18.5 **c**	17.0 **f**	14.5 **h**	14.5 **h**
Washing machine	15.6	15.6	15.6	15.6
Dishwasher	4.1	4.1	4.1	4.1
Recycled water			-13.4 **e**	-26.8 **g**
Total per head	124.4	106.3	77.3	63.9
Outdoor	5	5	0	0
TOTAL PER HOUSEHOLD	261.3	223.3	162.4	134.2

- **a** Combines kitchen sink and wash hand basin
- **b** 6/4 litre dual-flush toilet (f) recycled water
- **c** 185 litre bath
- **d** 4/2.6 litre dual flush toilet
- **e** Rainwater harvesting for external and toilet use
- **f** 170 litre bath

[38] Water Efficiency Retrofitting: A Best Practice Guide, Waterwise, 2009, www.waterwise.org.uk

- **g** Rainwater/greywater harvesting for toilet, external and washing machine
- **h** 145 litre bath

Table C-2 highlights that in order for high and very high efficiencies to be achieved for water use under 80 l/h/d; water re-use technology (rainwater harvesting and/or greywater recycling) needs to be incorporated into the development.

In using the BRE Water Demand Calculator[39], the experience of AECOM BREEAM/CHS assessors is that it is theoretically possible to get close to 80l/h/d through the use of fixture and fittings, but that this requires extremely high specification efficiency devices which are unlikely to be acceptable to the user and will either affect the saleability of new homes or result in the immediate replacement of the fixtures and fittings upon habitation. This includes baths at capacity below 120 litres, and shower heads with aeration which reduces the pressure sensation of the user. For this reason, it is not considered practical to suggest that 80l/h/d or lower can be reached without some form of water recycling.

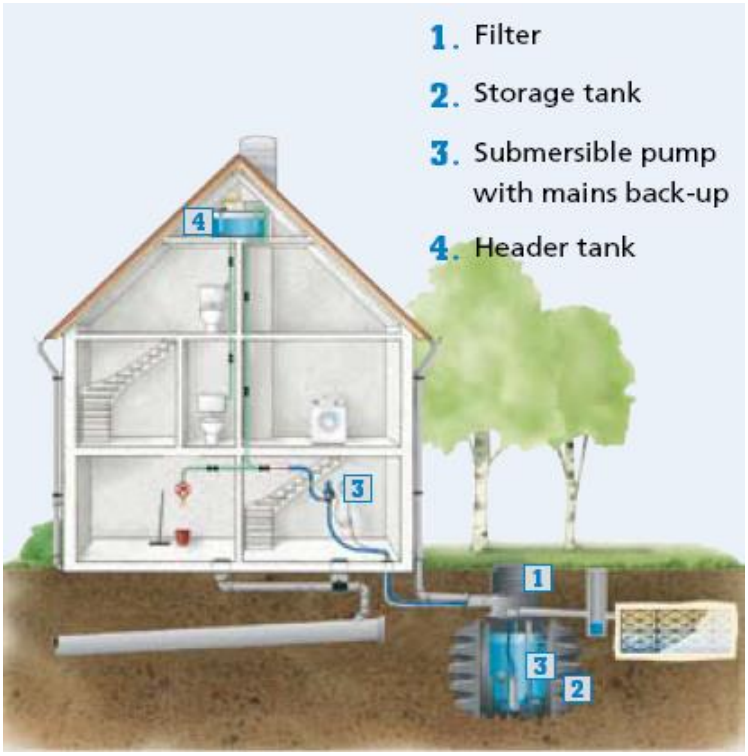
C.3.10 Rainwater Harvesting

Rainwater harvesting (RWH) is the capture and storage of rain water that lands on the roof of a property. This can have the dual advantage of both reducing the volume of water leaving a site, thereby reducing surface water management requirements and potential flooding issues, and be a direct source of water, thereby reducing the amount of water that needs to be supplied to a property from the mains water system.

RWH systems typically consist of a collection area (usually a rooftop), a method of conveying the water to the storage tank (gutters, down spouts and pipes), a filtration and treatment system, a storage tank and a method of conveying the water from the storage container to the taps (pipes with pumped or gravity flow). A treatment system may be included, depending on the rainwater quality desired and the source. Figure C-1 below gives a diagrammatic representation of a typical domestic system[40].

The level to which the rainwater is treated depends on the source of the rainwater and the purpose for which it has been collected. Rainwater is usually first filtered to remove larger debris such as leaves and grit. A second stage may also be incorporated into the holding tank; some systems contain biological treatment within the holding tank, or flow calming devices on the inlet and outlets that will allow heavier particles to sink to the bottom, with lighter debris and oils floating to the surface of the water. A floating extraction system can then allow the clean rainwater to be extracted from between these two layers[41].

Figure C-1: A typical domestic rainwater harvesting system



[39] http://www.thewatercalculator.org.uk/faq.asp
[40] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk
[41] Aquality Rainwater Harvesting brochure, 2008

A recent sustainable water management strategy carried out for a proposed EcoTown development at Northstowe[42], approximately 10 km to the north west of Cambridge, calculated the size of rainwater storage that may be required for different occupant numbers, as shown below in Table C-3.

Table C-3: Rainwater Harvesting Systems Sizing

Number of occupants	Total water consumption	Roof area (m^2)	Required storage tank (m^3)	Potable water saving per head (l/d)	Water consumption with RWH (l/h/d)
1	110	13	0.44	15.4	94.6
1	110	10	0.44	12.1	97.9
1	110	25	0.88	30.8	79.2
1	110	50	1.32	57.2	52.8
2	220	25	0.88	15.4	94.6
2	220	50	1.76	30.8	79.2
3	330	25	1.32	9.9	100.1
3	330	50	1.32	19.8	90.2
4	440	25	1.76	7.7	102.3
4	440	50	1.76	15.4	94.6

A family of four, with an assumed roof area of 50m3, could therefore expect to save 61.6 litres per day if a RWH system were installed.

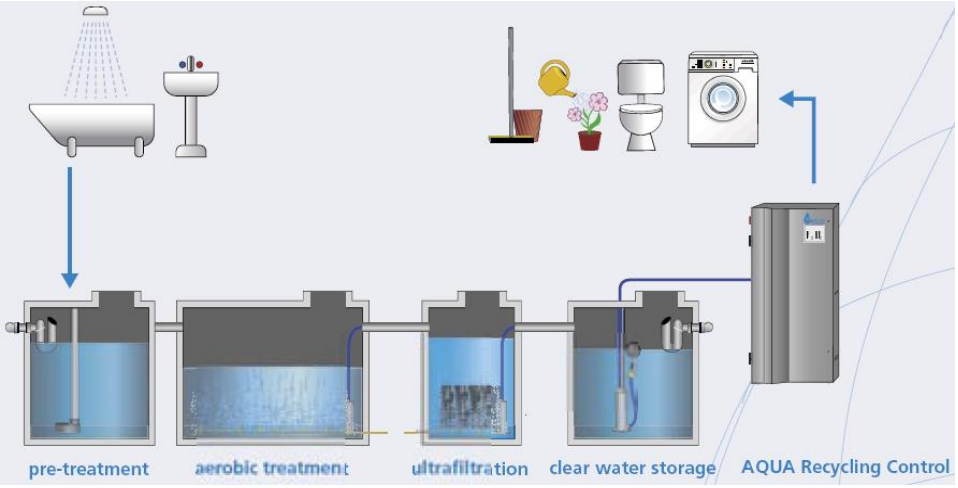
C.3.11 Greywater Recycling

Greywater recycling (GWR) is the treatment and re-use of wastewater from shower, bath and sinks for use again within a property where potable quality water is not essential e.g. toilet flushing. Recycled greywater is not suitable for human consumption or for irrigating plants or crops that are intended for human consumption. The source of greywater should be selected by available volumes and pollution levels, which often rules out the use of kitchen and clothes washing waste water as these tend to be most highly polluted. However, in larger system virtually all non-toilet sources can be used, subject to appropriate treatment.

The storage volumes required for GWR are usually smaller than those required for rainwater harvesting as the supply of greywater is more reliable than rainfall. In domestic situations, greywater production often exceeds demand and a correctly designed system can therefore cope with high demand application and irregular use, such as garden irrigation. Figure C-2 below gives a diagrammatic representation of a typical domestic system[43].

[42] Sustainable water management strategy for Northstowe, WSP, December 2007
[43] Source: Aquality Intelligent Water management, www.aqua-lity.co.uk

Figure C-2: A typical domestic greywater recycling system



Combined rainwater harvesting and greywater recycling systems can be particularly effective, with the use of rainwater supplementing greywater flows at peak demand times (e.g. morning and evenings).

The Northstowe sustainable water management strategy calculated the volumes of water that could be made available from the use GWR. These were assessed against water demand calculated using the BRE Water Demand Calculator[44].

Table C-4 demonstrates the water savings that can be achieved by GWR. If the toilet and washing machine are connected to the GWR system a saving of 37 litres per person per day can be achieved.

Table C-4: Potential water savings from greywater recycling

Appliance	Demand with Efficiencies (l/h/day)	Potential Source	Greywater Required (l/h/day)	Out As	Greywater available (80% efficiency) (l/h/day)	Consumptions with GWR (l/h/day)
Toilet	15	Grey	15	Sewage	0	0
Wash hand basin	9	Potable	0	Grey	7	9
Shower	23	Potable	0	Grey	18	23
Bath	15	Potable	0	Grey	12	15
Kitchen Sink	21	Potable	0	Sewage	0	21
Washing Machine	17	Grey	17	Sewage	0	0
Dishwasher	4	Potable	0	Sewage	0	4
TOTAL	**103**		**31**		**37**	**72**

The treatment requirements of the GWR system will vary, as water which is to be used for flushing the toilet does not need to be treated to the same standard as that which is to be used for the washing machine. The source of the greywater also greatly affects the type of treatment required. Greywater from a washing machine may contain suspended solids, organic matter, oils and grease, detergents (including nitrates and phosphates) and bleach. Greywater from a dishwasher could have a similar composition, although the proportion of fats, oils and grease is likely to be higher; similarly for wastewater from a kitchen sink. Wastewater from a bath or shower will contain suspended solids, organic matter (hair and skin), soap and detergents. All wastewater will contain bacteria, although the risk of infection from this is considered to be low[45].

Treatment systems for GWR are usually of the following four types:

[44] http://www.thewatercalculator.org.uk/faq.asp
[45] Centre for the Built Environment, www.cbe.org.uk

- basic (e.g. coarse filtration and disinfection);
- chemical (e.g. flocculation);
- physical (e.g. sand filters or membrane filtration and reverse osmosis); and,
- biological (e.g. aerated filters or membrane bioreactors).

Table C-5 below gives further detail on the measures required in new builds and from retrofitting, including assumptions on the predicted uptake of retrofitting from the existing housing and commercial building use.

Table C-5: Water Neutrality Scenarios – specific requirements for each scenario

WN Scenario	New development requirement			Retrofitting existing development	
	New development Water use target (l/h/d)	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption	Water Efficient Fixtures and Fittings
Low (Building Regulations)	125	- WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Bath 185 litres - Basin taps 6 l/min - Sink taps 8 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	97.5%	None
Low (Building Regulations + Retrofit)	125	- WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Bath 185 litres - Basin taps 6 l/min - Sink taps 8 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	97.5%	15% take up across study area: - WC 6/4 litres dual flush or - 4.5 litres single flush - Shower 10 l/min - Basin taps 6 l/min - Sink taps 8 l/min
Medium (Building Regulations Optional Requirement)	110	- WC 4/2.6 litres dual flush - Shower 8 l/min - Bath 170 litres - Basin taps 5 l/min - Sink taps 6 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	97.5%	None
Medium (Building Regulations Optional Requirement + Retrofit)	110	- WC 4/2.6 litres dual flush - Shower 8 l/min - Bath 170 litres - Basin taps 5 l/min - Sink taps 6 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	None	97.5%	25% take up across study area: - WC 4/2.6 litres dual flush - Shower 8 l/min - Basin taps 5 l/min - Sink taps 6 l/min
High	80	- WC 4/2.6 litres dual flush; - Shower 6 l/min - Bath 145 litres - Basin taps 2 l/min - Sink taps 4 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	Rainwater harvesting	100%	30% take up across study area: - WC 4/2.6 litres dual flush; - Shower 6 l/min - Basin taps 2 l/min - Sink taps 4 l/min
Very High	62	- WC 4/2.6 litres dual flush;	Rainwater harvesting and	100%	38% take up across study area:

WN Scenario	New development requirement			Retrofitting existing development	
	New development Water use target (l/h/d)	Water Efficient Fixtures and Fittings	Water Recycling technology	Metering Penetration assumption	Water Efficient Fixtures and Fittings
		- Shower 6 l/min - Bath 145 litres - Basin taps 2 l/min - Sink taps 4 l/min - Dishwasher 1.25 l/place setting - Washing machine 8.17 l/kilogram	Greywater recycling		- WC 4/2.6 litres dual flush; - Shower 6 l/min - Basin taps 2 l/min - Sink taps 4 l/min

C.4 Financial Cost Considerations for Water Neutrality scenarios

The financial cost of delivering the technological requirements of each neutrality scenario have been calculated from available research and published documents.

C.4.1 New Build Costs

The Department for Communities and Local Government (DCLG) published the Housing Standards Review in September 2014. A cost impacts report[46] formed part of this publication, providing the costs of the proposed standards, including the proposed Building Regulations optional requirement water efficiency standard.

Costs for water efficiency in new property have been provided based on homes achieving different code levels under the CSH based on the cost analysis undertaken by DCLG and as set out in Table C-6.

Table C-6: Building Regulation Specification and costs

	1B Apartment	2B Apartment	2B Terrace	3B Semi-detached	4B Detached
Cost all dwellings (extra over usual industry practice)					
Water, Code Level 1	-	-	-	-	-
Water, Code Level 2	-	-	-	-	-
Water, Code Level 3	£6	£6	£6	£9	£9
Water, Code Level 4	£6	£6	£6	£9	£9
Water, Code Level 5	£900	£900	£2,201	£2,697	£2,697
Water, Code Level 6	£900	£900	£2,201	£2,697	£2,697
Alternative standards					
Rainwater only	£887	£887	£2,181	£2,674	£2,674

An additional cost was required for the 'very high' neutrality scenario that included for greywater recycling as well as rainwater harvesting and this is detailed in the following section.

C.4.2 Water Recycling

Research into the financial costs of installing and operating GWR systems gives a range of values, as show in Table C-7.

Table C-7: Costs of greywater recycling systems

Cost	Cost	Comments
Installation cost	£1,750 £2,000 £800 £2,650	Cost of reaching Code Level 5/6 for water consumption in a 2-bed flat[47] For a single dwelling[48] Cost per house for a communal system[49] Cost of reaching Code Level 3/4 for water consumption in a 3-bed semi-detached house[50]
Operation of GWR	£30 per annum[51]	

[46] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/353387/021c_Cost_Report_11th_Sept_2014_FINAL.pdf

[47] Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008

[48] http://www.water-efficient-buildings.org.uk/?page_id=1056

[49] http://www.water-efficient-buildings.org.uk/?page_id=1056

[50] Code for Sustainable Homes: A Cost Review, Communities and Local Government, 2008

[51] Environment Agency Publication - Science Report – SC070010, Greenhouse Gas Emissions of Water Supply and Demand Management Options, 2008

Cost	Cost	Comments
Replacement costs	£3,000 to replace[23]	It is assumed a replacement system will be required every 25 years

There is less research and evidence relating to the cost of community scale systems compared to individual household systems, but it is thought that economies of scale will mean than larger scale systems will be cheaper to install than those for individual properties. As shown above, the Cost review of the Code for Sustainable Homes indicated that the cost of installing a GWR system in flats is less than the cost for a semi-detached house. Similarly, the Water Efficient Buildings website estimates the cost of installing a GWR system to be £2,000 for a single dwelling and £800 per property for a share of a communal system.

As it is not possible to determine how many of the outstanding housing developments in Colchester Borough will be of a size large enough to consider communal recycling facilities, an approximation has been made of an average per house cost (£1,400) using the cost of a single dwelling (at £2,000) and cost for communal (at £800). This has been used for the assessment of cost for a greywater system in a new property required for the 'very high' neutrality scenario.

C.4.3 Installing a Meter

The cost of installing a water meter has been assumed to be £500 per property. It is assumed that the replacement costs will be the same as the installation costs (£500), and that meters would need to be replaced every 15 years.

C.4.4 Retrofitting of Water Efficient Devices

Findings from the Environment Agency report Water Efficiency in the South East of England, costs have been used as a guide to potential costs of retrofitting of water efficient fixtures and fittings and are presented in Table C-8 below.

Table C-8: Water saving methods

Water Saving Method	Approximate Cost per House (£)	Comments/Uncertainty
Variable flush retrofit toilets	£50 - £140	Low cost for 4-6 litre system and high cost for 2.6-4 litre system. Needs incentive to replace old toilets with low flush toilets.
Low flow shower head scheme	£15 - £50	Low cost for low spec shower head; high costs for high spec. Cannot be used with electric, power or low pressure gravity fed systems.
Aerating taps	£10 - £20	Low cost is med spec, high cost is high spec.

Toilet cistern displacement devices are often supplied free of charge by water companies and this is therefore also not considered to be an additional cost.

Appendix D. Designated Site Background Detail

D.1.1 Cattawade Marshes SSSI

Cattawade Marshes lie at the head of the Stour Estuary, between freshwater and tidal channels of the River Stour. These grazing marshes with associated open water and fen habitats are of major importance for the diversity of their breeding bird community, which includes species that have become uncommon throughout lowland Britain as a result of habitat loss. The site has benefited from a sympathetic management regime aimed at enhancing the ornithological interest. The marshes are also of value as a complement to the adjacent Stour Estuary SSSI where breeding habitats for birds are relatively scarce.

The undisturbed nesting habitats are particularly favourable to waders and wildfowl. Redshank, Lapwing and Oystercatcher breed within the cattle-grazed pasture, while Ringed Plover and Shelduck nest on the relict seawalls. Marshy pools and a system of dykes within the grassland, together with dense riverside vegetation, provide further nesting habitats, most notably for Shoveler, Teal, Tufted Duck and Water Rail.

The neutral grassland is dominated by Couch *Elymus spp.*, Perennial Rye-grass *Lolium perenne* and Yorkshire Fog *Holcus lanatus*. Characteristic herbs of old grazing marsh, such as Grass Vetchling Lathyrus nissolia and Hairy buttercup *Ranunculus sardous* are present and, together with ant-hills, are indicative of the undisturbed nature of the site. Scattered marshy areas support a more diverse plant community including Marsh Foxtail *Alopecurus geniculatus*, Celery-leaved Buttercup *Ranunculus sceleratus*, Sea Club-rush *Scirpus maritimus* and Spear-leaved Orache *Atriplex prostrata*. Sea Club-rush also dominates the majority of ditches although those joining the river channels show a gradation, from saltmarsh with Common Saltmarshgrass *Puccinellia maritima*, Sea Aster *Aster tripolium* and Annual Sea-blite *Suaeda maritima* to marsh dominated by Common Reed *Phragmites australis* where salinity is lowest. Other species present along the fresh-water channel of the River Stour include Reed Sweet-grass *Gliceria maxima*, Great Willowherb *Epilobium hirsutum*, Purple Loosestrife *Lythrum salicaria* and Flowering-rush *Butomus umbellatus*.

D.1.2 Hamford Water SSSI, Ramsar site, SPA, and SAC

Hamford Water is a key site in "A Nature Conservation Review", edited by D.A. Ratcliffe, Cambridge University Press 1977. Most of the foreshore is leased by the NCC from The Crown Estate Commission and was declared a National Nature Reserve in 1983. It is proposed as a wetland of international importance under the Ramsar Convention and a Special Protection Area under the EEC Directive on the Conservation of Wild Birds. Skipper's Island, one of the four main islands in Hamford Water, and the John Weston Reserve on the eastern boundary, are Essex Naturalists' Trust Reserves. The boundary of the site has been modified at re-notification by partial deletions and an extension.

Hamford Water is a tidal inlet whose mouth is about three miles south of Harwich. It is a large and shallow estuarine basin comprising tidal creeks, intertidal mud and sand flats, saltmarshes, islands, beaches and marsh grasslands. The site is of international importance for breeding Little Terns and wintering Dark-bellied Brent Geese, wildfowl and waders, and of national importance for many other bird species. It also supports communities of coastal plants which are rare or extremely local in Britain, including Hog's Fennel *Peucedanum officinale* which is found elsewhere only in Kent.

The site includes a number of islands and parts of islands, and extensive saltmarsh covers one third of the area. Thrift *Armeria maritima*, and Common Sea-lavender *Limonium vulgare*, together with the rarer Rock Sea lavender *L. binervosum* and Lax-flowered Sea-lavender *L. humile*. Sea Purslane *Halimione portulacoides* and Saltmarsh-grass *Puccinellia sp*. occur on the higher area; Sea Aster *Aster tripolium*, Glasswort *Salicornia sp* and Annual Sea-blite *Suaeda maritima*, on the lower areas and creek edges. On the upper marsh and at the foot of the seawall Shrubby Sea-blite *S. vera*, Golden-samphire *Inula crithmoides*, Sea Wormwood *Artemisia maritima* thrive alongside the Hog's Fennel. The uncommon Slender Hare's-ear Bupleurum tenuissimum is also found on the seawall.

The intertidal areas support abundant invertebrates, mainly worms and thin shelled molluscs. The commonest species are the ragworm *Nereis diversicolor*, the bivalve molluscs *Macoma balthica, Scrobicularia plana* and the gastropod mollusc *Hydrobia ulvae*. There are Mussel *Mytilus edulis* beds and, in Kirby Creek, Oyster *Ostrea edulis* lays.

The mudflats also support a number of local plants such as Small Cord-grass *Spartina maritima*, Narrow-leaved Eelgrass *Zostera angustifolia* and Dwarf Eelgrass *z. noltii*. These form the main diet, on their autumn arrival, of approximately six thousand Brent Geese which over-winter in Hamford Water. Five other species winter in internationally important numbers - Shelduck, Teal, Grey Plover, Black-tailed Godwit and Sanderling. In addition, six species - Wigeon, Pintail, Ringed Plover, Curlew, Redshank and Dunlin - reach levels of national significance, together

with important numbers of Bewick's Swan, Knot and Turnstone. The open areas of water attract many species of dabbling and diving duck including Mallard, Goldeneye and Eider. In very severe winter weather Hamford Water can shelter tens of thousands of duck, especially Wigeon. There are also important autumn and spring passage populations of Lapwing, Ringed Plover, Golden Plover and Grey Plover, Curlew, Bar-tailed Godwit, Black-tailed Godwit and Sanderling. There are major roosts of Grey and Ringed Plover at Pewit Island, Stone Marsh, Middle Beach, and of Curlew, Redshank and godwits at Kirby Creek and on Horsey Island. Birds of prey, including Shorteared Owls, Hen Harriers and Marsh Harriers, are attracted to the area and Merlin have frequently been recorded. There is a Black-headed Gull colony on the breached and eroded seawall of Garnham's Island.

The shingle spits mark the seaward edge from Dovercourt to Crabknow Spit and from Walton to Stone Point, and provide nest sites for internationally important numbers of Little Terns and nationally important numbers of Ringed Plover. The shingle is topped by low, retreating sand dunes which are colonised by grasses such as Sand Couch *Elymus farctus*, Lyme-grass *Leymus arenarius* and Marram *Ammophila arenaria*, and several uncommon plants including Sea-kale *Crambe maritima*, Sea-holly *Eryngium maritimum* and Sea Sandwort *Honkenya peploides.*

Included within the site are the improved grass fields of Horsey Island which are feeding and roosting sites for the Hamford Water flock of Brent Geese, and for thousands of waders including Curlew and godwits. Also included are small remaining areas of unimproved grass marsh at Walton Hall, Old Moze Hall and on Bramble Island, and an area of grass and scrub at The Naze. This is the most easterly point in Essex and as such is major landfall for migrant birds.

The Ramsar site is designated under:

- Ramsar criterion 6 : species/populations occurring at levels of international importance. Qualifying Species/populations (as identified at designation):
  - Species with peak counts in spring/autumn: ringed plover *Charadrius hiaticula*, common redshank *Tringa totanus totanus*
  - Species with peak counts in winter: dark-bellied brent goose *Branta bernicla bernicla*, black-tailed godwit *Limosa limosa islandica*, grey plover *Pluvialis squatarola*,

The SPA is designated for:

- Summer: little terns Sterna albifrons
- Wintering: avocet Recurvirostra avosetta
- Supporting internationally or nationally important wintering populations migratory waterfowl (average peak counts for the five-year winter period 1986/87 to 1990/91): 5,650 dark-bellied brent geese Branta bernicla bernicla, black-tailed godwit Limosa limosa, redshank Tringa totanus, ringed plover Charadrius hiaticula, shelduck Tadorna tadorna, grey plover Pluvialis squatorola

The SAC is designated for:

- 1. Fisher's estuarine moth Gortyna borelii lunata

D.1.3 Landguard Common SSSI and LNR

Landguard Common is a sand and shingle spit protecting the northern entrance to the haven ports of Harwich and Felixstowe. It consists of a loose shingle foreshore backed by a stabilized, vegetated beach, earth banks and scrub. Pioneer shingle plants and vegetated shingle beaches are fragile and nationally scarce habitat type. The site is also of some ornithological interest as a landfall site for passage migrants and for breeding shorebirds.

The north part of the foreshore is protected by sea defences but this and the beach crest further south is sea washed and provides bare shingle for colonizing shingle species. This includes a large population of Sea Kale *Crambe maritima* as well as Sea Pea *Lathyrus japonicus*, Yellow-Horned Poppy, Sea Sandwort and Sea Campion. The bare shingle is also used by nesting Little Tern and Ringed Plover.

Inland the shingle is stabilized and vegetated. To the south Red Fescue, Early Hair Grass and Sand Sedge predominate whilst further north and on earthworks this merges with dry neutral grassland dominated by False Oat Grass, Cocksfoot and Sea Couch Grass. Other plants include Sea Holly, Sea Bindweed, Viper's Bugloss, English and Biting Stonecrops, Slender Thistle and Crow Garlic together with naturalised species such as Rough Dog's Tail, Hoary Cress, Dittander and Red Valerian. Rare and local species include *Medicago minima, Trifolium ornithopodioides, T. glomeratum, T. suffocatum, T. striatum*, *Poa bulbosa* and *Lathyrus nissolia*.

There are several wet areas which contain marsh or saltmarsh species including Sea Rush, Salt Mud-Rush, Sea Club-Rush and Sea Milkwort. Scrub, chiefly of Tamarisk, Elder, Rose and Bramble occur particularly on some earthworks. This provides cover for small birds and forms a favoured landfall for migrant species.

The LNR is designated for:

The Nature Reserve is designated as a Site of Special Scientific Interest due to the rarity of vegetated shingle habitat, Unusual and rare plants, migrating birds. Plants include sea kale and yellow -horned poppy. Birds include wheatear, purple sandpiper and snow bunting.

D.1.4 Orwell Estuary SSSI

The Orwell Estuary is of national importance for breeding avocet *Recurvirostra avosetta*, its breeding bird assemblage of open waters and their margins, nine species of wintering waterfowl (including black-tailed godwit Limosa limosa islandica), an assemblage of vascular plants, and intertidal mud habitats.

The Orwell is a long and relatively narrow estuary with extensive mudflats and some saltmarsh. Extensive mudflats border the channel and support large patches of eelgrass *Zostera marina*, and dwarf eelgrass *Z. noltii* as well as large numbers of invertebrates that are important for feeding waders. Where it occurs, the saltmarsh tends to be sandy and fairly calcareous with a wide range of communities. Glasswort *Salicornia spp*. and small cord-grass *Spartina maritima* are the principal colonisers of the mud, and sea aster *Aster tripolium* is abundant on the lower marsh. The central areas of marsh are dominated by common saltmarsh-grass Puccinellia maritima, sea purslane *Atriplex portulacoides*, and common sea-lavender *Limonium vulgare*. Other species include sea arrowgrass *Triglochin maritimum*, annual sea-blite *Suaeda maritima*, seamilkwort *Glaux maritima*, greater sea-spurrey *Spergularia media*, and sea plantain *Plantago maritima*. There are small areas of vegetated shingle on the foreshore of the lower reaches, but most of the saltmarsh is fringed by sea couch *Elytrigia atherica* or by common reed *Phragmites australis* and sea club-rush *Bolboschoenus maritimus* further upstream.

The freshwater grazing marshes which adjoin the estuary at Shotley, and the wet grassland and standing water of Trimley marshes, each form an integral part of the ornithological interest of the site. Shotley marshes are especially important for feeding dark-bellied brent geese *Branta bernicla bernicla*, wigeon Anas penelope and snipe *Gallinago gallinago*, and for breeding redshank *Tringa totanus* and lapwing *Vanellus vanellus*. Trimley marshes have become an important refuge for wintering and passage birds, as well as a key breeding site.

Breeding birds

The Orwell Estuary supports a nationally important breeding number of avocet. It also supports a nationally important assemblage of breeding birds characteristic of open waters and their margins comprising little grebe *Tachybaptus ruficollis*, great crested grebe *Podiceps cristatus*, mute swan *Cygnus olor*, shelduck *Tadorna tadorna*, gadwall *Anas strepera*, garganey *Anas querquedula*, shoveler *Anas clypeata*, pochard *Aythya ferina*, tufted duck *Aythya fuligula*, avocet, ringed plover *Charadrius hiaticula*, redshank, and reed bunting *Emberiza schoeniclus*. The breeding bird assemblage is concentrated in three main areas: Trimley Marshes, Shotley Marshes, and Loompit Lake.

Non-breeding birds

The estuary regularly supports an important assemblage of more than 20,000 nonbreeding waterfowl. It supports considerable numbers of oystercatcher *Haematopus ostralegus*, ringed plover, knot *Calidris canutus islandica*, curlew *Numenius arquata* and turnstone *Arenaria interpres*, but is particularly important for four other species of wader. These are grey plover *Pluvialis squatarola*, dunlin *Calidris alpina alpina*, black-tailed godwit (which regularly occur in numbers of international importance) and redshank. These regularly attain nationally important numbers in winter. The intertidal mud habitats, saltmarsh and adjacent areas used as high tide roosts are important for these wading birds.

Considerable numbers of wigeon and shoveler use the site, whilst cormorant, shelduck, gadwall and pintail *Anas acuta* regularly occur in numbers of national importance. Also of national importance are the large numbers of dark-bellied brent geese. Numbers often fluctuate because of interchange with neighbouring estuaries. The intertidal mud habitats, saltmarsh, freshwater marshes and river channel are important to these birds for feeding and roosting.

Vascular plant assemblage

The site supports a nationally important vascular plant assemblage, including at least nine nationally scarce plants. They are characteristic of intertidal mud, saltmarsh, shingle and coastal grazing marsh habitats. These are eelgrass, dwarf eelgrass, slender hare's-ear *Bupleurum tenuissimum*, golden-samphire *Inula crithmoides*, lax-flowered sea-lavender Limonium humile, shrubby sea-blite *Suaeda vera*, small cord-grass, perennial glasswort *Sarcocornia perennis*, and divided sedge *Carex divisa*.

Intertidal mud habitats

The Orwell Estuary supports a large area of intertidal mud habitat with very rich littoral sediments, particularly sandy muds. There is a high invertebrate species richness within the sediments. The estuary also supports an example of a nationally important tide swept algae community with sponges, ascidians and red algae.

In addition to the reasons for notification, the Orwell Estuary supports an inland nesting colony of cormorants at their only site in Suffolk.

D.1.5 Stour and Orwell Estuaries Ramsar site and SPA

The Stour and Orwell Estuaries is a wetland of international importance, comprising extensive mudflats, low cliffs, saltmarsh and small areas of vegetated shingle on the lower reaches. It provides habitats for an important assemblage of wetland birds in the non-breeding season and supports internationally important numbers of wintering and passage wildfowl and waders. The site also holds several nationally scarce plants and British Red Data Book invertebrates.

The Ramsar site is designated under:

- Ramsar criterion 2: Contains seven nationally scarce plants: stiff saltmarsh-grass Puccinellia rupestris; small cord-grass Spartina maritima; perennial glasswort Sarcocornia perennis; lax-flowered sea lavender Limonium humile; and the eelgrasses Zostera angustifolia, Z. marina and Z. noltei Contains five British Red Data Book invertebrates: the muscid fly Phaonia fusca; the horsefly Haematopota grandis; two spiders, Arctosa fulvolineata and Baryphema duffeyi; and the Endangered swollen spire snail Mercuria confusa.
- Ramsar criterion 5: Assemblages of international importance: Species with peak counts in winter: 63017 waterfowl (5 year peak mean 1998/99-2002/2003)
- Ramsar criterion 6: species/populations occurring at levels of international importance.
  - Species with peak counts in spring/autumn: common redshank *Tringa totanus totanus*
  - Species with peak counts in winter: dark-bellied brent goose *Branta bernicla bernicla*, northern pintail *Anas acuta* grey plover *Pluvialis squatarola,* red knot *Calidris canutus islandica,* dunlin *Calidris alpina alpina,* black-tailed godwit *Limosa limosa islandica,* common redshank *Tringa totanus totanus*,

The SPA is designated for:

- Over winter: hen harrier Circus cyaneus, black-tailed godwit Limosa limosa islandica, dunlin Calidris alpina alpina, grey plover Pluvialis squatarola, pintail Anas acuta, redshank Tringa totanus, ringed plover Charadrius hiaticula, shelduck Tadorna tadorna, turnstone Arenaria interpres
- Assemblage qualification: A wetland of international importance. The area qualifies under Article 4.2 of the Directive (79/409/EEC) by regularly supporting at least 20,000 waterfowl. Over winter, the area regularly supports 64,768 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: cormorant Phalacrocorax carbo, pintail Anas acuta, ringed plover Charadrius hiaticula, grey plover Pluvialis squatarola, dunlin Calidris alpina alpina, black-tailed godwit Limosa limosa islandica, redshank Tringa totanus, Shelduck Tadorna tadorna, great crested grebe Podiceps cristatus, curlew Numenius arquata, dark-bellied Brent goose Branta bernicla bernicla, wigeon Anas penelope, goldeneye Bucephala clangula, oystercatcher Haematopus ostralegus, lapwing Vanellus vanellus, knot Calidris canutus, turnstone Arenaria interpres.

D.1.6 Stour Estuary SSSI

The Stour Estuary is nationally important for 13 species of wintering waterfowl and three species on autumn passage. The estuary is also of national importance for coastal saltmarsh, sheltered muddy shores, two scarce marine invertebrates and a vascular scarce plant assemblage.

The Stour Estuary includes three nationally important geological sites. These provide exposures of early Eocene sediments containing the volcanic ash formations between Harwich and Wrabness. The same rocks are also important for the fossil fruits and seeds that they contain. At Stutton, much younger Pleistocene sediments have yielded an important and rich fossil vertebrate fauna.

The Stour Estuary forms the eastern part of the Essex/Suffolk county boundary. It is a relatively simply structured estuary with a sandy outer area and a muddier inner section. The six main bays, Seafield, Holbrook and Erwarton on the north, and Jacques, Copperas and Bathside on the south, encompass most of the intertidal flats. The mud is extremely rich in invertebrates and this, coupled with its relative lack of disturbance, enables the estuary to support an internationally significant assemblage of wildfowl and wading birds. The shoreline is one of the most natural in the region, often with low cliffs. Those at Stutton and Wrabness contain nationally important geological exposures.

The main concentration of feeding birds tends to be in the bays. High tide roosts are located in various places, mostly on the sheltered parts of the northern shore and on the southern shore at Deep Fleet and the 'tidal bank' of Copperas Bay and Bathside Bay. The majority of the redshank *Tringa totanus*, black tailed godwit *Limosa limosa islandica* and dunlin *Calidris alpina alpina* feed in the muddier upper reaches, whereas most of the grey plover *Pluvialis squatarola* and knot *Calidris canutus islandica* congregate towards the seaward end. Curlew *Numenius arquata*, ringed plover *Charadrius hiaticula* and turnstone *Arenaria interpres* feed throughout the estuary. Wigeon *Anas penelope* graze on the beds of eelgrass *Zostera spp*. and green algae *Enteromorpha spp*. and winter in large numbers on a par with nearby Hamford Water. Pintail *Anas acuta* congregate with the wigeon after arrival at Holbrook Bay, reaching peak numbers in mid-October and again in January-February. They prefer the upper and middle reaches where the very fine sediment favours their method of feeding and their major roost is on the saltings of Stutton Mill Creek. Shelduck *Tadorna tadorna* breed around the estuary and are present throughout the year apart from the August moult: maximum numbers occur in January. Shelduck also favour areas of high invertebrate density and concentrate in the upper reaches, roosting on the saltmarsh with other dabbling ducks. Wintering brent geese *Branta bernicla bernicla*, feeding on eelgrass and green algae, prefer the lower reaches of the Essex shore. The wintering herd of mute swans *Cygnus olor* feeds on the waste from the maltings at Mistley; their numbers peak in January and again in August when they are more widespread throughout the estuary, feeding particularly in Holbrook Bay.

The shoreline vegetation varies from oak-dominated wooded cliffs, through scrub covered banks to coarse grasses over seawalls, with reed-filled borrow dykes behind. The higher saltmarsh is dominated by saltmarsh grass *Puccinellia maritima*, sea purslane *Atriplex portulacoides*, with sea aster *Aster tripolium*, annual sea-blite *Suaeda maritima* and sea-lavender *Limonium vulgare* are scattered throughout, together with the scarce lax-flowered sea-lavender *L. humile*. Adjoining lower areas are colonised by clumps of sea lavender, perennial glasswort *Sarcocornia perennis* and cord-grasses *Spartina spp*. which grade through pure stands of cord-grass into large expanses of mud. These are colonised by green algae and eelgrasses.

Wintering and autumn passage birds

Thirteen species of wintering wildfowl and wader occur in qualifying numbers within the Stour Estuary: grey plover, knot, dunlin, redshank, black-tailed godwit, great crested grebe *Podiceps cristatus*, cormorant *Phalacrocorax carbo*, mute swan, darkbellied brent goose, shelduck, pintail, ringed plover and curlew.

Ringed plover, dunlin and redshank are regularly found using the Stour Estuary on autumn passage in nationally important numbers.

Coastal saltmarsh of East England

The saltmarshes of the Stour Estuary form an integral part of the estuarine system and are an essential feeding and roosting habitat supporting the nationally and internationally important numbers of waterbirds. The Stour has two of the three basic saltmarsh communities characteristic of south-east and east England. These are formerly grazed saltmarshes with saltmarsh-grass *Puccinellia maritima* and sea aster *Aster tripolium* often in extensive pioneer-and mid-marsh zones, and ungrazed and lightly grazed saltmarshes, typically with sea-purslane *Atriplex portulacoides* being dominant.

Sheltered muddy shores (including estuarine muds)

The mudflats of the Stour Estuary also form an integral part of the estuarine system and are an essential feeding and roosting habitat supporting the nationally and internationally important numbers of waterbirds.

In addition the estuary represents a good example of a sheltered muddy shore (including estuarine mud) within the Area of Search. Also present is a nationally important community of tide-swept lower shore mixed substrata with sponges, ascidians and red algae.

The site contains good examples of mixed substrata and estuarine muds for the Area of Search. Many of the individual biotopes in the Stour are highly rated, often as a result of their relatively high species richness and large extent. Both of these habitat features are nationally restricted.

There is an extensive area of estuarine sediments and the expected range of zonation of mixed substrata and estuarine sediments are present, including a clear variation in the composition of sediment communities along the salinity gradient up the estuary.

Scarce marine invertebrates

The site contains nationally scarce species at two locations within the estuary. These species are starlet sea anemone *Nematostella vectensis* and tentacled lagoon worm *Alkmaria romijni*. Of the ten estuaries in the Area of Search, the Stour is the only one to contain *N. vectensis*. Both species are listed in Schedule 5 of the Wildlife & Countryside Act 1981, as amended.

Scarce vascular plant assemblage

The site also exceeds the national threshold site-index value for a scarce vascular plant assemblage of saltmarsh, mudflats and shingle. This includes lax-flowered sealavender *Limonium humile*, dwarf eelgrass *Zostera noltii*, golden-samphire *Inula crithmoides*, hoary mullein *Verbascum pulverulentum*, curved hard-grass *Parapholis incurva*, sea barley *Hordeum marinum*, divided sedge *Carex divisa*, marsh-mallow *Althaea officinalis*, dittander *Lepidium latifolium* and perennial glasswort *Sarcocornia perennis*.

Appendix E.Development Site Assessment

Site Reference	Site Location	Site Area (km2)	Landuse Type	Dwellings Proposed in Plan Period	WRC	Foul Sewerage Network Capacity	Water Supply Network Capacity	% of Site in FZ1	% of Site in FZ2	% of Site in FZ3	Nearest Watercourse
New Local Plan 2017-233 allocations	WEST COLCHESTER/EAST BRAINTREE GARDEN COMMUNITY	66.69	Greenfield	1350	Copford			97%	0%	3%	River Blackwater or Domsey Brook
New Local Plan 2017-233 allocations	EAST COLCHESTER/WEST TENDRING GARDEN COMMUNITY	41.77	Greenfield	1650	Colchester			100%	0%	0%	Salary Brook
Hythe Special Policy Area sites	HAWKINS ROAD, COLCHESTER	8.23	Brownfield	360	Colchester			31%	17%	52%	River Colne
	COALYARD SITE, HYTHE STATION ROAD, COLCHESTER	N/A	Brownfield	40	Colchester						
	COLDOCK, HYTHE, COLCHESTER		Brownfield	40	Colchester						
	HYTHE GAS WORKS, HYTHE QUAY, COLCHESTER		Brownfield	40	Colchester						
	SCRAPYARD SITE, HYTHE QUAY, COLCHESTER		Brownfield	120	Colchester						
	BRIDGE HOUSE AND GARAGE, HYTHE QUAY, COLCHESTER		Brownfield	32	Colchester						
	26 HYTHE QUAY, COLCHESTER		Brownfield	24	Colchester						
Colchester (and Stanway) urban area allocations	EAST BAY MILL, COLCHESTER	N/A	Brownfield	22	Colchester			No Site Boundary Provided			River Colne
Colchester (and Stanway) urban area allocations	BARRINGTON ROAD/BOURNE ROAD, COLCHESTER	0.11	Greenfield	28	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	FIVEWAYS FRUIT FARM, STANWAY	1.71	Greenfield	550	Colchester			100%	0%	0%	Roman River
Colchester (and Stanway) urban area allocations	BRITANNIA CAR PARK, ST BOTOLPHS STREET, COLCHESTER	0.15	Brownfield	100	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	ST BOTOLPHS CULTURAL QTR, QUEEN ST, COLCHESTER	N/A	Brownfield	120	Colchester			No Site Boundary Provided			River Colne
Colchester (and Stanway) urban area allocations	FORMER ESSEX COUNTY HOSPITAL, COLCHESTER	0.17	Brownfield	40	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	ST RUNWALDS STREET, COLCHESTER	0.02	Brownfield	12	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	ST BOTOLPHS FARM, BRAISWICK, COLCHESTER	0.40	Greenfield	50	Colchester			84%	2%	14%	St Botolph's Brook
Colchester (and Stanway) urban area allocations	LAND NORTH OF ACHNACONE DRIVE, COLCHESTER	0.21	Greenfield	30	Colchester			100%	0%	0%	St Botolph's Brook
Colchester (and Stanway) urban area allocations	LAND SOUTH OF BRAISWICK GOLF CLUB, COLCHESTER	0.16	Greenfield	25	Colchester			100%	0%	0%	St Botolph's Brook
Colchester (and Stanway) urban area allocations	PORT LANE, COLCHESTER	0.35	Brownfield	130	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	CHITTS HILL, COLCHESTER	0.67	Greenfield	100	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	GOSBECKS PHASE TWO, COLCHESTER	0.68	Greenfield	150	Colchester			100%	0%	0%	Roman River
Colchester (and Stanway) urban area allocations	LAND SOUTH OF BERECHURCH HALL ROAD, COLCHESTER	0.81	Greenfield	150	Colchester			100%	0%	0%	Roman River
Colchester (and Stanway) urban area allocations	ST JOHNS ROAD, COLCHESTER	2.65	Greenfield	800	Colchester			100%	0%	0%	Salary Brook
Colchester (and Stanway) urban area allocations	BROMLEY ROAD, COLCHESTER	15.42	Greenfield	100	Colchester			97%	0%	3%	Salary Brook
Colchester (and Stanway) urban area allocations	SHAWS FARM, PARSONS HEATH, COLCHESTER	0.15	Greenfield	30	Colchester			100%	0%	0%	Salary Brook
Colchester (and Stanway) urban area allocations	RUGBY CLUB, MILL ROAD, COLCHESTER	0.65	Greenfield	300	Colchester			100%	0%	0%	Unknown
Colchester (and Stanway) urban area allocations	MIDDLEWICK RANGES, COLCHESTER	8.43	Greenfield	1000	Colchester			100%	0%	0%	River Colne
Colchester (and Stanway) urban area allocations	LAKELANDS SR6, CHURCHFIELDS AVENUE, STANWAY	0.02	Greenfield	28	Colchester			100%	0%	0%	Roman River
Colchester (and Stanway) urban area allocations	LAND WEST OF LAKELANDS, STANWAY	N/A	Greenfield	150	Colchester			No Site Boundary Provided			Roman River
Colchester (and Stanway) urban area allocations	LAND NORTH OF LONDON ROAD, STANWAY	N/A	Greenfield	130	Copford			No Site Boundary Provided			Roman River
Colchester (and Stanway) urban area allocations	LAND SOUTH OF A12, STANWAY	4.60	Greenfield	500	Copford			100%	0%	0%	Roman River
Other allocations	LAND WEST OF PELDON ROAD, ABBERTON	0.22	Greenfield	50	Fingringhoe			100%	0%	0%	Unknown
Other allocations	HILL FARM, BOXTED	0.19	Greenfield	36	Langham (Essex)			100%	0%	0%	Unknown
Other allocations	SWAN GROVE, CHAPPEL	0.17	Greenfield	30	Earls Colne			100%	0%	0%	River Colne
Other allocations	LAND EAST OF QUEENSBERRY AVENUE, COPFORD	0.29	Greenfield	70	Copford			100%	0%	0%	Roman River
Other allocations	HALL ROAD, COPFORD	0.18	Greenfield	50	Copford			100%	0%	0%	Roman River
Other allocations	PLUMMERS ROAD, FORDHAM	0.05	Greenfield	20	Eight Ash Green			100%	0%	0%	Unknown
Other allocations	SCHOOL LANE, GREAT HORKESLEY	1.12	Greenfield	13	W Bergholt			100%	0%	0%	Black Brook
Other allocations	GREAT HORKESLEY MANOR, GREAT HORKESLEY	1.12	Greenfield	80	W Bergholt			100%	0%	0%	Black Brook
Other allocations	GREENFIELD DRIVE, GREAT TEY	0.27	Greenfield	40	Great Tey			100%	0%	0%	Roman River
Other allocations	BROOK ROAD, GREAT TEY	0.08	Greenfield	17	Great Tey			100%	0%	0%	Roman River

Site Reference	Site Location	Site Area (km2)	Landuse Type	Dwellings Proposed in Plan Period	WRC	Foul Sewerage Network Capacity	Water Supply Network Capacity	% of Site in FZ1	% of Site in FZ2	% of Site in FZ3	Nearest Watercourse
Other allocations	WICK ROAD, LANGHAM	0.19	Greenfield	10	Langham (Essex)			100%	0%	0%	Unknown
Other allocations	SCHOOL ROAD, LANGHAM	0.21	Greenfield	55	Langham (Essex)			100%	0%	0%	Unknown
Other allocations	LAND WEST OF SCHOOL FARM, LANGHAM	0.32	Greenfield	60	Langham (Essex)			100%	0%	0%	Unknown
Other allocations	LAND ADJACENT THE FOLLEY, LAYER DE LA HAYE	0.51	Greenfield	50	Layer De La Haye			100%	0%	0%	Roman River
Other allocations	ROWHEDGE BUSINESS CENTRE, ROWHEDGE	N/A	Greenfield	60	Colchester			No Site Boundary Provided			River Colne
Other allocations	DAWES LANE, WEST MERSEA	0.45	Greenfield	150	West Mersea			100%	0%	0%	Unknown
Other allocations	BRIERLEY PADDOCKS, WEST MERSEA	0.90	Greenfield	50	West Mersea			100%	0%	0%	Unknown
Other allocations	CEDRICS, 1 THE AVENUE, WIVENHOE	N/A	Brownfield	24	Colchester			No Site Boundary Provided			River Colne
Other allocations	LAND NORTH OF ELMSTEAD ROAD, WIVENHOE	0.09	Greenfield	25	Colchester			100%	0%	0%	River Colne
Other allocations	BROADFIELDS, WIVENHOE	0.41	Greenfield	120	Colchester			100%	0%	0%	Sixpenny Brook or River Colne
Other allocations	CROQUET GARDENS, WIVENHOE	0.14	Greenfield	25	Colchester			100%	0%	0%	River Colne
Other allocations	COLCHESTER ROAD, WIVENHOE	0.27	Greenfield	80	Colchester			100%	0%	0%	River Colne
Magdalen Street allocations	EUROPIT GARAGE SITE, MAGDALEN STREET, COLCHESTER	N/A	Brownfield	20	Colchester			No Site Boundary Provided			River Colne
	MAGDALEN GARAGE, MAGDALEN STREET, COLCHESTER		Brownfield	10	Colchester						
	FORD CAR SALES, MAGDALEN STREET, COLCHESTER		Brownfield	50	Colchester						
	80-83 AND GM CAR SALES, MAGDALEN STREET, COLCHESTER		Brownfield	50	Colchester						
	LAND EAST OF TESCO, MAGDALEN STREET, COLCHESTER		Brownfield	35	Colchester						

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