Forest Heath
District Council

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Red Lodge Wastewater Treatment/Sewerage Capacity Study

Independent Study Report

Final Report

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Final Report

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This report has been prepared for Forest Heath District Council in accordance with the terms and conditions of appointment for Independent Study Report dated March 2014. Hyder Consulting (UK) Limited (2212959) cannot accept any responsibility for any use of or reliance on the contents of this report by any third party.

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GLOSSARY AND KEY TERMS

Acronym	Term
Amm. N	Ammoniacal Nitrogen
AMP	Asset Management Period
AWS	Anglian Water Services
CS7	FHDC Core Strategy Policy 7 – growth trajectory
DWF	Dry Weather Flow
EA	Environment Agency
FHDC	Forest Heath District Council
FTFT	Flow to Full Treatment
GIS	Geographical Information System
LDF	Local Development Framework
l/p/d	Litres per Person per Day
OFWAT	The Water Services Regulation Authority
P	Phosphorous
PCC	Per Capita Consumption
PE	Population Equivalent
PR09/ 14	Price Review 2009/ 2014
SAF	Submerged Aerated Filter
SIR	FHDC Single Issue Review of CS7
SPS	Sewage Pumping Station
TPS	Terminal Pumping Station
WFD	Water Framework Directive
WRC	Water Recycling Centre

1 SUMMARY

This report presents the findings of an independent study, completed on behalf of Forest Heath District Council, into the wastewater treatment and sewerage infrastructure serving Red Lodge.

Previous work in support of the Core Strategy had supported an embargo until 2021 on any additional development at Red Lodge, beyond the extant planning permissions, primarily due to:

- Likely exceedance of the volumetric discharge consent from the Tuddenham Water Recycling Centre (WRC), potentially resulting in tighter standards being enforced which would require significant works to achieve; and
- Process and hydraulic capacity constraints within the WRC which would be exceeded by any additional growth, increasing environmental and regulatory risks.

Additionally, historic capacity issues within the existing sewerage network serving Red Lodge and the wider area had been widely reported by residents and local media, including incidents of wastewater flooding and odour.

Since 2010, Anglian Water Services (AWS) have undertaken a significant programme of capacity improvement works to both the sewerage network serving Red Lodge and the surrounding area, and Tuddenham WRC.

In addition to a site visit to Tuddenham WRC, this study has reviewed:

- Sewerage network geographic and telemetry data;
- Design calculations undertaken for the recent AWS improvement works;
- Process performance data for the WRC; and
- The AWS log of customer contacts related to the Red Lodge and Tuddenham WRC network.

This study has concluded that the recent capacity improvements undertaken by AWS at Tuddenham WRC are sufficient to accommodate the proposed development trajectory, hence the 2021 embargo is no longer appropriate. Depending on growth levels realised, additional modifications/ extensions to the WRC processes will be required potentially from 2021 onwards, primarily to allow AWS to operate at a similar level of process risk as currently. The availability of land on site, and the modular design of these types of assets, should allow AWS to provide the necessary improvements as required.

The proposed growth in Red Lodge can be accommodated within the existing discharge consent of the WRC up until approximately 2029/30. Exceedance of this consent may trigger a tightening of quality standards, which may require alternative treatment or discharge options. AWS have sufficient time to investigate long term treatment and discharge solutions with the Environment Agency, hence this should not be considered a constraint to the proposed development.

This study has concluded that many of the historic sewerage network issues are unrelated to growth. Furthermore, changes in network connectivity undertaken by AWS now allow a strategy of connecting the proposed development sites into the network by utilising recent capacity improvements, and avoiding the areas of the network with historic capacity concerns.

Wastewater flooding and odour historically experienced at Herringswell relate to operational and resilience issues, rather than a lack of asset capacity. The additional flows from the proposed development should reduce the risk of wastewater becoming septic, which in turn should reduce the risk of odour nuisance.

2 Introduction

Hyder Consulting (Hyder) were commissioned by Forest Heath District Council (FHDC) in March 2014 to produce an independent study of the capacity of the sewerage network and wastewater treatment facilities serving the Red Lodge settlement, near Mildenhall.

This report illustrates the findings of this study.

2.1 Conventional delivery mechanism

Conventional provision of sewerage networks, and wastewater collection/ treatment infrastructure in the Red Lodge area is via the statutory wastewater undertaker Anglian Water Services (AWS), under the provisions of the Water Industry Act 1991.

AWS have a duty to provide and maintain a system of public sewers under Section 94 of the Water Industry Act. The Environment Agency (EA) use the provisions of the Water Resources Act 1991, and Urban Wastewater Treatment Directive, to control the quality and quantity of effluent discharged from water recycling centres (WRC).

The investment plans of AWS are based on a five-year cycle, known as Asset Management Periods (AMPs). In general, wastewater treatment improvements, maintenance of the existing sewerage network, and the provision of regionally important sewerage schemes, are agreed by Ofwat and funded via investment through the business plan process, whereby the water regulator (Ofwat) sets agreed price increases in customer bills

The current AMP is AMP5 (2010–2015), and AWS are currently working to deliver wastewater treatment improvements and infrastructure maintenance which they identified in their Final Business Plan (agreed by Ofwat) during the Price Review period in 2009 (PR09).

Figure 2-1 illustrates the AMP5 process to 2015, and the currently ongoing PR14 process which dictates investment strategy for AMP6.

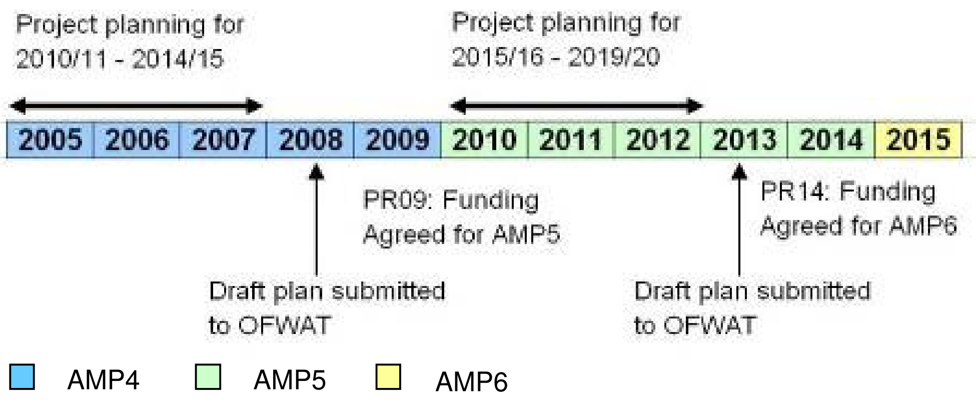

Figure 2-1 Conventional wastewater company planning and funding cycle

AWS have limited powers under the Water Industry Act 1991 to prevent connection of new dwellings ahead of the required infrastructure upgrades, and therefore rely on the planning system (through appropriate planning conditions) to ensure that development does not lead to an unacceptable risk of flooding, or pollution of watercourses.

Where new sewerage network (pipes and/or pumping stations) is required to serve the development site, developers may requisition this infrastructure in accordance with S41 and S98 of the Water Industry Act 1991.

2.2 Historical context

Hyder were commissioned by FHDC in 2008 to prepare a Water Cycle Study (WCS) to support the development of the Core Strategy.

The Outline WCS[1] identified a number of wastewater infrastructure and water environment constraints that would require further investigation by the WCS stakeholders in order to support the proposed growth in the District. FHDC took these constraints into account in their Core Strategy[2] by proposing in Policy CS7 that (with the exception of sites already granted permission) the majority of development in Red Lodge be constructed towards the end of the plan period (post 2021).

It was intended that this would provide an adequate timeframe for the Environment Agency (EA) and AWS to investigate the wastewater treatment and sewerage network capacity, which they had highlighted as a potential constraint to development.

Following adoption of the Core Strategy (2010), FHDC again commissioned Hyder to produce a Stage 2 WCS, the purpose of which was to bring the constraint information up to date, and further analyse the detailed wastewater infrastructure to provide guidance to FHDC as they progressed through their Local Development Framework (LDF) to Site Specific Allocations (SSA).

The following development trajectory was assessed in the Stage 2 WCS:

Dwelling Type	2010-2015	2015-2020	2020-2025	2025-2031	Total
Extant planning permissions	642 remaining to be built		0	0	642
New Brownfield to be allocated	0	0	90	40	130
New Greenfield to be allocated	0	0	200	200	400
New mixed site to be allocated	0	0	400	270	670
Total	*341*	*341*	*690*	*510*	*1,882*

Table 2-1 Development trajectory assumed in Stage 2 WCS (aligned with FHDC Policy CS7)

Following consultation with AWS, the Stage 2 WCS[3] concluded that:

- The extant planning permissions at Red Lodge would use up any existing capacity within the discharge consent at Tuddenham Water Recycling Centre (WRC). Any additional growth from FHDC Policy CS7 would require negotiation of an increased discharge consent from 2021 onwards. The resulting tightening of discharge quality standards may make the current discharge location unfeasible, and hence require AWS to undertake significant capital works (such as a new discharge pipe to the River Lark). It was recommended that the stakeholders continued to investigate options prior to 2021;
- AWS were planning a programme of improvement works during the Asset Management Plan period 2010-2015 (AMP5), to upgrade the hydraulic and process capacity at Tuddenham WRC to accommodate the new wastewater flows from the extant planning permissions. However, any additional flows from Policy CS7 growth post 2021, and the associated tightening of discharge consent standards, would require the construction of additional process capacity, and potentially a step change in treatment process, taking up to 10 years to plan and construct;
- Proposed development sites to the west of Red Lodge would require extensive upgrades to the existing sewer network through the town;

- Due to the proximity of the proposed development sites to the east of Red Lodge to either the Warren Road Sewage Pumping Station (SPS) or King's Warren SPS, connection to the existing pumped sewerage network would be relatively simple (subject to some capacity investigations/ improvements); and
- The Herringswell Terminal Pumping Station (TPS), which conveys flows from the Red Lodge network to the inlet at Tuddenham WRC, was upgraded in 2010/11 to provide the necessary capacity to accommodate at least the extant planning permissions (642 dwellings). Additional growth in FHDC Policy CS7 may however require that further capacity improvements are constructed here.

The Stage 2 WCS conclusions supported the concept that the 2021 embargo on additional Policy CS7 development should be retained, and this recommendation was reiterated by FHDC via the Strategic Housing Land Availability Assessment (SHLAA) review in 2012.

Since publication of the Stage 2 WCS, AWS have further investigated the discrepancy between their measured and calculated flow results. This discrepancy was highlighted in the Stage 2 WCS, and the higher value used as the baseline flows to ensure calculations were conservative.

AWS advised that this discrepancy was caused by erroneous flowmeter data, which has since been resolved as part of the AMP5 improvement works.

2.3 Location

The indicative location of the sewerage and wastewater infrastructure serving Red Lodge is illustrated in Figure 2-2.

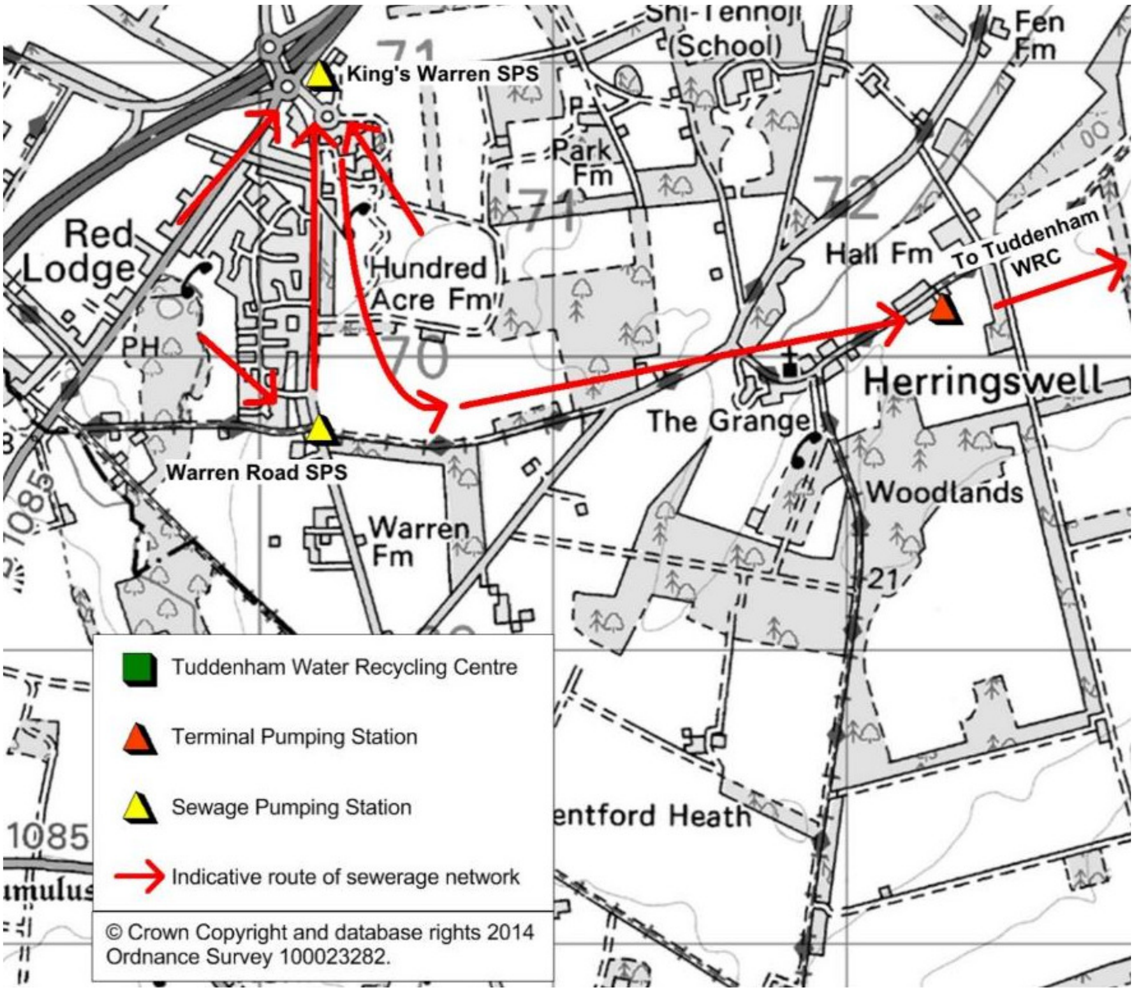

Figure 2-2 Sewerage and wastewater infrastructure serving Red Lodge

The indicative wider sewerage network serving the Tuddenham WRC catchment is illustrated in Figure 2-3.

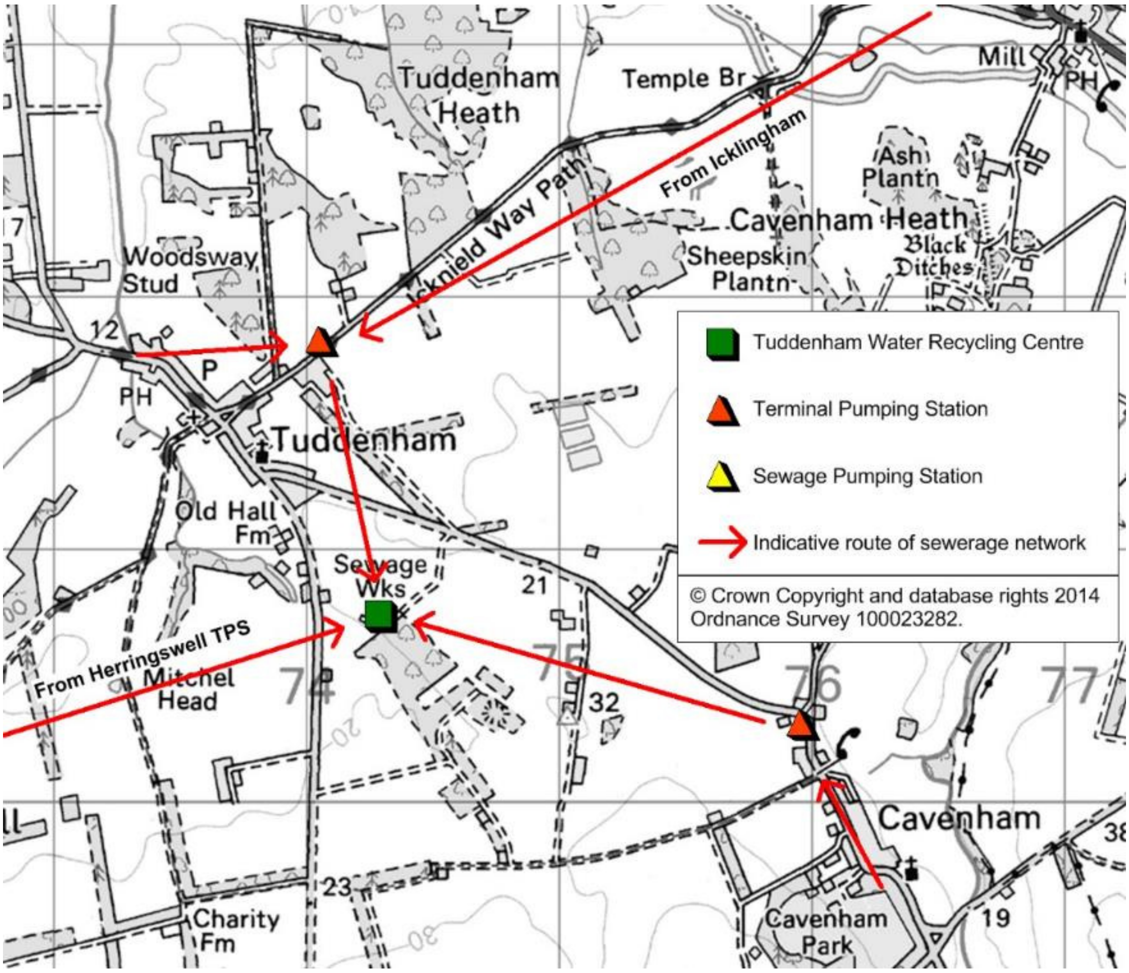

Figure 2-3 Tuddenham WRC catchment infrastructure

2.4 Study objectives

Since the Stage 2 WCS, consultation regarding wastewater treatment and sewerage network capacity has been ongoing between FHDC, AWS, the EA and prospective developers. The emerging view from these recent consultations is that, due to the capital works completed by AWS, the 2021 embargo on Policy CS7 growth is no longer appropriate.

The scope of this study includes assessing whether it is now appropriate for FHDC to rescind the embargo on additional Policy CS7 development prior to Red Lodge before 2021, which was initially instigated due to wastewater treatment and sewerage network capacity concerns. It is intended that this study inform the finalisation of the FHDC Single Issue Review (SIR) and also provide evidence to support planning decisions in the interim.

Additionally, FHDC have advised Hyder that residents and Members remain concerned regarding the capacity of the sewerage network, particularly Warren Road SPS and Herringswell TPS.

This study therefore has the following objectives:

- Gather stakeholder data to provide an updated robust appraisal of the wastewater/sewerage capacity and water environment constraints;
- Assess if there is any evidence of sewerage network capacity issues which should immediately constrain development;
- Independently assess the work undertaken by AWS to Tuddenham WRC and the Red Lodge sewerage network since the Stage 2 WCS, to determine if the Policy CS7 development embargo prior to 2021 remains appropriate;
- Assess if the recent capacity improvement works can accommodate the emerging FHDC development trajectory to 2031, to support the FHDC SIR and identify if any recommendations should be made in terms of the quantum or phasing of new dwellings at Red Lodge; and
- Identify if further wastewater treatment or sewerage network capacity constraints will impede the proposed development quantum, and identify thresholds for future stakeholder action.

2.5 Methodology

Current and future wastewater flows have been estimated based on AWS telemetry data for the Tuddenham WRC inlet meter, and industry standard dry weather flow (DWF) calculations.

DWF represents the baseline foul water flows through the sewerage network, originating from domestic uses in residential and non-residential properties, any specially consented trade effluent discharges, and an allowance for infiltration.

DWF is calculated as follows:

$$DWF = PE \times PCC + I + E$$

Where:

- PE (Population Equivalent) – calculated for residential areas as number of dwellings x occupancy rate;

- Occupancy rate is assumed to be 2.3 persons per household, consistent with AWS planning variables for the Region;
- This is considered a conservative estimate, given that the 2011 census data[4] suggested an occupancy rate of 2.15 in Red Lodge;

- PCC (per capita consumption) – estimated as 131 litres per person per day (l/p/d) by AWS – which whilst lower than standard regional estimates, would be consistent with a catchment with an increasing proportion of new build, metered homes – and is still conservative for new build homes given that the Building Regulations specify 125 l/p/d;
- I (infiltration) - an additional proportion of unaccounted for flows, to account for unplanned infiltration of surface water and misconnections to new sewers in the long term. AWS estimate this value as 10% of DWF, which whilst lower than standard regional estimates, would be consistent with a catchment where the majority of the sewerage network is relatively recently constructed;
- E (trade effluent) – additional flows discharged to the network from industrial processes under a special agreement with AWS – none are recorded in the Tuddenham WRC catchment.

Consistent with Environment Agency practice, the average flows received, treated and discharged at the WRC are estimated as 1.25 x DWF.

The capacity of Tuddenham WRC is considered in three components:

- The volumetric consent – the DWF (expressed as m^3/d) which AWS are permitted to discharge to the receiving watercourse, as agreed by the EA under the provisions of the Water Resources Act 1991, and more recently the Environmental Permitting Regulations 2010;
- The process capacity – the ability of the biological and chemical process components to treat the load from the population to the required physio-chemical standards, as stipulated in the consent to discharge/ environmental permit; and
- The hydraulic capacity – the ability of the physical components in the works to accommodate the wastewater flows, normally expressed for combined sewer systems in terms of flow to full treatment (FTFT- often approximated as 6 x DWF), or for a separate sewer system such as Red Lodge, considered in terms of peak DWF (often approximated as 3 x DWF).

Current wastewater treatment capacity, and any future headroom to accept growth, has been ascertained through consultation with AWS, a site visit to Tuddenham WRC, and review of the design envelope calculations used by the AWS supply chain during the recent improvement works.

Current sewerage network capacity has been ascertained through consultation with AWS, review of their Geographical Information System (GIS) network data and raw data of pump run times extracted from the AWS telemetry system. Foul water sewerage networks such as Red Lodge, where surface water and foul water are separated, can be assessed in terms of their capacity to accommodate peak daily flows, normally approximated as 3 x DWF.

2.6 Limitations

In order to satisfactorily complete this study, technical input from AWS is required. The capacity of their assets, and any future improvement plans, are best understood by their catchment planners, WRC site managers and engineers.

In order to ensure that this study remains independent, every effort has been made to obtain raw telemetry and asset size data. Additionally, a site visit was undertaken to Tuddenham WRC to independently observe the recently completed improvement works.

Process unit sizes and types were recorded during the site visit, and used to calculate the hydraulic and process capacity of the WRC based on industry standard formulae. This allowed for independent verification of the design envelope calculations presented by AWS.

The capacity of the sewerage network, particularly the SPS and TPS facilities depends on a number of factors, including wet well size and depth, level sensor/operational settings, pump and motors types, and pump performance characteristics. AWS were unable to provide this data to the study. Additionally, AWS do not routinely measure outlet flows from King's Warren, Warren Road and Herringswell SPS/TPS.

AWS have advised that a flow meter was recently installed on the outlet of Warren Road SPS, although flow data is only available for the month of May 2014.

Whilst the lack of reliable historic flow data for the three SPS/TPS of concern prevents an exhaustive assessment, AWS were able to provide telemetry data relating to the durations that the SPS/TPS have run historically. This data has been combined with estimates of catchment populations to allow a sufficiently robust estimate of the flow rates, and hence capacity.

3 Growth trajectory

In order to appraise the capacity of the WRC and sewerage network to accommodate future development, and ascertain if the 2021 embargo remains appropriate, this study required a definitive development trajectory for the Red Lodge area and Tuddenham WRC catchment.

Following consultation with FHDC, and review of the Five Year Supply document[5], Site Allocations document[6] and Single Issue Review document[7], the following development trajectory for the Tuddenham WRC catchment was confirmed for this study:

No of new properties:	2013-2016	2016-2021	2021-2026	2026-2031	TOTAL
Existing permission as per 5 year supply (Apr 2013)	363	-	-	-	***363***
Emerging site (Crest Nicholson)	-	374	-	-	***374***
Brownfield (Policy CS7)	-	-	20	20	***40***
Greenfield (Policy CS7) – *previously delayed until after 2021 due to FHDC embargo in Core Strategy, 2010*	100	100	100	100	***400***
Mixed (Policy CS7)	-	-	200	200	***400***
TOTAL	***463***	***474***	***320***	***320***	**1,577**

Table 3-2 Independent study development trajectory for Tuddenham WRC catchment

In addition to Red Lodge, the above table includes existing permissions in the other settlements within the Tuddenham WRC catchment, specifically Covenham, Freckenham, Herringswell, and Icklington.

In light of further phasing information (not anticipated until further Core Strategy consultation is completed), the build out of the above trajectory is considered linear within each of the four time periods.

4 Existing wastewater treatment

In March 2014 Hyder undertook a site visit at Tuddenham WRC accompanied by the AWS Regional Services Planner, Treatment Manager, and Senior Growth Planning Engineer.

The ongoing AMP5 construction works were witnessed on site, which were nearly completed and due to be commissioned within the following month.

Additionally, AWS have made available to this study:

- The design envelope calculations (from their supply chain) for the above mentioned capital improvement works, plus detailed drawings and specification for the new tertiary treatment module recently completed;
- Population estimates, wastewater flow calculations and daily measured in-flow data for Tuddenham WRC for the last four years; and
- Discharge consent data, and quality performance data for the last 19 months.

Hyder have completed a process capacity assessment based on the dimensions of the existing and new process units identified in the above. This technical assessment is included as Appendix A.

4.1 Baseline wastewater flows

In order to ascertain the capacity of Tuddenham WRC to accommodate increased DWF from the proposed development, a baseline DWF and PE for the start of the plan period is required.

AWS estimated that the Tuddenham WRC catchment had a population equivalent (PE) of 3,850 at the end of 2011/12. Comparison of this estimate with recorded flow data, and the 2011 census data, suggests that this was an appropriate estimate.

FHDC report that 164 properties were completed within the catchment in 2012/13. It is therefore reasonable to assume that the Tuddenham WRC PE increased by 377 in this period, and therefore stood at 4,227 by April 2013.

FHDC has not made data available regarding completions in 2013/14, hence the baseline for this independent study is considered to be April 2013.

Using the methodology described in Section 2.5, a PE of 4,227 is calculated as producing a DWF of 609 m^3/d.

A conservative estimate of average flow adopted by AWS and the EA is to multiply DWF by 1.25.

This results in an estimated average flow for April 2013 of 761 m^3/d, which correlates closely with an average flow of 767 m^3/d measured by AWS at the Tuddenham WRC inlet during 2012/13.

4.2 Existing wastewater treatment process

As discussed in Appendix A, Tuddenham WRC receives wastewater from terminal pumping stations (TPS) at Herringswell, Tuddenham and Cavenham.

The incoming wastewater is passed through screens and a grit separator to remove gross solids, before entering two circular primary settlement tanks.

Following primary settlement, the wastewater is filtered through beds of rock media (believed to be blast furnace slag). This secondary treatment biologically breaks down pollutants in the wastewater.

The effluent from the filters is allowed to settle further in humus tanks, and then passed through a submerged aerated filter (SAF) unit to provide tertiary nitrification, to reduce concentrations of Ammoniacal Nitrogen (Amm. N) in the final effluent.

Prior to discharge to the Tuddenham Stream, the effluent is passed through a system of reedbeds on the south western edge of the site as a final polishing stage, to further reduce suspended solids.

4.3 Recent process improvement works

In March 2014 Hyder undertook a site visit of Tuddenham WRC to observe the recent capital improvement works being completed and commissioned by the AWS supply chain.

AWS reported that the intermittent delivery of flows to the inlet via the three TPS had historically led to operational difficulties, including the risk of overwhelming the primary settlement tanks, with knock on repercussions further down the process.

The works undertaken during AMP5 include a balancing tank at the WRC inlet, designed to allow peak incoming flows from the TPS to be attenuated, and hence provide a more steady flow through the processes to resolve the above issue. This also provides a steadier flow through the inlet flowmeter to the WRC, which has assisted with AWS verifying the flowmeter data (an improvement since the Stage 2 WCS – where a discrepancy existed between measured and calculated flows).

Notably, it was evident from the site visit that AWS have allowed sufficient space on site for an additional balancing tank to be efficiently added in the future, to allow the flexibility to accommodate future growth in the catchment.

The other AMP5 improvement works on the site are described in Appendix A, and include a new screen and grit separator unit, new humus tank, and new tertiary treatment (plastic media trickling filter) to replace the SAF. Anecdotal evidence from AWS suggests that the SAF was struggling to provide the necessary levels of tertiary treatment, particularly during cold winters (corroborated by the noticeable peak in Amm. N in the effluent monitoring data for the discharge during December 2012).

The replacement process, in conjunction with the improved inlet works, is intended to reliably meet the required Amm. N consent.

The capacity of the recent improvement works is discussed in more detail in Section 5.2.

5 Future wastewater treatment

5.1 Volumetric discharge consent

Using the methodology described in Section 2.5, and the growth trajectory described in Section 3, the cumulative DWF received at Tuddenham WRC has been estimated up until 2030/31.

Figure 5-4 illustrates the total DWF to be treated at Tuddenham WRC with reference to the current DWF consent of 1,100 m^3/d.

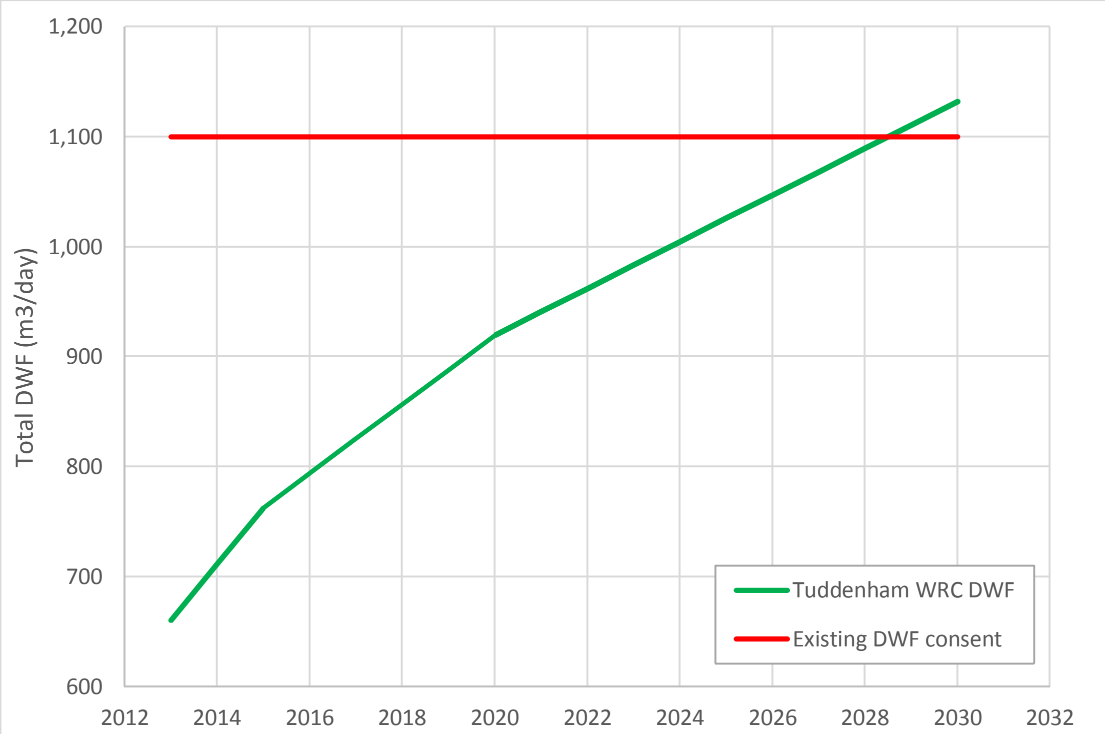

Figure 5-4 Future DWF estimate for Tuddenham WRC

The above results illustrate that the DWF from the proposed growth in Red Lodge (and other settlements within the Tuddenham WRC catchment) can be accommodated within the existing volumetric discharge consent up until approximately 2029/30.

This remains consistent with the best case DWF scenario assessed in the Stage 2 WCS, and allows AWS nearly three five year AMP cycles in which to:

- Monitor growth in the catchment;
- Work with the EA to understand if the physio-chemical consent standards for the discharge to the Tuddenham Stream will become more stringent;
- Appraise the likelihood of meeting these standards with process technology advances; and
- Investigate alternative discharge options if required.

Alternative future discharge options, including discharge to the River Lark, are discussed in detail in the Stage 2 WCS. These options remain viable and should continue to be investigated by AWS and the EA as development in the catchment is built out.

Notably, AWS would tend to plan to a 10% buffer between actual DWF and consented DWF, to allow some flexibility to accommodate seasonal variations. Even if investigation was not undertaken in the interim, the breach of this buffer would likely trigger action by AWS. It is estimated that this 10% buffer would be breached by 2024/25. Based on the above trajectory, this would allow AWS the majority of the AMP8 cycle in which to negotiate an increased volumetric discharge consent, if required.

For reference, using the trajectory and variables described above, it can be estimated that the 10% buffer and existing DWF consent would be breached following the build out of approximately 1,193 and 1,513 dwellings respectively.

5.2 Hydraulic and process capacity

In undertaking the design work for the recent AMP5 improvements to Tuddenham WRC, AWS used the 2011/12 baseline PE of 3,850.

A review of the design envelope calculations used by the AWS supply chain revealed that, in line with the Stage 2 WCS, AWS based the design of the improvement works on the following trajectory for Red Lodge:

- 682 properties built at Red Lodge between 2011/12 – 2021; and
- 1,200 properties from 2021-2031.

This level of growth would more than double the PE of Tuddenham WRC, from 3,850 to 8,178.

However, in order to limit commercial risks to their existing customer base, AWS have only to date implemented capital works to meet the above trajectory to 2021.

For example, the design sizing of the new tertiary plastic media filter is based on a PE of 5,418. This PE would result in an estimated DWF of 781 m^3/d (9 l/s), average flow of 976 m^3/d (11.3 l/s) and peak flow of 2,200m^3/d (25.5 l/s).

Based on the above, and allowing for some factors of safety in design:

- The new balancing tank and associated pumps are designed to normally accommodate between 12 and 19 l/s, and also contain (and if necessary pump onwards) peaks flows up to 28 l/s; and
- The new tertiary plastic media filter is capable of providing the necessary discharge quality at flows up to 28 l/s.

It can therefore be concluded that peak flows of 28 l/s, and DWF of 781 m3/d, are a key threshold of the current hydraulic and process capacity of the WRC.

Figure 5-5 illustrates that the trajectory proposed by FHDC (see Section 3) will create DWF exceeding this capacity by approximately 2016/17.

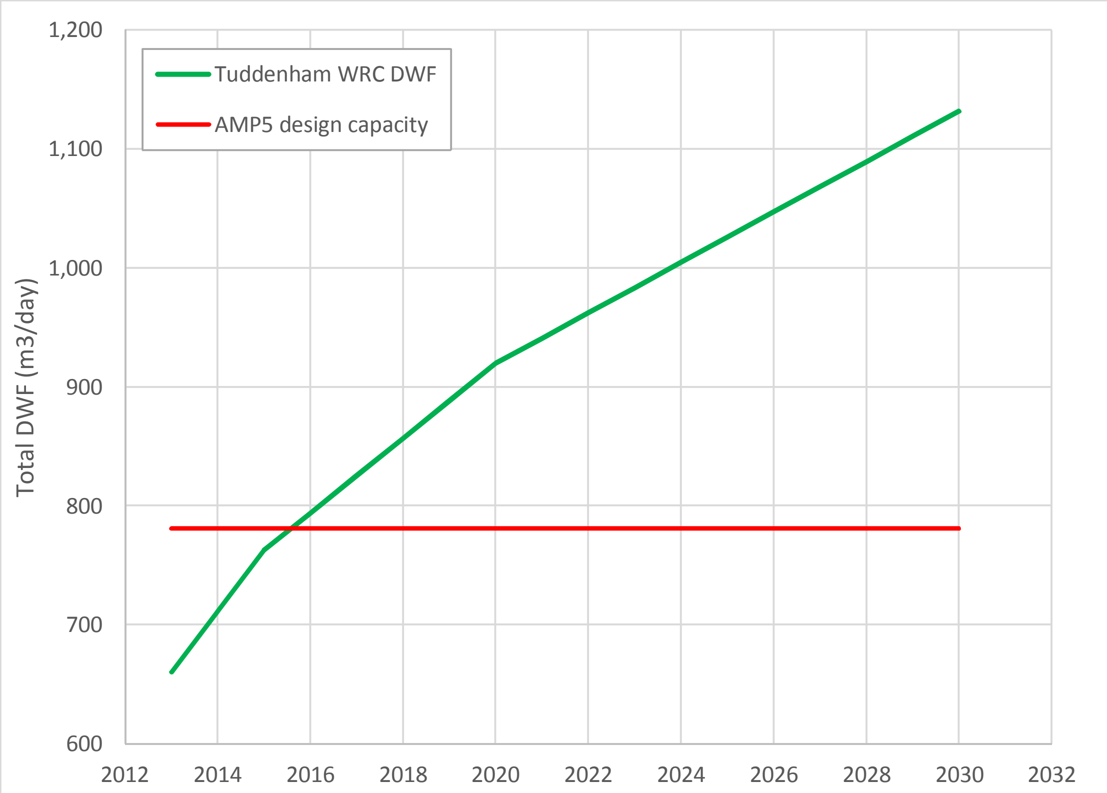

Figure 5-5 Predicted DWF vs AMP5 process capacity

5.2.1 Inlet works and balancing tanks

Based on the above calculations, it can be determined that AWS will require an additional balancing tank at Tuddenham WRC in the early stages of AMP6 to maintain the improved flow control that has recently been established, as the potential peak flows from the increased population will exceed the 28 l/s of the recent installation.

However, it is noted that as the catchment relies on pumped flows from a number of SPS, the sewer network will have inherent capacity to dampen the effect of peak flows – for example one TPS sump may continue to fill whilst another part of the catchment is pumping to the WRC. This reduces the chances of the peak flows from the three TPS in the Tuddenham catchment arriving at the WRC inlet all at once, and provides AWS additional flow balancing options.

Given the modular nature of the flow balancing tanks, and the availability of land on-site adjacent to the inlet works, this should not be considered a constraint to development. AWS should be able to make this decision as and when development in the catchment begins to put at risk the existing flow balancing facilities, and readily provide an additional flow balancing facility.

As observed on site, recent upgrades to the inlet works have incorporated space to add additional screens in the future (a relatively simple mechanical and electrical installation, rather than large civil engineering project). The design envelope states that the structures housing the grit separation and screening facilities have been designed to hydraulically accommodate the instantaneous peak flow possible should all three TPS discharge peak flows to the WRC at the same time.

This figure is 90 l/s (proven by AWS with physical tests at the TPS, and includes a 10% safety margin) – for comparison the theoretical peak flows estimated from the entire catchment by 2031, including for all the proposed growth, would be approximately 38 l/s. It is therefore apparent that the new inlet works have capacity to accommodate the peak flows expected from the proposed increase in population.

5.2.2 Primary treatment - settlement

The calculations in Appendix A suggest that the primary settlement tanks can satisfactorily accommodate flows up to at least 30 l/s (even with one of the two tanks temporarily out of service). This is well above the 2031 calculated average flow, hence primary treatment is not considered a constraint to the proposed development.

5.2.3 Secondary treatment – trickling filters

Based on the proposed development trajectory, the calculations in Appendix A suggest that, if left unaltered, the secondary treatment rock media trickling filters would only be achieving approximately 70% of the necessary ammonia removal by 2031.

To maintain compliance with the existing consent, it is calculated that additional tertiary nitrification capacity may be required beyond 2021 to supplement the secondary treatment processes. This should not be considered a constraint to the proposed development - the provision of additional tertiary treatment is discussed below.

5.2.4 Tertiary treatment – plastic media filters

Based on the calculations in Section 5.2, it could be determined that AWS will require a parallel tertiary treatment unit in the early years of AMP6, as the calculated DWF from the proposed growth will approach the DWF used in the design envelope. However, as discussed in Appendix A, it will be possible for AWS to operate the existing unit beyond this point. This will have the effect of the final effluent quality approaching and then matching the consent standard by 2022.

To avoid the statutory and environmental risks of operating ever closer to the consent standard, it is likely that AWS would monitor the growth in the catchment over the next few years, and make a decision to invest in additional tertiary treatment once this risk is no longer acceptable.

As illustrated in Appendix A, it is likely that this point will occur early in AMP7. This allows AWS the five year AMP6 period in which to monitor the growth, and undertake the necessary preparatory investigations and design work to provide additional tertiary treatment capacity. Additionally, this will also allow AWS to monitor the likely decrease in secondary treatment performance as the flows increase (described in the Section 5.2.3) and ensure that additional tertiary treatment provided in early AMP7 allows for this reduction.

As observed on site, there is sufficient land available to accommodate a similar style and size of plastic media trickling filter – and additional land will be available once the SAF is decommissioned and demolished.

The proximity of the available land to the existing process, and the modular nature of the chosen system, will result in relatively shorter lead times to deliver and commission. It is therefore concluded that tertiary treatment should not be considered a constraint to development.

5.2.5 Further tertiary treatment

As the existing volumetric consent limit is approached towards 2031, there is a possibility (discussed in the Stage 2 WCS) that the EA may determine the discharge consent standards require tightening to achieve the objectives of the Water Framework Directive (WFD) – this may also include the introduction of a phosphorous standard.

Should this be required in the future, modular options should be available to AWS. The reedbed area, which is no longer an integral phase in the treatment process, could be used to accommodate more technologically advanced tertiary treatment systems to remove suspended solids and phosphorous concentrations, such as sand filters.

Given that the calculated exceedance in volumetric flow rate is only marginal by 2031, and that there is sufficient timeframe available for AWS to investigate such options (as per Section 5.1), this is not considered a constraint to the proposed growth.

6 Sewerage infrastructure

AWS have made available to this study:

- Records of customer contacts/ complaints made within the catchment since 2010, with some specific cases including incidents from 2008;
- Plans and Graphical Information System (GIS) asset data for the Tuddenham sewerage network;
- Initial calculations undertaken by AWS when sizing the King's Warren SPS;
- Pump run times for the King's Warren SPS; and
- A descriptive assessment of sewerage network capacity and connectivity changes.

FHDC had indicated that there is a history of sewerage complaints in the Red Lodge and Herringswell area, some of which have been documented in local media.

This Section appraises the capacity of the existing sewerage infrastructure to accommodate the increased flows from the proposed development.

6.1 Existing sewerage infrastructure

As illustrated in Section 2.3, all of the wastewater from Red Lodge is pumped to Tuddenham WRC via the TPS at Herringswell.

From reviewing the GIS data provided by AWS, and following consultation with AWS, the existing sewerage network within the town is best described as:

- Older areas to the west of Warren Road drained via a series of small SPS, sometimes serving one or two individual streets, which ultimately flow to Warren Road SPS for pumping northwards to King's Warren SPS, and onwards transmission to Herringswell TPS;
- More recent developments to the east of Warren Road drained northwards via gravity to the recently constructed King's Warren SPS, for onwards transmission to Herringswell TPS; and
- More recent developments to the northeast of Turnpike Road drained via a new SPS, bypassing the historic Warren Road network and instead pumped to King's Warren SPS for onwards transmission to Herringswell TPS.

The above philosophy of concentrating new development connections towards the King's Warren SPS is in line with position AWS set out during the Stage 2 WCS. Reviewing the GIS data shows adherence to this strategy, for example it shows the assets built in 2011 connecting the Wintergreen Road development to the King's Warren SPS.

6.2 West of Warren Road

As discussed above, the area of Red Lodge to the west of Warren Road is served by a network of small SPS, sometimes serving one or two individual streets. This network allows for the efficient transportation of wastewater without the need for large deep pumping stations and replication of sewer pipes, and similar systems are in place across the Mildenhall area.

However, the multitude of SPS increases the maintenance burden to AWS, and provides more locations where blockages or power outages can become problematic and result in sewer flooding. Historically, sewer flooding issues in this area were reported widely in the local media.

Additionally, the location of some of these SPS was particularly poor in terms of health and safety and traffic management. Maintenance/ repair works often had to be undertaken overnight – causing disruption to residents.

6.2.1 Existing sewerage capacity

Whilst the above issues will have been frustrating for residents, AWS are aware of the issue and it is apparent that they have been resolving the worst offending SPS through their ongoing package of capital works.

Notably, in AMP5 AWS have been undertaking a programme of SPS replacement for sites such as these. At least 15 sites were targeted in the Mildenhall area with a capital cost of around £2.5M[8].

As an example of this strategy being delivered, the GIS record shows that the SPS at the Bennett Road/ Warren Road junction was replaced in 2012. The records show that AWS moved it out of the highway in to the adjacent verge, to allow safer and more efficient access should there be a blockage or power outage, and hence reduce the risk of sewer flooding and disruption to residents in this area of Red Lodge.

Projects such as this also reduce the risk to upstream streets to the west of Warren Road, such as the Heatherset Way and Boundary Road areas, which are connected to Warren Road SPS through this point.

6.2.2 Future sewerage capacity

Providing AWS continue with the philosophy of connecting new developments at Red Lodge to the King's Warren SPS network, and hence avoid the historic Warren Road network, this issue should not be considered a constraint to the proposed development.

Should other small SPS in the Warren Road network continue to present as hotspots for blockages and sewer flooding, it is likely that AWS would consider these for investigation and capital works, perhaps in AMP6.

As with all water/wastewater undertakers, the prioritisation of capital improvement works to the existing network will be subject to a robust cost benefit analysis which will take in to account the risks of sewer flooding to the existing residents.

6.3 Warren Road SPS

Aside from the above, AWS informed this study that the capacity of Warren Road SPS was historically recognised as a constraint.

This capacity constraint was most notable around 2007, following the completion of the King's Warren SPS. At this time, the connectivity of the network was such that King's Warren SPS collected flows from the most recent and emerging developments, and pumped these flows in to the Warren Road SPS. The older (and smaller sized assets) at Warren Road SPS were then required to pump all of the wastewater from Red Lodge to Herringswell TPS.

The increase in flows received at Warren Road SPS resulted in the exacerbation of the risk of external flooding/ odour issues should the pumps suffer an outage or a blockage, as less buffering would have been available given the finite volume of the SPS wet well.

6.3.1 Existing sewerage capacity

AWS have informed FHDC, developers and this study, that the above issue at Warren Road SPS was resolved in 2007/2008 by altering the sewerage network connectivity. According to AWS, Warren Road SPS now only receives flows from the areas to the west of Warren Road, excluding the Newmarket Road area. Warren Road SPS pumps these flows northwards to King's Warren SPS, which then pumps all flows from Red Lodge directly south back past Warren Road SPS and onwards to Herringswell TPS (bypassing the older assets entirely).

The network GIS data for the area has not been updated locally to accurately represent the 2007/2008 change in connectivity – this would usually have been the first point of reference for this study to independently verify the AWS information above.

However, the GIS does show a pair of parallel rising mains between King's Warren SPS and Warren Road SPS, which would make the AWS explanation reasonable, as the change in connectivity would have been relatively straightforward to undertake given the existence of these mains.

In order to further verify the AWS information above, Hyder requested all available flow data for the King's Warren SPS and Warren Road SPS. Unfortunately, AWS have not historically had the required telemetry monitoring in place to collect such data. However, AWS were able to provide 15 minute outlet flow data for the Warren Road SPS from May 2014 (following a recent installation to improve monitoring capability).

This recent flow data for Warren Road SPS indicates the following:

- An average daily throughput of 15.4 m^3; and
- A maximum daily throughput of 74.9 m^3.

In comparison, average daily flows received at Tuddenham WRC in 2012/13 were 767 m^3/d. Data from the 2011 census suggests that the population of Red Lodge accounts for at least 75% of the Tuddenham WRC catchment. The total wastewater 2012/13 flows emerging from Red Lodge can therefore be approximated as 75% of 767 m^3/d, i.e. 575 m^3/d.

6.3.2 Future sewerage capacity

Given the order of magnitude difference between the flows measured through Warren Road SPS, and the total flows expected to be emerging from Red Lodge, it can be concluded that the majority of the wastewater from Red Lodge does not pass through the Warren Road SPS. This supports the AWS explanation that flows from King's Warren SPS now bypass the Warren Road SPS.

As the AWS plans for accommodating the proposed growth at Red Lodge are to continue to connect new sites directly to King's Warren SPS, it can be concluded that the capacity of Warren Road SPS does not represent a constraint to development.

6.4 King's Warren SPS

As discussed above, King's Warren SPS was provided in 2007 following a developer requisition. King's Warren SPS initially pumped to Warren Road SPS via two parallel rising mains, for onwards transmission to Warren Road SPS. This was creating capacity issued at the older Warren Road SPS.

However, in mid-2008 AWS altered the network connectivity, reversing the flow in one of the rising mains, and bypassing the second rising main around Warren Road SPS. Warren Road SPS now pumps to King's Warren SPS, which in turn pumps all of the wastewater from Red Lodge to Herringswell TPS.

6.4.1 Existing sewerage capacity

In the absence of outlet flowmeter data for King's Warren SPS, AWS have provided telemetry data detailing the maximum run times for each of the three pump units in this SPS, for 2013/14, and the daily total run times for the very dry month of September 2014 (a useful data source due to the decreased chance of surface water or ground water entering the foul network).

Analysis of this data suggests an average daily pumping duration of 248 minutes. In the absence of data confirming the pump duty flow rates, the flow rate from King's Warren SPS is therefore estimated as 38 l/s. This is consistent with the 38 l/s duty flow which AWS considered in their initial sizing calculations for the SPS.

This appears to be a suitably conservative estimate, given that it is well within the 60.8 l/s flow rate measured at Herringswell TPS by AWS during their AMP5 Tuddenham WRC improvements design work.

6.4.2 Future sewerage capacity

If the estimate of 38 l/s is used as the maximum throughput from King's Warren SPS, an equivalent maximum population can be estimated, based on the theory that 3 x DWF should approximate to peak flow.

Using the standard variables discussed in Section 2.5, a peak flow of 38 l/s is equivalent to a DWF of approximately 1,164 m3/d, or a PE of over 8,000, sufficiently above the 7,461 PE predicted as being served by this SPS from the proposed growth trajectory by 2031.

Alternatively, assuming a pump rate of 38 l/s, it can be estimated that the time taken to pump the additional average flows from the proposed development up to 2031 would be 287 minutes. Added to the existing average pump run times of 248 minutes, this represents a total pumping time of 535 minutes per day, or approximately nine hours.

As a comparison, daily run times of up to 12 hours are not unusual for assets of this type. It can therefore be concluded that the peak capacity of King's Warren SPS does not present a constraint to the proposed development.

AWS may need to increase the flow rate of the pumps at King's Warren SPS towards the end of the plan period, dependent on their monitoring of actual peak flows received and pump run times. If upsizing the pumps is considered a necessity due to growth, this would likely be funded via the standard developer requisition process under the Water Industry Act.

Depending on the accounting conventions and operational guidance used by AWS, mechanical and electrical equipment installed in 2007 may be considered as near to the end of its asset life by 2031 (regardless of growth), hence the site may be considered for capital maintenance through the standard business cycle.

6.5 Herringswell TPS

Herringswell TPS pumps all of the wastewater from Red Lodge (via King's Warren SPS) onwards to Tuddenham WRC for treatment. In addition, a smaller SPS serving the village of Herringswell also pumps in to the Herringswell TPS.

6.5.1 Existing sewerage capacity

Capacity concerns at Herringswell TPS have historically been widely reported in local media, with a number of incidents and complaints during AMP4. However, the reports also go on to verify the position of AWS; that they upgraded the capacity of Herringswell TPS in 2010/11, and implemented odour control technology (see Section 7.5). These upgrades were in part due to historic issues, and in part related to the proposed growth in the catchment at that time.

AWS have not provided details of the improvement works undertaken at Herringswell TPS. However, the design envelope calculations for the AMP5 Tuddenham WRC include reference to a physical pump test undertaken at Herringswell TPS, which confirmed a maximum flow rate of 60.8 l/s.

As discussed in Section 6.4.2, this is in excess of the maximum estimated flow rate incoming from King's Warren SPS, which results in some capacity remaining to account for the local Herringswell flows even during peak times.

The 2012/13 baseline PE and peak flows accommodated by Herringswell can be conservatively approximated from the 2011 census data as follows:

Settlement	PE (Parish data – 2011 census)	Comments	Estimated peak flow (l/s)
Red Lodge	3,834	Conservative, as 75% of 2012/13 WRC PE would be 3,170	18.02
Herringswell	290	Conservative, as 5.68% of 2012/13 WRC PE would be 240	1.36
Total	4,124	-	19.38

Table 6-3 Herringswell TPS baseline flows

The estimated 2012/13 peak flows of 19.38 l/s represent approximately one third of the peak flow pumping capacity of Herringswell TPS.

6.5.2 Future sewerage capacity

Assuming that all of the wastewater from the proposed growth in the catchment is routed via Herringswell TPS, the increase in peak flows from the growth between 2012/13 and 2031 is approximated as 17.05 l/s.

Assuming an existing baseline peak flow of 19.38 l/s, this would estimate the peak flows through Herringswell TPS as 36.43 l/s by 2031. This is approximately 60% of the maximum peak flows which AWS report that Herringswell TPS can accommodate.

In the longer term AWS may seek to further increase storage capacity at Herringswell TPS to further reduce the risks to customers and the environment should there be a power outage or blockage. However, it is likely AWS would continue to monitor these risks, and the growth realised in the catchment before making a decision on further capital investment here.

Additionally, AWS have advised that a telemetry link now operates between King's Warren SPS and Herringswell TPS, which inhibits the pumps at the former if a failure is detected at the latter, hence improving the current resilience at Herringswell TPS.

It is therefore concluded that the capacity of Herringswell TPS should not be considered a constraint to the proposed development.

7 Customer complaints

7.1 Sewerage network west of Warren Road

Table 7-4 illustrates the notable ten-fold decrease in the number of customer contacts in these areas following the improvement works in 2012.

Period	Count of customer contacts (total)
2010/11	34
2011/12	41
2012/13	4
2013/14	4

Table 7-4 Analysis of AWS customer contact log for area adjacent to Bennett Road/ Warren Road SPS

Notably, the majority of customer contacts from 2012/13 relate to the request for advice following contact with wastewater (possibly following private drain cleaning), asset appearance or superficial issues such as deterioration of manhole cover seating in the highway. Only one of the contacts since 2012/13 related to external flooding, and the AWS log shows that this was attributed to a blockage in a small sewer which (prior to adoption of such assets by AWS in 2011) would have been considered to be a private lateral sewer.

The above data highlights the recent improvements made by AWS to the existing sewerage network near Warren Road.

7.2 Warren Road SPS

The AWS customer contact data does show a history of contacts to investigate odours in the vicinity of Warren Road SPS, with a number of contacts between 2006 and 2011. Interestingly, these complaints bridge the 2007/2008 period in which the above connectivity change at Warren Road SPS was undertaken.

The AWS customer contact data does not provide sufficient information for the 2006 occurrence to attribute a cause for this issue, but it is notable that this is around the date that a number of new developments east of Warren Road were built out. Issues occurring at Warren Road SPS in 2006 could well be attributed to the early connection of some of this development prior to the full completion of King's Warren SPS in 2007.

Similarly, the customer contact issues here in the earlier half of 2008 would have been around the time that AWS decided to change the connectivity from King's Warren SPS to Herringswell TPS, and bypass Warren Road SPS. The AWS customer contact data shows that the customer concerned was contacted in mid-2008 to explain the engineering works (i.e. the change in connectivity).

The AWS customer contact data does not contain sufficient information to attribute a cause to the 2011 occurrence. However, it may be that this was a result of localised blockages, outages or asset failure, rather than a capacity issue related to development. Given the conclusions in Section 6.3, it is reasonable to conclude that more recent issues at Warren Road SPS (since the 2007/2008 connectivity change) are not specifically attributed to growth and capacity concerns.

7.3 King's Warren SPS

The only AWS customer contact recorded in the immediate vicinity of King's Warren SPS since 2008 is for the investigation of noise.

Five other customer contacts are recorded in the gravity sewerage system in the neighbouring streets upstream of King's Warren SPS, two of which were attributed to cosmetic/maintenance issues, and three of which were attributed to the blockages in customers' private pipes.

The above data reinforces the conclusion that the capacity of King's Warren SPS is not a constraint to the proposed growth.

7.4 Herringswell TPS

The following table illustrates the causes attributed to the customer contacts from customers in the vicinity of Herringswell TPS since 2009/10.

Period	Total customer contacts	Blockage	Odour	Noise	Advice following contact	Burst main	Asset appearance/ vandalism	Customer requested call-back	Flooding/ pollution risk due to power outage
2009/10	7	7							
2010/11	7	4		3					
2011/12	3	2	1						
2012/13	6	1				1	4		
2013/14	5				3			1	1

Table 7-5 Herringswell TPS customer contacts

Additional data was requested from AWS for a number of the above customer contacts. These details cannot be reproduced in this study for confidentiality reasons. However, it is noted that the majority of the blockages reported in 2009/2010 related to external wastewater flooding outside of Herringswell TPS. These incidents can be attributed to a variety of factors including blockage of the pumps or power outages, and there is no record of this being caused by the incoming flows from Red Lodge overwhelming the outgoing pump rate.

Where an emergency outfall from the TPS does not exist (as is the case with Herringswell TPS), a typical solution to reduce the risk of external flooding in the event of a power outage/ pump blockage is to provide additional wet well volume, to allow more incoming flows to be retained until the pumps can be restarted.

This was part of the improvements that AWS undertook in 2010/11, and it is notable that in the following periods the customer contacts attributed to this type of incident have more than halved. However, it is uneconomical in terms of land take, construction impacts and costs to customers to provide indefinite volumes of storage; hence the risk may be minimised but not entirely removed.

For example, an additional incident occurred during the stormy winter of 2013/14. Repeated power outages to the TPS site led to external flooding on a number of days. As evidenced in the customer contact log, AWS aim to attend site, restore power and reset the pumps as soon as practicable.

Similar to all wastewater undertakers, AWS will typically employ a fleet of portable generators and vacuum tankers for use during power outages, subject to prioritisation. Whilst the potential effect of such events on customers and the environment can be serious, it is uneconomical to supply every pumping station with a permanent fixed standby generator (and can invite crimes such as fuel theft).

Notwithstanding, if occurrences of power outages continue to occur at Herringswell TPS leading to increased risks to customers and the environment, the priority of the site (in terms of cost benefit ratio) may increase, leading to AWS investigating further the supply of a backup power source. The increased flows due to the proposed growth would likely also make this site a higher priority in the future. However, it must be noted that this statement is based on the experience of Hyder working for a number of water and wastewater undertakers, and is in no way indicative of any decision that may or may not be made by AWS.

Given the recent improvement works undertaken by AWS at Herringswell TPS, and with the understanding that it is unfeasible to eliminate every risk of power outage/ pump blockage, it is considered that the capacity of Herringswell TPS does not present a constraint to the proposed development.

7.5 Odour issues

The AWS customer contact data in the vicinity of Herringswell TPS shows one request to investigate and solve odour issues since 2009, dating from 2011. However, the more detailed historic data requested for a number of customer contacts also highlights incidents where residents complained about odour.

Additionally, the issue of odour at Herringswell has been widely reported in local media, and raised by residents and Councillors during recent Development Control Committee meetings. The scope of this Independent Study has therefore been extended to investigate this issue further.

Wastewater inherently has an unpleasant odour, hence during the wastewater flooding incidents caused by the power outage/ pump blockages described above it is understandable that nearby residents would unfortunately be subjected to some odour. However, as described in the section above, such events are not indicative of a lack of appropriate capacity in the network.

Aside from the above, during the normal operation of the wastewater network odour can occur as air leaves the system. This odour can be exacerbated and may become a particular nuisance to nearby properties if the wastewater has become septic. TPS facilities such as at Herringswell cannot be constructed air-tight, as ventilation of the wet well is required to allow air in and out during pumping operations.

Septicity occurs in wastewater when micro-organisms have utilised all of the dissolved oxygen and any nitrates that may be present. These anaerobic conditions promote biological processes resulting in the bacteria producing sulphides. When wastewater becomes septic, the hydrogen sulphide and organic sulphides produced are extremely malodorous and can hence cause a nuisance if released in to the atmosphere[9].

There is a high risk of septicity where the retention time of wastewater is high. High retention times can be caused by a number of contributing factors, including the size and length of the rising main, the volume of the wet well, low flow rates and the operating levels of the pumps.

As a rough guide, rising mains in excess of 500 m length are often considered at risk of septicity. The sewer from King's Warren SPS to Herringswell TPS is over 3.5 km in length and hence is at a significant risk of septicity occurring.

Works to increase the capacity of wet wells ahead of development build out (and hence provide additional resilience) can lead to increased retention times, and therefore exacerbate the risk of septicity and odours occurring.

Whilst the 2007/2008 changes in network connectivity (see Section 6.3.1) relieved the capacity concerns at Warren Road SPS, this resulted in wastewater from this area having to be pumped a longer distance via King's Warren SPS, and hence increased the risk of septicity occurring.

The large wet well of King's Warren SPS (built with additional resilience/capacity to accommodate future growth) means that the retention time of this wastewater is increased. Additionally, following the upsizing of the Herringswell TPS wet well in 2011 (again to improve capacity/resilience) there is a further risk that wastewater is retained for longer here, and hence becomes septic.

To counter the above risks, AWS installed a calcium nitrate variable dosing system in 2011 at King's Warren SPS, to inhibit septicity and hence reduce the risk of nuisance odours occurring at Herringswell TPS.

Variable dosing systems such as this can involve complex monitoring and controls to ensure efficient and consistent operation. However, as with all mechanical and electrical processes, there is a risk that asset failures or extreme operational conditions reduce the efficacy of this process. For example, if the King's Warren SPS pumps were to fail (or be inhibited by the telemetry link), over sufficient time the wastewater held in the rising main and wet well would still become septic regardless of the dosing.

Table 7-6 illustrates the reduction in retention time, reduction in the production of sulphide, and hence reduction in the risk of odour that would accompany the increase in flows from the proposed development, based on the Pomeroy–Parkhurst empiric equations[10].

This is based on the following assumptions:

- The total length of the rising main from King's Warren SPS to Herringswell TPS is 3,573 m, comprising 1,277 m of 255.8 mm diameter pipe, and 2,296 m of 228.6 mm diameter pipe;
- The pump rate is 38 l/s;
- The maximum usable wet well volume of the SPS is estimated as 90 m^3 by AWS, but the telemetry data suggests that the pump control levels are currently set so that the operational volume is approximately 9 m^3 (suggesting that AWS are minimising retention times where practicable);
- The average chemical oxygen demand of the wastewater is 832 mg/l (based on AWS design guidance of 0.15 kg/h/d);
- The temperature of the wastewater is 20 °C (a conservative estimate of the wastewater temperature during the summer, where the risk of septicity is higher); and
- The dosing of calcium nitrate is disregarded.

	2013			2021			2031		
	3DWF	Average	DWF	3DWF	Average	DWF	3DWF	Average	DWF
Flows in to King's Warren SPS (l/s)	14.9	6.6	5.3	25	11.1	8.9	31.9	14.2	11.3
Retention time (minutes)	188	425	530	112	253	315	88	198	248
Retention time (hours)	3.14	7.09	8.83	1.87	4.21	5.26	1.47	3.29	4.14
Concentration of sulphide (mg/l)	4.85	24.71	38.33	2.90	14.70	22.86	2.28	11.49	18.14

Table 7-6 Retention times and sulphide concentrations (excluding benefits from current dosing)

Retention times of greater than six hours are likely to result in septicity.
Odour nuisance may become apparent when the concentration of sulphide is above 2 to 5 mg/l.

The above illustrates that, under normal operation, the increased flows through the network from the proposed growth will serve to decrease retention times. The increased inflows to King's Warren SPS would cause the wet well to fill faster, hence the pumps would run more often and potentially for longer.

Wastewater would therefore spend less time held in the rising main to Herringswell, so would have less risk of becoming septic before arriving at the TPS wet well, and hence produce less sulphides and potential odour nuisance.

The decrease in retention times associated with the proposed development should reduce the quantity of dosing required and therefore may allow AWS to better manage the risk of septicity and odours occurring, however due to the length of the rising main it is estimated that some dosing will still be required.

The above argument would not be valid if the pump capacities were not capable of passing forward the proposed increase in peak flows. If this were the case then incoming wastewater would be retained for longer in the wet wells to allow adequate time for the pumps to pass this forward – however as described in Sections 6.4 and 6.5 the existing pumps appear to have sufficient capacity to accommodate the proposed increase in flows.

8 Conclusions

The conclusions of this independent study and process capacity review can be summarised as follows:

- The proposed growth in Red Lodge will result in the existing volumetric discharge consent at Tuddenham WRC being marginally exceeded by 2029/30. Exceedance of the volumetric discharge consent may trigger a tightening of physio-chemical consent standards, which may require AWS to explore advanced treatment processes or alternative discharge options. However, this is now predicted to occur much later than previously (the Stage 2 WCS had originally predicted 2021, due to erroneous measured flow data - which has since been corrected by AWS through flow meter verification as part of the AMP5 works). This now provides a suitable timeframe for AWS to consult with the EA and determine a strategy for providing the necessary treatment to meet current and future WFD objectives. **Therefore, the 2021 embargo is no longer required in terms of compliance with volumetric discharge consents/ water quality targets.**
- AWS had previously reported (during the Stage 2 WCS) that the process units at Tuddenham WRC had capacity to accommodate the extant planning permissions at Red Lodge, but no additional development. AWS had predicted that significant works would be required to accommodate additional growth, particularly if the volumetric discharge consent was due to be breached by the growth. AWS have since undertaken a significant package of capacity improvements at Tuddenham WRC during AMP5, to increase the process and hydraulic capacity of the WRC. This represents a significantly improved position since the Stage 2 WCS, and provides capacity to accommodate the full growth trajectory until at least 2021.**Therefore, the 2021 embargo is no longer required in terms of WRC hydraulic/ process capacity.**
- As an exception to the above, due to the proposed growth to 2031, some additional modifications/ extensions to the WRC processes will be required potentially from 2021 onwards, primarily to allow AWS to operate at a similar level of process risk as currently – these include an additional screen, balancing tank, and plastic media trickling filter tertiary treatment unit. The availability of land on site, and the modular design of these types of assets, should allow AWS to provide the necessary improvements as required. **Therefore, the 2021 embargo is no longer required in terms of WRC hydraulic/ process capacity.**
- Historically there have been capacity issues in the Red Lodge sewerage network, particularly at Warren Road SPS and Herringswell TPS. However, AWS have undertaken a programme of improvement works and network connectivity changes in AMP5 which alleviate these capacity concerns. This study has observed that AWS are continuing with a strategy of connecting new development to the King’s Warren SPS, avoiding the historic capacity constraint which would have otherwise emerged had they connected in to the older Warren Road SPS network. Additionally, from the data that AWS have provided, this study has concluded that, given the scale of the proposed growth, there are no immediate capacity concerns at either King’s Warren SPS or Herringswell TPS. The increased future flows should reduce the risk of odour at the latter. **Therefore, the sewerage network capacity is not considered to present a constraint to the proposed development, and does not warrant a 2021 embargo.**

- There are no specific development thresholds emerging from this study which FHDC should be required to consider in the emerging SIR. It should however be noted that if the development trajectory is accelerated, or the development quantum increased beyond that identified in Section 3, the capacities identified in Sections 5 and 6 will be expended at a faster rate. **The current proposed trajectory offers sufficient timeframes for AWS to assess, investigate, design and commission additional capacity post 2021 as required.**

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Appendix A

Process Capacity Assessment

Forest Heath District Council

Forest Heath District Council

Tuddenham Water Recycling Centre

Process Capacity Assessment

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Tuddenham Water Recycling Centre

Process Capacity Assessment

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CONTENTS

1 SUMMARY

The Anglian Water Water Recycling Centre (WRC) at Tuddenham serves several small Suffolk villages and the new town development at Red Lodge. Further developments at Red Lodge require assurance that the treatment capacity at the Tuddenham WRC will be adequate.

Hyder Consulting have undertaken a process review of the capacity of the WRC on behalf of Forest Heath District Council. This review indicates that:

a) The Tuddenham WRC has recently been extended with a new inlet works and tertiary treatment plant.

b) The estimated capacity of the existing works (including recent installations) is considered adequate to treat additional loads that would arise from projected further development of the Red Lodge estate, increasing the catchment population by a nominal 2155 persons by 2021, continuing to meet the present discharge consent limits. Further development beyond 2021 may require additional tertiary nitrification capacity. This could be similar to the plant recently installed.

c) The additional flows may only marginally increase the Dry Weather Flow (DWF) above the present consent limit, hence it is not anticipated that the Environment Agency would impose tighter limits on the treated effluent discharge until the end of the design horizon.

Most of the dimensions of the treatment works tanks have been provided by Anglian Water. Where these have not yet been made available they have been estimated, from a site visit and scaling from aerial photographs. These dimensions are to be confirmed by Anglian Water.

2 INTRODUCTION

The Anglian Water Water Recycling Centre at Tuddenham serves several small Suffolk villages together with the new town development at Red Lodge.

In order to provide assurance that the capacity of the wastewater infrastructure would be adequate to handle increased flows and loads from proposed further development at Red Lodge, Hyder Consulting (Hyder) were commissioned by Forest Heath District Council (FHDC) in March 2014 to produce an independent study of the capacity of the sewerage network and wastewater treatment facilities serving the Red Lodge settlement.

This report details a process review of the treatment capacity of the Tuddenham WRC as part of this study.

3 WORKS CATCHMENT

The Tuddenham WRC receives sewage flows from the nearby villages of Tuddenham, Cavenham, Herringswell, and Icklingham, and from the Red Lodge Development. As the landscape is relatively flat, all of the flows are pumped. The combined flows are pumped mainly from the terminal pumping station (TPS) at Herringswell, with smaller flows from the Tuddenham TPS.

It is understood that much of the catchment, particularly the recent developments, is provided with separate foul and surface water sewerage systems. Hence there is little impact on flows due to surface water. As much of the sewerage system is relatively new, infiltration due to groundwater is also relatively low compared to most catchments.

There is also understood to be very little, if any, trade effluent discharges within the catchment.

Present populations served have been estimated as 3850[1] at 2011, plus 164 house completions to April 2013, giving a present total population of 4227. Additional loads are projected to arise[2]:

	2013 - 2016	2016 - 2021	2021 - 2026	2026 - 2031	Total
Existing permission as per 5 yr supply (Apr 2013)	363				363
Emerging site (Crest Nicholson)		374			374
Brownfield	0	0	20	20	40
Greenfield	100	100	100	100	400
Mixed	0	0	200	200	400
TOTAL	**463**	**474**	**320**	**320**	***1577***

At the standard Anglian Water estimate for occupancy of 2.3 persons per dwelling, the treatment requirements for the catchment would be expected to develop as:

	Present	2013 - 2016	2016 - 2021	2021 - 2026	2026 - 2031
Catchment Population	4227	5292	6382	7118	7854

1 SEW-07961-07-04-04-0007 Flow and Load Calculations (2021)(1) prepared by @One Consultants to Anglian Water Sept 2012

2 Email from Marie Smith, Planning Service Manager – West Suffolk Council, dated 06/05/2014

4 CONSENT

The works is presently required to achieve a standard for discharge to the River Lark:

Biological Oxygen Demand (BOD):	15 mg/l (95 percentile) 50 mg/l (upper tier)
Suspended Solids:	25 mg/l (95 percentile)
Ammonia (as nitrogen)	5 mg/l (95 percentile) 20 mg/l (upper tier)
The consented Dry Weather Flow is:	1100 m^3/day

An increase in the Dry Weather Flow above the consent level would trigger a revision to the consent, with, potentially, tighter numeric consent limits.

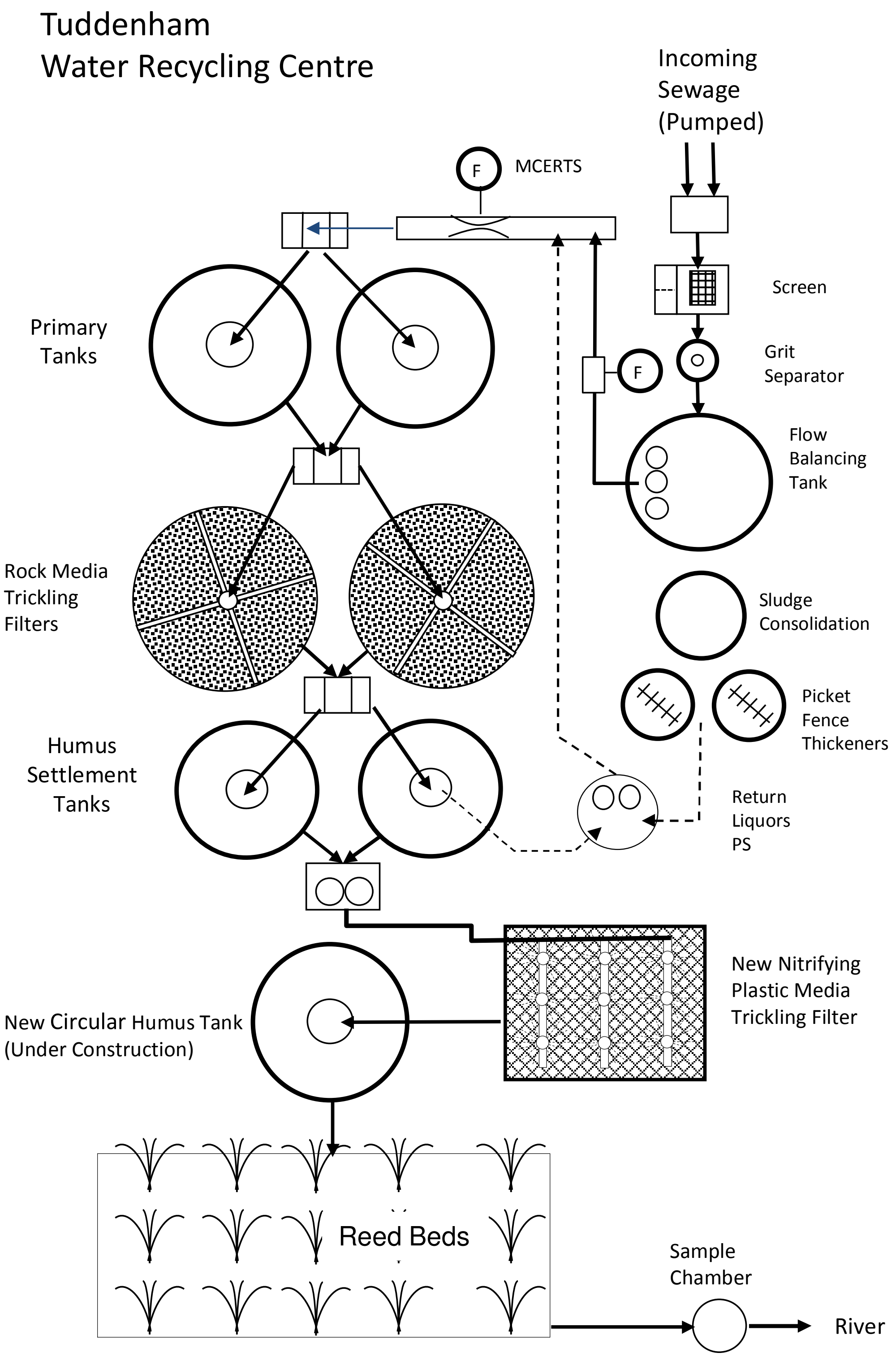
There is no storm water bypass at the works and no Full Flow to Treatment standard as the works is required to treat all flows pumped to the works. This is determined by the capacity of the terminal pumping station pumps, understood to be around 90 l/s at maximum.

5 WORKS DESCRIPTION

5.1 Flow Diagram

A simple flow diagram for the works is presented below:

Figure 1



5.2 Works Inlet

The inlet works has been modified recently with a new screen (6 mm spacing), grit separator and a flow balancing tank.

The rising mains from the terminal pumping stations discharge to a chamber upstream from the screen and grit separator. The flow discharges to the balancing tank. This is provided with pumps controlling the flow passed forward to treatment dependent on the level in the tank.

The flow is maintained at a minimum of 12 l/s, increasing to 19 l/s and up to a peak (pumped) flow of 28 l/s under high flow conditions. Higher flows bypass the balancing tank directly to the primary tanks.

There is no storm balancing tank and the works treats all flows received by the works. This could be up to 90 l/s with all the TPSs at maximum flow.

The balance tank pumps discharge to the old inlet channel, fitted with the MCERTS flowmeter.

Photograph 1 Balance Tank

5.3 Primary Tanks

Primary settlement is in 2 No. circular radial flow tanks, dimensions:

Diameter:	m	8.0
Side Wall Depth:	m	2.0
Floor Slope		7.5^{o} (estimate)
Settlement Area (Total)	m^2	99.0
Volume (Total):	m^3	215.3

Photograph 2 Primary Tank

These are desludged by automatic operation of the desludge pumps.

5.4 Trickling Filters

Settled primary tank effluent is distributed between 2 No. rock media trickling filters. Flow to the filters was originally controlled by a dosing siphon. However, as the filter distributors are now motorised, this is not required.

Photograph 3 Trickling Filter

The dimensions of the filters are:

Diameter:	m	25
Media depth:	m	2.0
Total Filter Area:	m^2	981.4
Total Media Volume:	m^3	1962.7

The media is believed to be blast furnace slag, nominally 50mm.

Photograph 4 Filter Media

5.5 Humus Tanks

The effluent from the filters is settled in two, relatively small, circular radial flow humus tanks.

Diameter:	m	8.0
Side Wall Depth:	m	2.0
Floor Slope		7.5^{o} (estimate)
Settlement Area (Total)	m^2	99.0
Volume (Total):	m^3	215.3

5.6 Tertiary Nitrification

To provide additional nitrification capacity, a tertiary nitrification plant has recently been installed at Tuddenham.

This is a plastic media trickling filter Bio-Blok® supplied by Cougar Coatings Ltd

This is specified[3] to achieve the ammonia discharge standard treating secondary effluent containing up to 19.4 mg/l ammonia, at flows up to 28 l/s.

Photograph 5 Cougar Bio-Blok Tertiary Filter

[3] Cougar Coatings Ltd Tuddenham WRC Operating Manual

5.7 Final Settlement

The effluent from the tertiary nitrification plant will be settled in a final humus settlement, presently under construction.

Diameter:	m	12.5
Side Wall Depth:	m	2.0 (estimate)
Floor Slope		10º (estimate)
Settlement Area (Total)	m^2	121.0
Volume (Total):	m^3	286.3

Photograph 6 New Final Settlement Tank

5.8 Reed Beds

Further polishing treatment of the effluent, mainly to reduce suspended solids, is provided by passing the effluent through reed beds before discharge to the outfall.

Photograph 7 Reed Beds

These have an area of 1470 m^2.

5.9 Sludges and Liquors

Humus sludges, from desludging the humus tanks, are discharged to the works liquor return pumping station, for return to the works inlet upstream from the primary tanks.

Co-settled primary and humus sludges are transferred from the primary tanks, by the auto-desludge pumps, to the picket fence thickeners.

Thickened sludge is lifted to the sludge storage/consolidation tank. This is provided with decant valves to allow return of top water as the sludges consolidate.

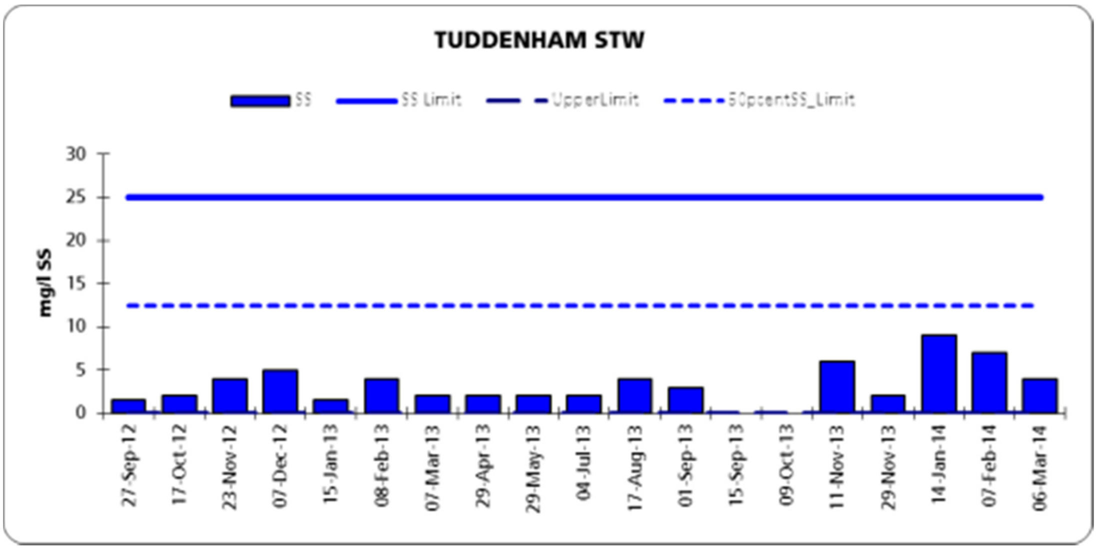
Consolidated sludge is collected by road tanker for further processing elsewhere.

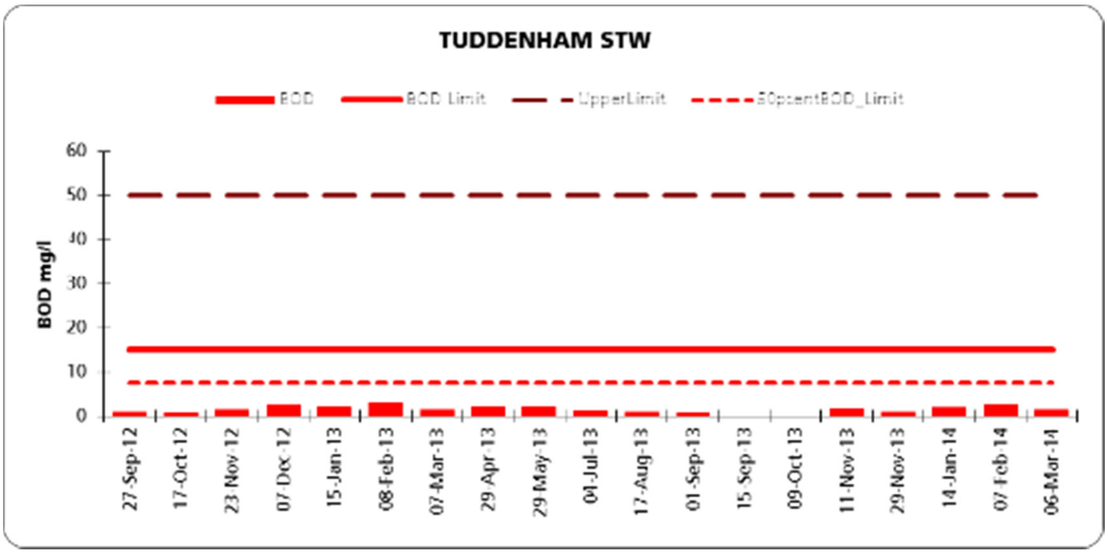
Supernatant liquors from the picket fence thickeners and consolidation tank also drain to the liquors return pumping station for return to the inlet works.

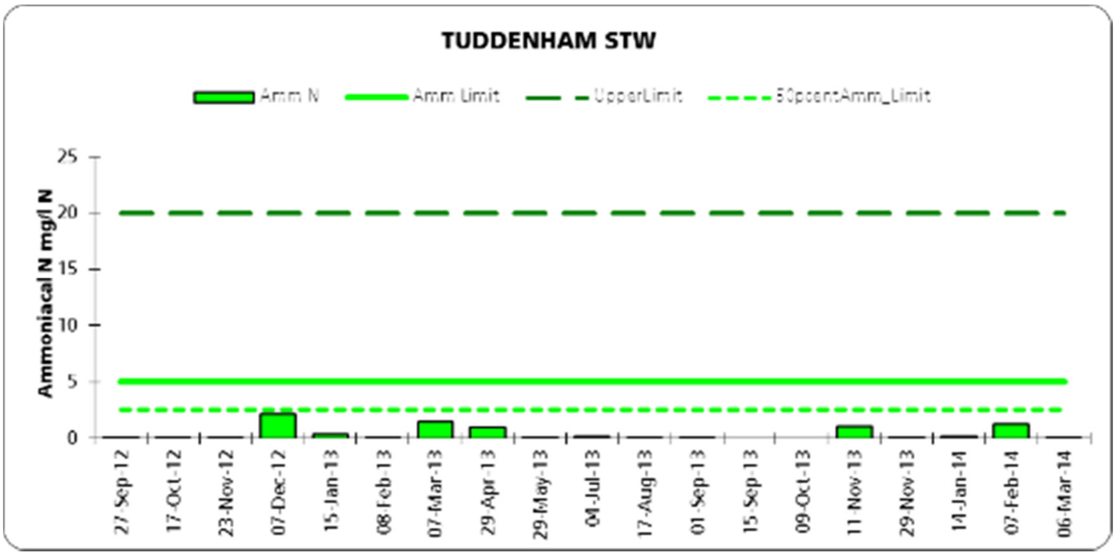
6 REVIEW OF WORKS CHARACTERISTICS AND PERFORMANCE

6.1 Effluent Quality

The effluent analyses for the last 2½ years, as presented by AWS, are shown graphically as:







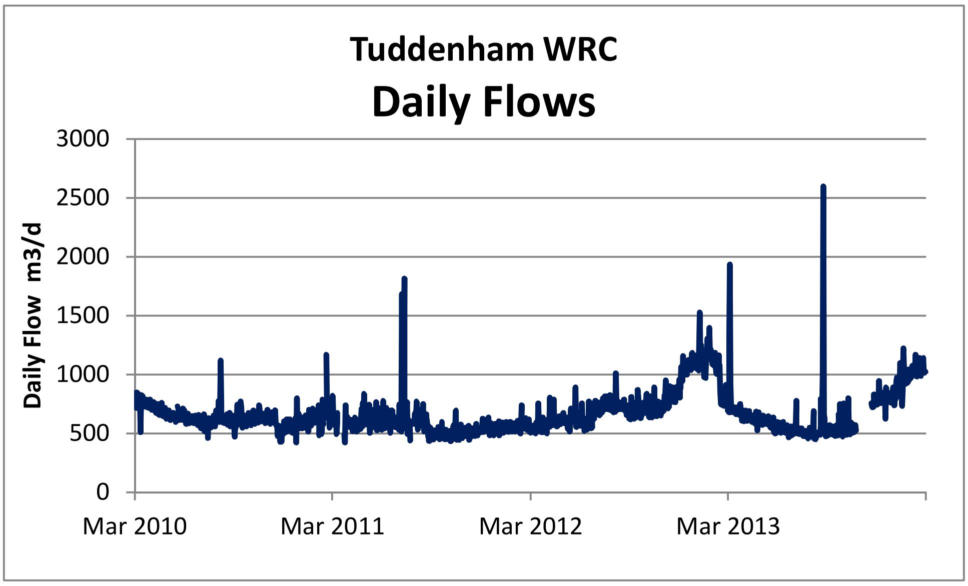
Generally the effluent was well within the Consent and there have been no failures since 2012.

6.2 Flow Characteristics

6.2.1 Daily Flows

The daily flows, recorded by the MCERTS flow meter over the last 4 years are presented graphically and tabulated below:

Figure 2



This shows minimum flows around 500 m^3/d, with rare peaks of 1500 – 2000 m^3/d.

		2010*	2011	2012	2013
Average Flow	m^3/d	632	569	767	680
Minimum	m^3/d	422	424	499	451
Maximum	m^3/d	1165	1817	1524	2595
Q80 (20 percentile)	m^3/d	573	498	602	508
Q90 (10 percentile)	m^3/d	549	474	560	490

* Flow data March - March

Typically, the Q90 Flow is accepted as the Dry Weather Flow for compliance by the Environment Agency, setting the Dry Weather Consent at the water company's planned annual Q80 flow.

6.3 Dry Weather Flow

6.3.1 Infiltration

Where no data is available, a figure of around 40% of the domestic flow is typically assumed for estimating groundwater infiltration. For this catchment, where most of the sewerage system is relatively new, it is likely that groundwater infiltration would be relatively low. For the purposes of this evaluation, a figure of 10% of the domestic flow has been assumed.

6.3.2 Flow to Treatment

The actual effluent flows (based on 2013 flow records) may be compared to calculated flows based on the present and projected estimated populations:

		2013	2016	2021	2026	2031
Estimated Population	Resident	4227	5292	6382	7118	7854
	Trade	0	0	0	0	0
	Total	4227	5292	6382	7118	7854
Flow per head[4]	m^3/p.e.d	0.131	0.131	0.131	0.131	0.131
Domestic Flow	m^3/d	554	693	836	932	1029
Estimated infiltration*	m^3/d	55	69	84	93	103
DWF	m^3/d	609	763	920	1026	1132
Actual DWF	m^3/d	508				
Estimated Average	m^3/d	731	915	1104	1231	1358
Actual Average Flow	m^3/d	680				
	l/s	7.9				
Formula A**	l/s	68.2	85.4	102.3	114.1	125.9

* estimated as 10% of the domestic flow

** Formula A flow is calculated as:

(P1+3P2)G+I+3E+1.36P1

Where:

P1 is the population with separate sewerage systems (assumed 90% in for this catchment)

P2 is the population with combined sewerage systems

G is the per capita flow (0.131 m^3/head.d)

E is the trade effluent contribution (zero)

I is infiltration (m^3/d)

[4] Anglian Water

These calculations indicate that, from the actual flow on dry days, either the resident population is around 20% less than the current estimate, or the flow per head is less (possibly due to a proportion of the population working, or going to school, outside the catchment).

These calculations also suggest that the present actual dry weather flow rate is much lower than the consent dry weather flow (1100 m^3/d).

Although the DWF is projected to eventually just exceed the DWF Consent, this is negligible and it is considered unlikely that the DWF Consent will need to be revised in the foreseeable future, even with the additional flows arising from the projected increase in catchment population.

6.4 Inlet Works

The inlet works, screen and grit separator, has been replaced recently. There is space allowed for an additional screen if/when required. Hence it is considered that this section of the works would not impose any restriction on the projected increase in flows and loads.

6.5 Primary Tanks

The hydraulic loads to the primary tanks have been estimated based on the present actual and future predicted average and peak flows:

		2013 Average	2016 Average	2021 Average	2026 Average	2031 Average	Peak Balanced	Peak Catchment
PST Area	m^2	99.0						
PST Total Volume	m^3	215.3						
Flow Rate	l/s	12.0	14.5	17.1	19.0	20.7	30	90
Hydraulic Load	m/h	0.4	0.5	0.6	0.7	0.8	1.09	3.27
Retention	hours	4.98	4.11	3.49	3.15	2.89	1.99	0.7

With both tanks in service, the upflow rate, at the normal peak flow rate, would be around 1.09 m/h at the peak pumped flow from the balance tank plus return liquors (30 l/s), increasing to 2.18 m/h with one tank out of service.

These loadings are considered acceptable to achieve satisfactory settlement of primary solids.

Extreme peak flows could be much higher under conditions when the balance tank is bypassed – up to 90 l/s. At this flow rate the primary tanks would be overloaded. However, as the catchment is a mainly separate sewerage system, such flow events are likely to be extremely rare and of short duration, also, under such high flow conditions the wastewater strength would be very much diluted.

6.6 Rock Media Trickling Filters

Assuming typical removals through the primary tanks (30% BOD, 60% suspended solids), for a total filter media volume of 1962.7 m^3, the average loading to the rock media filters is estimated at:

		2013	2016	2021	2026	2031
BOD Load	kg/d	212	265	320	357	394
	kg/m^3.d	0.108	0.135	0.163	0.182	0.201
Ammonia Load	kg/d	34.6	43.3	52.2	58.7	64.8
	kg/m^3.d	0.018	0.022	0.027	0.030	0.033

Projected future loading rates are relatively high to achieve complete ammonia removals. Typically a maximum loading rate of around 0.15 kgBOD/m^3.d is specified to achieve nitrification to a 10 mg/l ammonia standard. Hence, it is considered that the rock media filters would only achieve partial reduction in ammonia load by 2031, estimated at around 70% on average. To maintain compliance, additional tertiary nitrification capacity may be required beyond 2021.

6.7 Old Humus Tanks

Similarly to the primary tanks, the hydraulic loads to the old humus tanks, serving the rock media filters, have been estimated based on the actual and future predicted average and peak flows:

		2013 Average	2016 Average	2021 Average	2026 Average	2031 Average	Peak Balanced	Peak Catchment
Humus Tank Area	m^2	99.0						
Tank Total Volume	m^3	215.3						
Flow Rate	l/s	12.0	14.5	17.2	20.1	23.0	30	90
Hydraulic Load	m/h	0.44	0.53	0.63	0.73	0.84	1.09	3.27
Retention	hours	4.99	4.11	3.47	2.97	2.60	1.99	0.7

With both tanks in service, the upflow rate would be around 1.09 m/h at the peak pumped flow from the balance tank plus return liquors (30 l/s), increasing to 2.18 with one tank out of service.

These loadings are also considered acceptable to achieve satisfactory settlement of humus solids.

Under extreme peak flow conditions at 90 l/s, the humus tanks would be overloaded. Again, as the catchment is a mainly separate sewerage system, such flow events are likely to be extremely rare and of short duration, also, under such high flow conditions the wastewater strength would be very much diluted.

6.8 Tertiary Nitrification

Based on the removal efficiencies estimated above, the loadings to the tertiary nitrifying plastic media filter, assuming a preliminary estimate of the media volume of 167 m^3, with a specific surface of 150 (TBC) m^2/m^3, are estimated at:

		2013	2016	2021	2026	2031
BOD Load	kg/d	31.7	38.4	45.2	50.1	54.7
	$kg/m^3.d$	0.19	0.23	0.27	0.29	0.32
Ammonia Load	kg/d	4.2	7.5	12.4	16.7	21.8
	$kg/m^3.d$	0.025	0.044	0.073	0.098	0.128
Predicted[5] Effluent Ammonia	Ave mg/l	0.2	0.7	1.8	3.2	5.3
	95%ile mg/l	0.6	1.8	4.4	7.8	12.7

Using the Thames Formula for estimating the effluent ammonia concentration for plastic media trickling filters[5], a 95 percentile effluent ammonia concentration of 4.4 mg/l is predicted for the peak load condition at the 2021 design horizon. Assuming a linear increase in population, the 95 percentile ammonia concentration would be predicted to exceed the 5 mg/l limit during 2022.

Hence, beyond 2021, with further development in the catchment, additional tertiary treatment for ammonia removal will become necessary. It is understood that there is space on the site for a second nitrifying filter, similar to the Cougar plant recently installed.

6.9 Final Humus Settlement Tank

The characteristics of the final humus settlement tank have been estimated as:

		2013 Average	2016 Average	2021 Average	2026 Average	2031 Average	Peak Balanced	Peak Catchment
Humus Tank Area	m^2	121.0						
Tank Total Volume	m^3	286.3						
Flow Rate	l/s	6.9	7.9	8.9	9.9	10.9	30.0	90
Hydraulic Load	m/h	0.21	0.24	0.26	0.29	0.32	0.89	2.68
Retention	hours	11.53	10.07	8.94	8.03	7.30	2.65	0.88

[5] P. Pearce, Upgrading Trickling Filters, 2011

Apart from the extreme peak flow conditions, these loads are considered acceptable for settlement of the humus solids arising from the tertiary nitrification plant.

6.10 Reed Beds

Further polishing of the final effluent will be achieved passing the final humus tank effluent through the reed beds.

Typically, small tertiary reed beds are sized based on the population served or on average hydraulic load.

The area of the Tuddenham WRC reed beds has been estimated at: 1470 m^2.

		2013	2016	2021	2026	2031
Population	p.e.	4227	5292	6382	7118	7854
Load area	m^2/p.e.	0.35	0.28	0.23	0.21	0.19
Hydraulic area	m^2/m^3.d	2.0	1.6	1.3	1.2	1.1

These beds are considered relatively small for tertiary treatment (solids removal), where an area of 0.7 m^2/p.e. or an area equivalent to 2.5 m^2/m^3.d is specified by some water companies[6].

However, with the tertiary nitrifying plastic media filter provided for removal of residual ammonia, and a lightly load final humus tank, the reed beds should not be necessary for achievement of the discharge standard, although it is understood that they will be retained as a safety feature.

[6] Severn Trent Water and Thames Water Design Standards

7 RESERVATIONS

This review has been based on the dimensions of the water recycling works process tanks, some of which have estimated from a site visit and scaled from aerial photographs of the works. These dimensions should be confirmed by Anglian Water, with revisions to the calculations if necessary.

Further investigation of the flow characteristics of the works is recommended, particularly a review of the diurnal flow rates (typically 15 minute interval records) to gain a better understanding of the catchment pump characteristics.

Also, analyses for the incoming sewage (preferably 24 hour composite samples), is required to gain information regarding the actual loads (organic and ammonia), which would help to resolve the issue of the apparent low flow compared with the estimated catchment population.