Cambridge Waste Water Treatment Plant Relocation Project
Anglian Water Services Limited

Appendix 3.1: Initial Options Appraisal Report

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MOTT MACDONALD

Cambridge Waste Water Treatment Plant Relocation

Initial Options Appraisal Report

1 July 2020

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Contents

Executive summary

S.1. To facilitate the regeneration of the North East Cambridge area, The Cambridge and Peterborough Combined Authority applied for funding from the Housing Infrastructure Fund (HIF), which is administered by Homes England. The funding will enable the relocation of Cambridge WWTP, which is owned and operated by Anglian Water Services Limited (Anglian Water).

S.2. The Government announced in March 2019 that funding would be granted for the relocation of Cambridge WWTP and, as a result, Anglian Water is currently planning the relocation.

S.3. A Statement of Requirement has been produced by Anglian Water, which explains the background to the project and establishes the requirement for a site selection study to identify a suitable site for the relocation of Cambridge WWTP. The Statement of Requirement also confirms that the new Cambridge WWTP will also treat waste water from the Waterbeach drainage catchment area, which is adjacent to the Cambridge WWTP drainage catchment area.

S.4. A number of detailed appraisal steps are required to move from the Statement of Requirement to the identification of site or sites that are be suitable for the relocation of the waste water treatment plant to replace the existing Cambridge WWTP. This appraisal process assesses site options against planning, operational, community impact, environmental and, in the final stages, economic and programme criteria.

S.5. As a first step in the identification of a new location for the existing Cambridge WWTP it is important to consider the approach, i.e. transfer of all of Cambridge's waste water from the existing WWTP site to a single, new treatment plant, is the most appropriate solution, and if so, also confirm the most appropriate area in which to search ('Study Area') for a site for the relocated WWTP. This first step should take into consideration policy context, technical, environmental, social and cost factors.

S.6. This report describes this first step, an Initial Options Appraisal study, including context, approach, options identification and findings of the assessment.

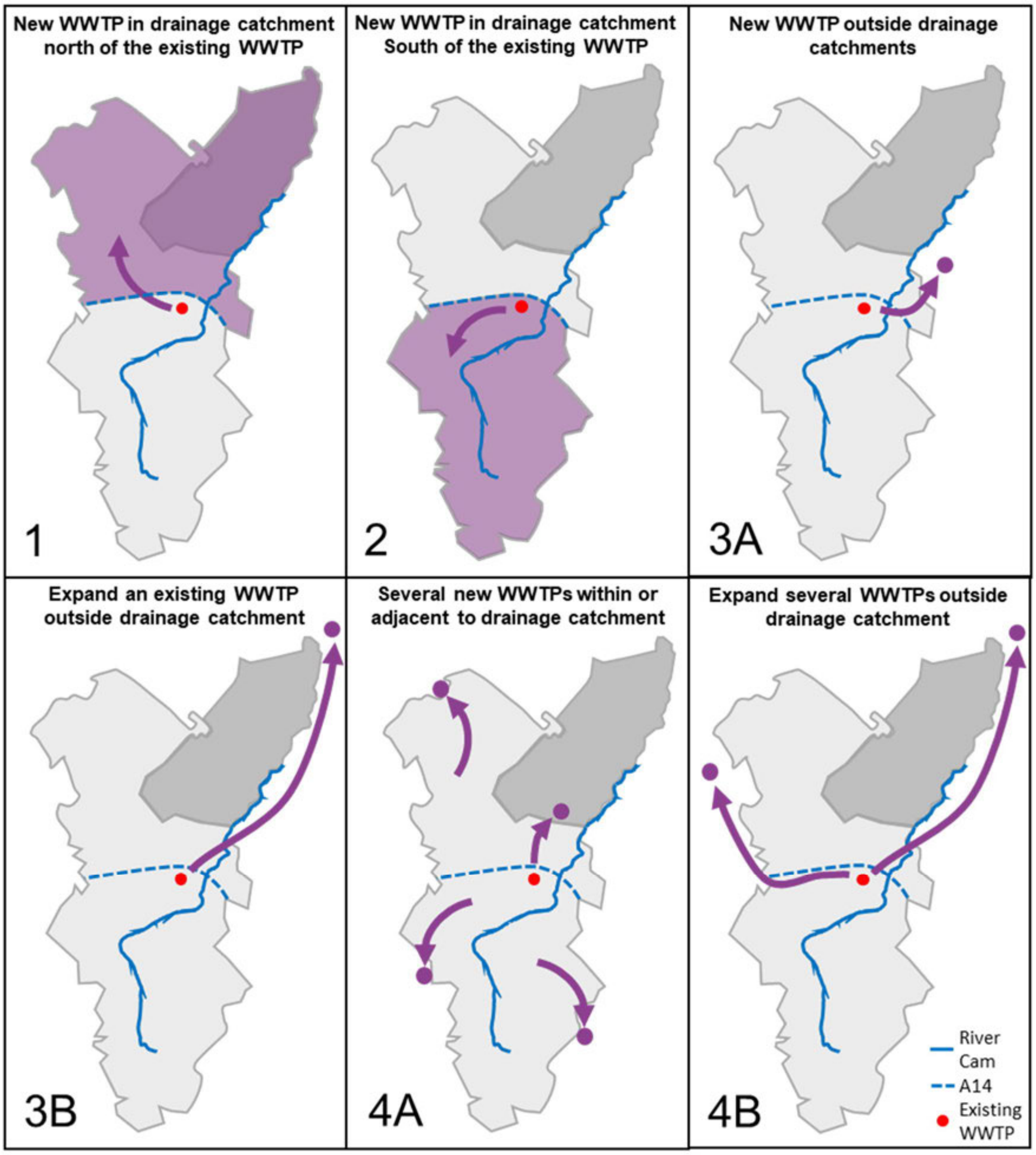
S.7. Subsequent stages of the site selection process will build on the findings of this study in order to arrive at the preferred site or sites to take forward for further detailed assessment and stakeholder consultation.

S.8. The approach used in this appraisal has the following steps:

1. Options identification, taking into account the existing context in the drainage catchment area, including drainage catchment boundaries and existing waste water collection and treatment assets, as well as policy, strategic and technical considerations for future options.
2. Assessment of options against appropriate criteria using a RAG (Red-Amber-Green) assessment approach and presenting conclusions on the way forward.

S.9. This initial options appraisal has identified a range of potential options for the relocation of the existing Cambridge WWTP as shown in the Figure S.1.

Figure S.1: Initial Options



S.10. A number of criteria for evaluating these options have been selected together with RAG assessment definitions. The criteria selected are as follows:

- Proximity principle
- Potential environmental impact of the effluent discharge location
- Impacts on local communities
- Carbon emissions
- Construction complexity
- Cost (capital and operational)

S.11. The results of the RAG assessment of the potential options indicate that Option 1 is the preferred solution (a single new WWTP, within a Study Area covering the combined Cambridge and Waterbeach drainage catchment areas, to the north of both the existing Cambridge WWTP site and current Cambridge urban boundary).

S.12. Option 1 performs favourably against a number of the criteria and its overall performance is considered to exceed that of all other options. Particular benefits of the option are:

- Location within the existing Cambridge and Waterbeach drainage catchment areas (compliance with the proximity principle)
- Continued discharge of treated effluent to the River Cam at or close to the existing discharge point (hence minimising the risk of water quality or flow impacts in alternative watercourses as well as the extent of any changes to the current discharge permit requirements)
- Reduced need to modify the existing sewer network or cause disruption to urban areas during construction of the plant and waste water transfer infrastructure
- Reduced traffic impacts during operation – due to the availability of a comprehensive trunk road network in the area
- Relatively lower carbon emissions and costs – largely as a result of the transfer and traffic benefits described above

S.13. The next best performing option is Option 2 (a single new WWTP, within a Study Area covering the Cambridge drainage catchment area, to the south of the existing Cambridge WWTP site). This option is inferior to Option 1 in terms of the potential impacts on the local community as well as carbon, cost and construction complexity. However, if a suitable site could be identified within the drainage catchment area but outside of the urban area, it is possible that the impact on local community and construction complexity would be reduced resulting in a similar score to Option 1.

S.14. This initial options appraisal therefore concludes that a new single site located within the combined Cambridge and Waterbeach drainage catchment areas (Options 1 and 2 in this initial options appraisal) is the preferred solution to take forward for more detailed assessment including a site selection process as outlined in Section 1 and illustrated below.

1 Introduction

This section provides an introduction to the Cambridge Waste Water Treatment Plant relocation project and initial options appraisal (this report). It describes the background to the project and the options appraisal approach.

1.1 Background to Cambridge Waste Water Treatment Plant Relocation Project

1.1.1 Cambridge City Council and South Cambridgeshire District Council are leading the regeneration of North East Cambridge (NEC). The principle of regeneration for this area was established in the recently adopted Cambridge Local Plan[1] and the South Cambridgeshire Local Plan[2]. An Area Action Plan (AAP) for development of this area is in preparation. A Regulation 18 version of the AAP is due to be published for public consultation in July 2020 and a Regulation 19 version of the AAP is programmed to be prepared by Summer 2021.

1.1.2 The existing Cambridge Waste Water Treatment Plant (WWTP) is situated in a section of NEC to the east of Milton Road and occupies a significant part of the area designated for regeneration. Cambridge WWTP provides waste water treatment for the residents and businesses of Greater Cambridge as well as sludge treatment for communities over a wider area around Cambridge.

1.1.3 To enable the regeneration of NEC, The Cambridge and Peterborough Combined Authority applied for funding from the Housing Infrastructure Fund (HIF), which is administered by Homes England. The funding will enable the relocation of Cambridge WWTP, which is owned and operated by Anglian Water Services Limited ('Anglian Water').

1.1.4 The Government announced in March 2019 that funding would be granted for the relocation of Cambridge WWTP and, as a result, Anglian Water is currently planning the relocation.

1.1.5 The Cambridge Waste Water Treatment Plant Relocation (CWWTPR) project ('the relocation project') will allow Anglian Water to continue to provide critical used water treatment and recycling services to residents in and around Cambridge in a modern, low-carbon facility designed in collaboration with stakeholders and the community.

1.1.6 A Statement of Requirement has been produced by Anglian Water[3], which explains the background to the project and establishes the requirement for a site selection study to identify a suitable site for relocation of Cambridge WWTP. The Statement of Requirement also:

- Considers that the relocated WWTP, using similar technology to the existing WWTP, would require a footprint of 22ha (this is the operational area and any landscaping around the site would be in addition to this area).
- Confirms that the new Cambridge WWTP will also treat waste water from the Waterbeach drainage catchment area, which is adjacent to the Cambridge WWTP drainage catchment area.

[1] Cambridge City Council, Cambridge Local Plan, 2018. https://www.cambridge.gov.uk/media/6890/local-plan-2018.pdf

[2] South Cambridgeshire District Council, South Cambridgeshire Local Plan, 2018. https://www.scambs.gov.uk/media/12740/south-cambridgeshire-adopted-local-plan-270918_sml.pdf

[3] Anglian Water, 2019. Cambridge Waste Water Relocation Project, Statement of Requirement

1.2 The site selection process and initial options appraisal

1.2.1 A number of detailed appraisal steps were developed to identify sites that may be suitable for the relocation of the waste water treatment plant to replace the existing Cambridge WWTP.

1.2.2 The site selection process assesses options against planning, operational, community impact, environmental and, in the final stages, economic and programme criteria. This iterative process was devised to comply with relevant national and local planning policies, including the National Policy Statement for Waste Water (NPS) and EIA Regulations, in relation to considering alternative options. During the development of the appraisal process, relevant host authorities were invited to comment on the site selection methodology and their feedback was incorporated into the process.

1.2.3 The first step is an Initial Options Appraisal (this report), which examines the strategic issues to be considered in investigating relocation options, and also identifies the most appropriate area in which to search for new WWTP sites (the Study Area).

1.2.4 Once the Study Area has been identified, subsequent study stages (Stage 1 Initial Site Selection, Stage 2 Coarse Screening and Stage 3 Fine Screening) are used to assess site location options in increasing levels of detail, each building on the findings of the previous stages, and eliminating less suitable options at each stage until only the best performing sites remain.

1.2.5 The remaining site areas are then assessed in the final stage in the site selection process (Stage 4, which includes consultation with stakeholders and the public, initial environmental surveys and technical feasibility assessments.

1.2.6 Figure 1.1 illustrates the sequence of studies and how this Initial Options Appraisal contributes to subsequent studies[4].

1.2.7 This report presents the Initial Options Appraisal, including the study context, approach, options identification and appraisal findings.

1.3 Approach to initial options appraisal

1.3.1 The approach used in this appraisal has the following steps:

1. **Options identification**, taking into account the existing context in the drainage catchment area – drainage catchment boundaries and existing waste water collection and treatment assets, as well as policy, strategic and technical considerations for future options
2. **Assessment of options** against appropriate criteria using a RAG (Red-Amber-Green) assessment approach and presenting conclusions on the way forward.

1.3.2 These steps are described further in sections 2 and 3 of this report.

[4] This sequence of option appraisal and site selection screening is compatible with the guidance published for preparation of Water Resources Management Plans and he more recently developed Drainage and Waste Water Management Plans which each water company in England and Wales is required to produce.

Figure 1.1: Site selection process

Source: Mott MacDonald

1.4 Operational context

1.4.1 The existing Cambridge WWTP receives waste water flows from the entire city as well as nearby villages and this area is referred to as the Cambridge drainage catchment area.

1.4.2 Adjacent to the drainage catchment area served by the existing Cambridge WWTP is the drainage catchment area served by the existing Waterbeach WWTP. Due to development of Waterbeach New Town[5], the existing Waterbeach WWTP site will be redeveloped[6]. Consequently, capacity will need to be provided elsewhere to treat the existing and future waste water flows from the Waterbeach drainage catchment area. Anglian Water decided that the relocation project will address this requirement by treating the flows from both the Cambridge and Waterbeach drainage catchment areas in a single new WWTP, in effect combining the two drainage catchment areas[7].

1.4.3 The drainage catchment area served by the existing Cambridge WWTP is shown in Figure 1.2 together with the drainage catchment area served by the existing Waterbeach WWTP.

1.4.4 For simplicity in the remainder of this report the combined Cambridge and Waterbeach drainage catchment area is referred to as the 'drainage catchment area'.

1.4.5 For the purpose of the Initial Options Appraisal and overall site selection process, the drainage catchment area was sub-divided at the existing WWTP discharge location and along the A14 carriageway to take account of the distinct differences in landscape in the area i.e. the Cambridge urban area upstream of the discharge location (south of the A14) and the more open and rural area downstream of the discharge location (north of the A14).

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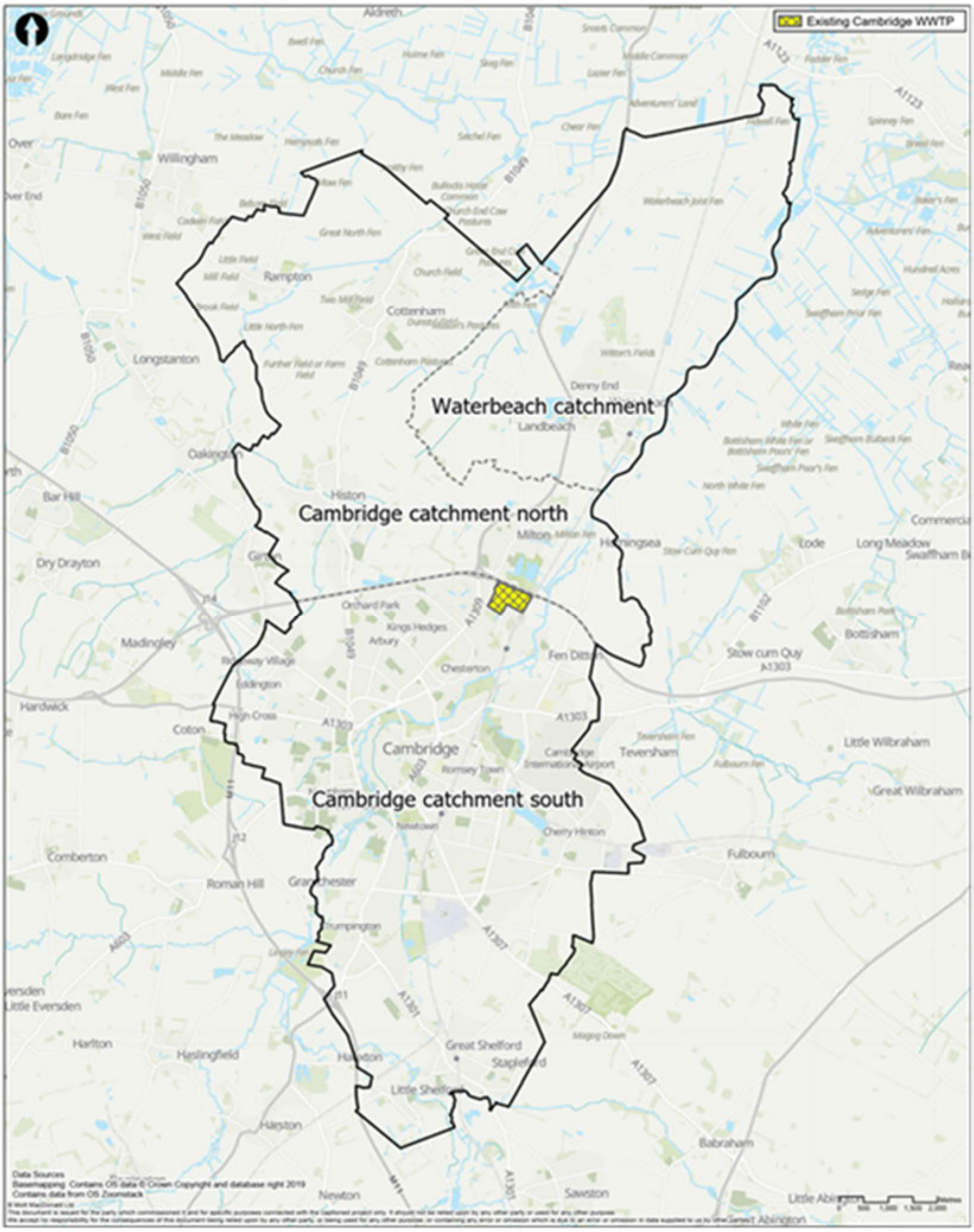
[5] Waterbeach New Town, A Spatial Framework and Infrastructure Delivery Plan, Supplementary Planning Document, Adopted February 2019, South Cambridgeshire District Council.

[6] It is noted that a new pumping station will be required at the location of the existing Waterbeach WWTP in order to transfer waste water flows from Waterbeach village and Waterbeach New Town to the new Cambridge WWTP.

[7] Anglian Water, 2019. Cambridge Waste Water Relocation Project, Statement of Requirement

Figure 1.2: Cambridge and Waterbeach drainage catchment areas (including current connected areas and potential areas, currently unconnected)[8]



Source: Drainage catchment areas provided by Anglian Water

[8] The plan shows the overall drainage catchment area including both currently connected and unconnected areas. 'Connected' areas are already connected to the Anglian Water sewerage network and drain to the Cambridge WWTP. An 'unconnected' area is an area that is currently without sewerage but has the potential to become connected to the existing sewerage network serving Cambridge WWTP in the future via a successful application to the first time sewerage programme, (section 101A Water Industry Act 1991) or as a result of growth, because it would be the most logical connection, operationally, to make.

1.4.6 The existing Cambridge WWTP site, located off Cowley Road in north-eastern Cambridge, was built in 1895 to receive the waste water from Cambridge. Waste water was pumped from the old pumping station (now the Museum of Technology) in the centre of the city to the site where it was spread across the land. Since then, the site has been serving the growing needs of Cambridge by taking used water from people's homes, cleaning it and returning it to the environment.

1.4.7 In the 1980s, a deep sewer tunnel was constructed through Cambridge, to improve the collection and transport of waste water and storm flows to the treatment site. The site plays a vital role storing and treating storm flows during heavy rainfall before discharging to the River Cam and provides a material contribution to the flow within the River Cam.

1.4.8 Most of the waste water treated by Cambridge WWTP still comes from the city (i.e. from the drainage catchment area to the south of the existing WWTP) and is conveyed to the Inlet Works of the existing WWTP by gravity in the deep sewer tunnel. The tunnel terminates in a deep shaft from where waste water flows are pumped up into the Inlet Works. The small proportion of flows from outlying villages such as Cottenham (approximately 3% of total flows treated) are pumped to the Inlet Works in pressurised pipelines.

1.4.9 The current site includes a sludge treatment plant, which treats all of the solids removed during the waste water treatment process. The sludge treatment plant also receives imported sludge solids from waste water treatment plants serving smaller communities in the area surrounding Cambridge, which are too small to be able to have their own sludge treatment facilities. The imported sludge comprises more than half of the total sludge treated at the existing WWTP.

1.4.10 Waste water is treated at the WWTP to remove pollutants and then the treated effluent is discharged through an outfall to the River Cam. The quantity and quality of the treated effluent that can be discharged to the River Cam, as well as the precise location of the discharge, are governed by the Environment Agency (EA) in its environmental permits for the WWTP. Any changes to the permit, such as to relocate the discharge location, would need to be approved by the EA and would need to satisfy the EA's requirement that the changes do not cause any deterioration in river quality.

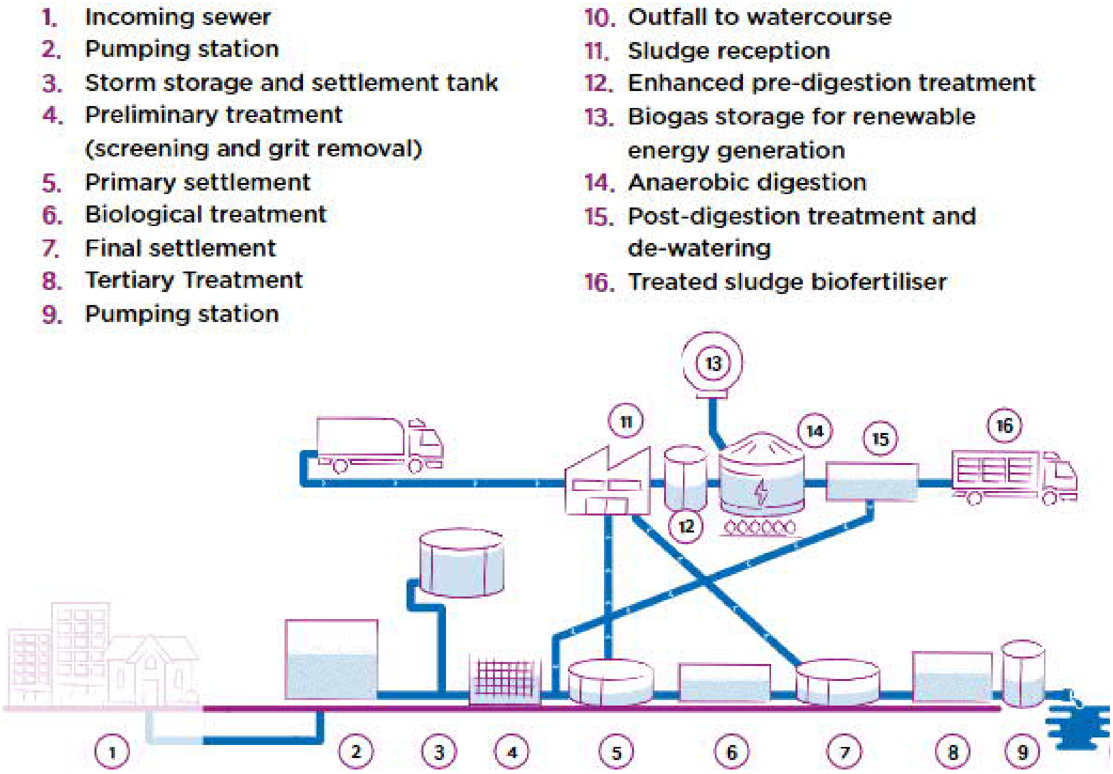
1.4.11 The WWTP includes the following treatment processes which are needed in order to meet the required effluent quality:

- **Inlet pumping**, pumps lifting waste water and stormwater flows from the tunnel up into the WWTP.
- **Preliminary treatment**, including screens and grit removal, removing larger solids and floating debris from the waste water before further treatment.
- **Stormwater storage**, storing excess flows during heavy rain events, which are then returned for treatment in the WWTP after waste water flows have returned to normal levels.
- **Primary settlement**, which retains the waste water in tanks for a period of time to enable settlement (by gravity) and removal of suspended solids and the bio-chemical oxygen demand (BOD), nutrients and other contaminants they contain. Conventional primary settlement tanks, as used at the existing Cambridge WWTP, are a simple, economic and low energy (hence low carbon) way of reducing the amount of contamination in the waste water.
- **Secondary (biological) treatment**, are large tanks in which the settled waste water is aerated, creating conditions under which selective microorganisms can develop, reproduce, and consume remaining (soluble) contaminants in waste water (particularly BOD, ammonia and phosphorus), hence, converting soluble BOD, nutrients, metals, etc., into a solid sludge which can then be removed from the waste water. Essentially this treatment stage is

intensifying and controlling what would naturally happen to these contaminants if they were released into a river without prior treatment. The secondary treatment stage at the existing Cambridge WWTP uses the conventional activated sludge (CAS) process, first used in the UK and now the most common process adopted globally due to its efficiency, flexibility and reliability.

- **Sludge treatment**, to treat the solid by-product of the primary and secondary treatment stages described above, producing a stabilised product that is suitable for use in agriculture (as a soil conditioner and fertiliser) as well as biogas, which is used to generate renewable heat and power for use by the WWTP. An illustration of the main components of the existing Cambridge WWTP is shown in Figure 1.3.

Figure 1.3: Components of the existing Cambridge waste water treatment plant



Source: Not to scale and for indicative purposes only.

2 Option Identification

2.1 Strategic and technical considerations in options identification

2.1.1 In order to identify options for replacing the existing Cambridge WWTP, it is necessary to consider various strategic and technical factors, as follows:

- Need to vacate the existing WWTP site
- Waste water treatment and effluent discharge location (proximity to the waste water source as well as proximity and status of receiving watercourse)
- Single site versus multiple site treatment
- Expansion of existing sites or development of new sites
- Type of treatment technology
- Impact of water demand reduction measures.

2.1.2 These are described further below.

2.1.3 The objective when providing a new treatment plant is that it should use an operationally reliable process that ensures compliance with environmental standards (defined by the EA), has operational resilience to mitigate the impacts of growth and climate change, and achieves this whilst also keeping carbon emissions as low as possible.

2.1.4 Different options will have differing environmental, social, technical and cost impacts and hence criteria based on these categories (such as impact on customers, carbon and cost) are used to assess the options. These criteria are discussed in Section 3.

Need to vacate the existing WWTP site

2.1.5 Cambridge City Council and South Cambridgeshire District Council are leading the regeneration of North East Cambridge (NEC). This is supported by planning policy in the recently adopted Cambridge Local Plan and the South Cambridgeshire Local Plan. The existing Cambridge WWTP is situated in a section of NEC and occupies a significant part of the area designated for regeneration.

2.1.6 Although it would be technically feasible to consolidate the existing treatment assets and occupy a smaller area of the existing site, this is not desirable for the following reasons:

- The application for funding from the HIF, including the business case, is predicated on moving the whole WWTP to enable regeneration of the entire site. A partial release of land would not provide a sufficient business case to justify the HIF funding, as it would not be possible to deliver the number of residential properties required.
- Anglian Water's Asset Encroachment Policy[9] is used to minimise the potential risk to proposed developments in proximity to existing WWTPs, primarily in relation to odour impacts. The assessment methodology states that developments within 400m of a treatment plant serving more than 50,000 people would encounter a high risk of potential impacts. If the WWTP was consolidated, much of the remaining area available for development would be within 400m of the plant (like the existing WWTP, a consolidated WWTP would be designed to serve a population in excess of 50,000 people). Therefore, consolidation of the existing WWTP and development of the remaining area would present a potential risk to the

[9] Asset Encroachment Policy, Anglian Water, 2019

amenity of the development and could constrain Anglian Water's ability to operate its plant efficiently.

- In addition, the local waste planning strategy stipulates that a new WWTP within 400m of properties normally occupied by people would require an odour assessment demonstrating that the proposal is acceptable, together with appropriate mitigation measures[10].

2.1.7 **For these reasons, no options have been identified in this study that retain any waste water treatment capacity on the existing site.**

Providing waste water treatment in proximity to the waste water source

2.1.8 This section considers the practical and environmental reasons for providing treatment facilities within reasonable proximity to the communities that produce the waste water. The planning policy arguments for such an approach, including the 'proximity principle', are also discussed.

2.1.9 **Practical considerations**

2.1.10 Historically, WWTPs serving towns such as Cambridge were normally located near to the urban areas which they serve so that waste water flows largely by gravity to the WWTP and treated effluent from the WWTP was discharged to a river (or other suitable watercourse) downstream of the urban area (thus reducing any adverse environmental impacts on urban residents).

2.1.11 Locating new WWTPs near to the source of waste water reduces both capital costs (for waste water transfer infrastructure such as tunnels and pipelines) and operating costs (due to the pumping of large volumes of waste water). Reduced transfer infrastructure construction and energy usage also reduces environmental impacts including lower carbon emissions.

2.1.12 **Planning policy and the proximity principle**

2.1.13 The EU Waste Framework Directive (2008/98/EC) sets out in Article 16 the principles of self-sufficiency and proximity (commonly referred to as the 'proximity principle'). Local planning authorities are required, under Regulation 18 of the Waste (England and Wales) Regulations 2011, which transposed the Directive, to have regard to these requirements when exercising their planning functions relating to waste management. The National Planning Practice Guidance for Waste[11] includes a list of matters that come within the scope of 'waste development'. This list includes waste water management. Therefore, it is considered that projects related to waste water management should also abide by the same principles set out in the Waste Framework Directive, including the proximity principle.

2.1.14 In summary, the proximity principle highlights a need to treat and dispose of waste water in reasonable proximity to its point of generation. The principle seeks to minimise the environmental impact of waste water transport and treatment and makes communities responsible for the wastes that they generate.

Single site versus multiple site treatment of waste water and sludge

2.1.15 Another parameter that needs consideration is the number of sites that could treat the waste water. One approach would be to have a single large site (centralised treatment) whereas the alternative would be to have multiple (two or more) smaller sites. There are advantages and disadvantages associated with each of these two approaches.

[10] Cambridgeshire and Peterborough Minerals and Waste Development Plan Core Strategy, Cambridge County Council and Peterborough City Council, 2011

[11] National Planning Policy Guidance for Waste, Ministry of Housing, Communities & Local Government, 2015

2.1.16 Larger geographically disbursed cities such as London often have multiple WWTPs located around the perimeter of the city, which would have been at the edge of the urban area when they were first constructed. However, smaller towns such as Cambridge have usually been served by a single (but sometimes two) WWTP. There are technical, historical and/or political reasons for this.

2.1.17 A single site has the advantage of employing larger, generally more efficient, process units which, due to economies of scale, would result in both lower unit capital costs and lower unit operating costs than would be expected for multiple smaller WWTPs with the same overall capacity. Factors that help to reduce operating costs for larger plants are:

- More efficient deployment of operations and maintenance staff
- Generally, more efficient use of chemicals and power
- The potential for renewable energy generation from sludge biogas (such equipment is usually only technically and economically viable at larger scale), which is used to power the WWTP and thus help reduce operating costs and carbon emissions associated with grid power consumption.
- Reduced transport of sludge – as sludge produced at smaller sites, which are too small to have their own efficient sludge treatment facilities, has to be transported to larger, more efficient, sites for treatment.

2.1.18 It is also easier to manage and monitor the quality of the treated effluent at a single site compared to multiple sites, each with a separate discharge location and discharge permit.

2.1.19 The NPS indicates that for cities of the scale that might generate a Nationally Significant Infrastructure Project (NSIP), such as Cambridge, it will remain more cost effective to centralise treatment to a single large treatment works[12]. In addition, the NPS states that generally, it will be necessary to transfer waste water to a suitable location for a treatment works and effluent discharge, outside of urban centres.

2.1.20 Some of the disadvantages associated with having a single site include the need for a larger land area in one location, which can constrain initial site identification, as well as future expansion if land is not available. However, total land take for a single site is normally lower than that for multiple smaller WWTPs (with the same overall treatment capacity) due to use of more efficient (larger) treatment process tanks and buildings and the lower proportion of total area needed for access roads and administration buildings within the WWTP boundary.

2.1.21 The multiple treatment site (decentralised) approach may have the advantage of flexibility in terms of network connectivity (waste water can be diverted to treatment at several points in the drainage catchment area).

2.1.22 Disadvantages associated with the multiple site approach include the need for a larger network (connecting to several different WWTPs) as well as the need for more, smaller treatment plants, which are often less efficient in terms of construction, operation and maintenance (for the same reasons that single sites are more efficient – as listed above).

2.1.23 The NPS indicates that it is not practical to locate large numbers of small treatment works retrospectively throughout urban areas.

2.1.24 Finally, there would be a need for multiple new discharge permits, potentially into smaller watercourses than the River Cam. Smaller watercourses may be less likely to be able to receive discharge of the same effluent quality than larger rivers such as the Cam, even if more stringent

[12] Paragraph 2.4.14, National Policy Statement for Waste Water, DEFRA, 2012

effluent quality requirements are imposed, and also discharges of significant treated effluent flows into smaller watercourses could create or increase the risk of flooding.

2.1.25 **To illustrate the above points, both single and multiple site WWTP options are assessed in Section 3.0 of this report.**

Expansion of existing sites or development of new sites

2.1.26 The objective of the relocation project is to vacate the existing Cambridge WWTP site and provide sufficient treatment capacity for the drainage catchment area flows in another location or locations.

2.1.27 When providing waste water treatment capacity, the options normally considered are to expand an existing WWTP (if space is available) or to build a separate new WWTP (if expansion of an existing site is not feasible).

2.1.28 Given the size of the combined drainage catchment area and the difficulty, cost and carbon impact of transferring such large flows outside of the drainage catchment area, as well as policy considerations such as the proximity principle, development of a new site within the existing drainage catchment area would be the default solution, and this is the baseline assumption being tested by this initial options appraisal. However, in theory, an existing WWTP outside the drainage catchment area could be expanded to provide capacity for drainage catchment area flows.

2.1.29 The potential benefits of expanding an existing WWTP might include the following:

- Modification of an existing discharge permit might be more acceptable to the EA than a new permit (if that was the alternative)
- An existing WWTP site might already have currently unused land, within or close to the existing site, that could be built upon
- From a land use planning perspective, the site's existing use as a WWTP might make it easier to expand than building on a new site (whether brownfield or greenfield).

2.1.30 However, in the case of relocating Cambridge WWTP, there would also be considerable challenges to such an approach given the lengthy transfer distances and the large additional capacity required, compared to the capacity of other existing WWTPs within a conceivable distance from the drainage catchment area.

2.1.31 **To illustrate the above points, both new and expanded WWTP options are assessed in Section 3.0 of this report.**

Type of treatment technology

2.1.32 Different treatment technology types have widely varying characteristics including significant differences in operational complexity, energy usage (and hence carbon emissions), economics and land area required. This section describes these differences and the choice of treatment technology type assumed in subsequent site selection stages.

2.1.33 The existing Cambridge WWTP, described in Section 1.4 of this report, uses primary settlement followed by an activated sludge plant which is a standard approach for this size of WWTP. The HIF funding and subsequent Statement of Requirement are based on the assumption that the relocated WWTP will have a similar treatment process to the existing WWTP.

2.1.34 To demonstrate that this approach is appropriate in the context of the Cambridge WWTP relocation project the key aspects of this treatment approach are presented below and compared with the two other types of treatment approaches that are often considered when investigating different types of treatment technology. These are:

- Type 1: Low energy, larger footprint
- Type 2: Standard approach (which is used at the existing Cambridge WWTP)
- Type 3: High energy, smaller footprint

2.1.35 **Type 1: Low energy, larger footprint**

2.1.36 Low energy, larger footprint plants include ‘trickling filters’ but can also include constructed wetlands or lagoon technologies. The trickling filter process is a proven, low energy, wastewater treatment technology used at both small and large scale, though it requires considerably more land area than the standard treatment approach described below. Constructed wetlands or lagoon technologies aim to promote the use of natural processes to treat the waste water and typically have lower specific energy requirements (in terms of energy use per m^3 of waste water treated or kg of pollutant removed) than standard treatment technologies. The limits of such natural systems result in larger land area requirements as each unit of natural process can only treat a limited amount of human waste without becoming overloaded.

2.1.37 **Type 2: Standard approach – balancing energy use and footprint**

2.1.38 This is the standard approach adopted for the majority of medium and large WWTP in countries such as the UK. Treatment plants tend to be based on forced aeration processes in which micro-organisms are fixed to media (fixed-film processes) or suspended in the water column (activated sludge). The micro-organisms feed on the dissolved pollutants in the water and either convert them into settled solids or off-gas them into the atmosphere. The maximum energy density (smallest footprint) that can be achieved tends to be limited by either: the available surface and contact time (for fixed film processes) or the settleability of the micro-organisms as their concentration increases (activated sludge processes).

2.1.39 **Type 3: High energy, smaller footprint**

2.1.40 Various processes enable the treatment energy density to be increased and the footprint decreased but can require significantly greater energy input, due to additional aeration or pumping requirements, as well as increased operational complexity. Examples include replacement of the gravity settlement phase (in the standard treatment approach) by a more energy intensive but compact membrane filtration phase. The significantly higher costs, operational complexity and carbon emissions (due to higher energy use) of these processes are considered to outweigh the benefits of their smaller footprint.

2.1.41 In reality, process technologies do not occur in discrete technology groups but exist along a continuum and process solutions may involve elements from different types. The above broad grouping is intended to provide a high level description.

2.1.42 A simplified comparison of the groups is presented in Table 2.1.

2.1.43 In preparing this comparison it is assumed that all three plant types would be designed to achieve the required effluent quality and would be safe to operate and maintain.

Table 2.1: Comparison of technology categories against main parameters

Parameter	Type 1	Type 2	Type 3	Comment
Land area required	High	Medium	Low	Land area is inversely related to the energy intensity of the processes.
Energy intensity[13]	Low	Medium	High	Natural systems such as reed beds (Type 1) are low energy but need large areas in order to provide sufficient treatment time. Concentrating the waste treatment into smaller areas reduces treatment time and hence space but requires more and more energy.
Effluent quality	Low – Medium (variable)	Medium - High	High	Type 2 and 3 systems produce a low turbidity effluent. Type 1 processes used alone can struggle to reliably achieve tight discharge standards
Effluent stability	Low	Medium	High	Type 2 and 3 systems generally produce more stable effluent.
Process controllability	Low	High	High	Type 1 systems require limited control when operating normally, but it can be difficult to manage adverse events.
Storm tolerance	High	Medium	Medium	Type 2 and 3 systems tend to be hydraulically intolerant of storm flows but maintain stable effluent quality for the flow that they can treat.
Amenity or ecological value	High	Low	Low	Natural systems (Type 1) potentially provide greater habitat opportunities for wildlife.
Capital cost (including initial construction as well as future renewals and replacement)	Low – High (depends on land value, geological conditions, and topography)	High	Highest	Type 1 processes use predominantly natural treatment systems with lower reliance on hard engineering and electromechanical equipment. The higher capex for types 2 and 3 is due to the greater requirement for concrete and steel tanks and electromechanical equipment.
Operational costs (operations and maintenance)	Low with periodic large spends	Medium	High	Type 1 systems have low routine running costs, but periodic large capital maintenance is required for desludging or relining. Type 3 processes are generally more reliant on chemical and energy consumption resulting in higher operating costs.
Flexibility – for adapting to changing future requirements	Low	High	Low	It can be difficult to modify both Type 1 and Type 3 systems to meet changing requirements such as increased pollutant loads. Type 2 processes can generally be upgraded or expanded more easily.

2.1.44 In general, Type 1 (low energy, larger footprint) treatment solutions are preferred where the population served is low and sufficient land is available. This is not considered appropriate for the new Cambridge WWTP due to the large population served and hence extremely large land area that would be required for treatment. The proposed footprint of 22ha for the relocated WWTP would need to more than double if trickling filters were used and would need to be five to seven times greater (depending on sub-type) for a constructed wetland approach.

2.1.45 Trickling filter type processes can also struggle to reliably achieve low effluent ammonia concentrations (such as those required for Cambridge WWTP) during cold winter months.

[13] Energy intensity is the energy used to treat a m^3 of waste water or a kg of pollutant such as BOD)

Multiple stages of filtration or tertiary ammonia removal could be needed to meet the required ammonia standard, which would increase both the energy and land area required for treatment.

2.1.46 Constructed wetlands or lagoon technologies can also have difficulty in maintaining compliance with tight effluent phosphorus limits (such as those currently stipulated by the EA in the discharge consent for the existing Cambridge WWTP).

2.1.47 Hence, Type 1 processes would require greater land area and carry greater risk of failure to meet the required effluent quality standards for ammonia and phosphorus. These are significant drawbacks which are considered to outweigh the lower carbon emissions benefit of such processes.

2.1.48 Type 3 (high energy, smaller footprint) systems are used when there is limited footprint available. They are less tolerant of rapidly varying flows (such as following heavy rain) than Type 1 or Type 2 systems so tend to be less preferred when serving combined sewer networks (containing both foul sewage and a proportion of rainwater) such as in the existing drainage catchment area. The higher energy and chemical consumption associated with such processes also result in higher operational carbon emissions.

2.1.49 Hence, Type 2 treatment processes (balancing energy use and footprint) are considered be the most appropriate treatment type for the new Cambridge WWTP. Therefore, for this options appraisal and subsequent site selection stages, it has been assumed that the options would all use a Type 2 treatment process.

Impact of water demand reduction measures

2.1.50 The south of England (including East Anglia) includes regions that are expecting increased demand due to population growth[14] whilst at the same time experiencing pressures on existing water resources due to over-use as well as climate change impacts.

2.1.51 As part of a range of measures to combat these pressures, water companies such as Anglian Water and Cambridge Water are implementing demand management initiatives that are intended to encourage customers to reduce their water consumption per person (such as increased water metering coverage, installation of more efficient water using equipment in homes and industries, greywater re-use, rainwater harvesting and education about water usage). In the case of Cambridge Water (which provides most of the water supply in the Cambridge WWTP drainage catchment area), if successful, these measures could reduce average per capita water demand (normal year conditions) from a level of 137 litres per person per day (l/p/d) in 2017/18 to 129 l/p/d by 2044/45[15]. In addition, the water efficiency policy in the South Cambridgeshire[16] and Cambridge[17] Local Plans stipulates that all new residential developments must achieve a water efficiency equivalent to 110 l/p/d or less.

2.1.52 This reduction may also reduce the amount of water discharged to the sewer system and hence reduce the flow to the treatment plant. It might be assumed that this would then reduce the capacity and land area required for a new WWTP and therefore should be considered in

[14] For example, Cambridge Water is forecasting a population increase of 67,000 in its supply area, with 37,000 new properties being built from 2020/21 until 2044/45 – roughly a 25% increase. This forecast is described in Cambridge Water's Revised Draft Water Resources Management Plan 2019 v2 (page 16).

[15] Cambridge Water, Revised Draft Water Resources Management Plan 2019 v2 (page 181). This document sets out Cambridge Water's draft long-term Water Resources Management Plan (WRMP) for the 25 years between 2020 and 2045. It includes the company's proposals for maintaining the balance between available water supply and the demand for hat water in he Cambridge area, including measures to reduce both leakage and per capita demand.

[16] South Cambridgeshire District Council, South Cambridgeshire Local Plan – Policy CC/4, 2018.

[17] Cambridge City Council, Cambridge Local Plan, 2018.

relocating the WWTP. However, the impact on WWTP footprint is less certain, for the following reasons:

- Although waste water flow volumes may decrease with reduced water demand the level of pollutant load in the waste water (in terms of biological oxygen demand) would not reduce as each person would still excrete the same level of organic pollutants and industries in the drainage catchment area would still discharge similar levels of pollutants from manufacturing processes. As treatment process size is driven by pollutant load as well as waste water flows (hydraulic loads), the impact on WWTP footprint would be low.
- There is uncertainty of the level of success such demand management initiatives will achieve, in terms of total consumption reduction, and the timescale for such reductions to occur, hence it is premature to assume lower design flows for a future WWTP at this stage.

2.1.53 **As a result, the potential impact of water demand management initiatives on waste water flows have not been taken into account in this initial options appraisal or subsequent site selection stages.**

2.2 Option identification

2.2.1 The strategic and technical considerations described in Section 2.1 have been used to identify a number of options for subsequent assessment.

2.2.2 Hence, the options list includes:

- Locations within or outside of the combined drainage catchment area
- Single and multiple site options
- Provision of new WWTPs in new locations as well as expansion of existing WWTPs
- All options assume that a standard waste water treatment technology (Type 2) would be used (as described in Section 2.1.39).

2.2.3 The range of options put forward for this assessment includes some that are unlikely to be considered attractive on technical, environmental, social or cost grounds (for example, transfer of large volumes of waste water relatively long distances for treatment at existing WWTP in other drainage catchment areas – options 3B and 4B below). However, the inclusion of such options at this stage is considered necessary in order to demonstrate that a comprehensive range of technically possible options has been assessed and thus provide a sound basis for subsequent site selection stages as well as for consultation with stakeholders.

2.2.4 The list of identified options is presented in Table 2.2 and illustrated in schematic form in Figure 2.1. Brief descriptions of each option are provided below the table.

2.2.5 The preferred option or options from this list will form the Study Area for subsequent site identification and selection stages.

Table 2.2: List of Options

Ref	Description/location	Existing or new treatment site(s)	Nr of sites
1	New WWTP within drainage catchment area – north of the existing Cambridge WWTP	New	Single
2	New WWTP within drainage catchment area – south of the existing Cambridge WWTP	New	Single
3A	New WWTP outside drainage catchment area	New	Single
3B	Expand an existing WWTP outside drainage catchment area	Expand existing	Single
4A	Several new WWTPs within or adjacent to drainage catchment area	New	Multiple
4B	Expand several WWTPs outside drainage catchment area	Expand existing	Multiple

Source: Mott MacDonald

2.2.6 **Option 1:** The Study Area would be the whole of the drainage catchment area to the north of the existing WWTP. It is assumed that a new WWTP would discharge treated effluent at or close to the existing WWTP discharge point on the River Cam as this would be the closest discharge point to the Study Area and the EA already permits discharge of treated effluent, from the existing Cambridge WWTP, to this section of the river.[18]

2.2.7 **Option 2:** The Study Area would be the whole of the drainage catchment area to the south of the existing WWTP. It is assumed that the new WWTP would need to pump its treated effluent to the existing WWTP discharge location, or close to it, on the basis that discharges to the River Cam within the drainage catchment area would either not be permitted by the EA or would entail significantly more stringent discharge requirements, in order to minimise potential impacts on river users and residents in the city.

2.2.8 **Option 3:** Single large WWTP outside city and existing drainage catchment area. This option has two sub-options:

- **Option 3A** comprises a single new WWTP in a new brownfield or greenfield location. It is assumed that the new WWTP would discharge treated effluent at or close to the existing WWTP discharge point (for the same reasons as for Option 1), hence, for example, the new WWTP could be located in an area to the east of the River Cam (i.e. right hand bank) and to the north of the A14 in an area which comprises largely of open farmland.
- **Option 3B** comprises the expansion of an existing WWTP. This option assumes that flows from the drainage catchment area would be pumped to a more distant existing WWTP downstream of the existing drainage catchment area, which would be expanded to take the additional flows. Potential sites for Option 3B would include the existing WWTP to the south of Ely which also discharges to the River Cam.

2.2.9 **Option 4:** Multiple WWTPs, each taking a proportion of the total waste water flows for treatment. This option also has two sub-options:

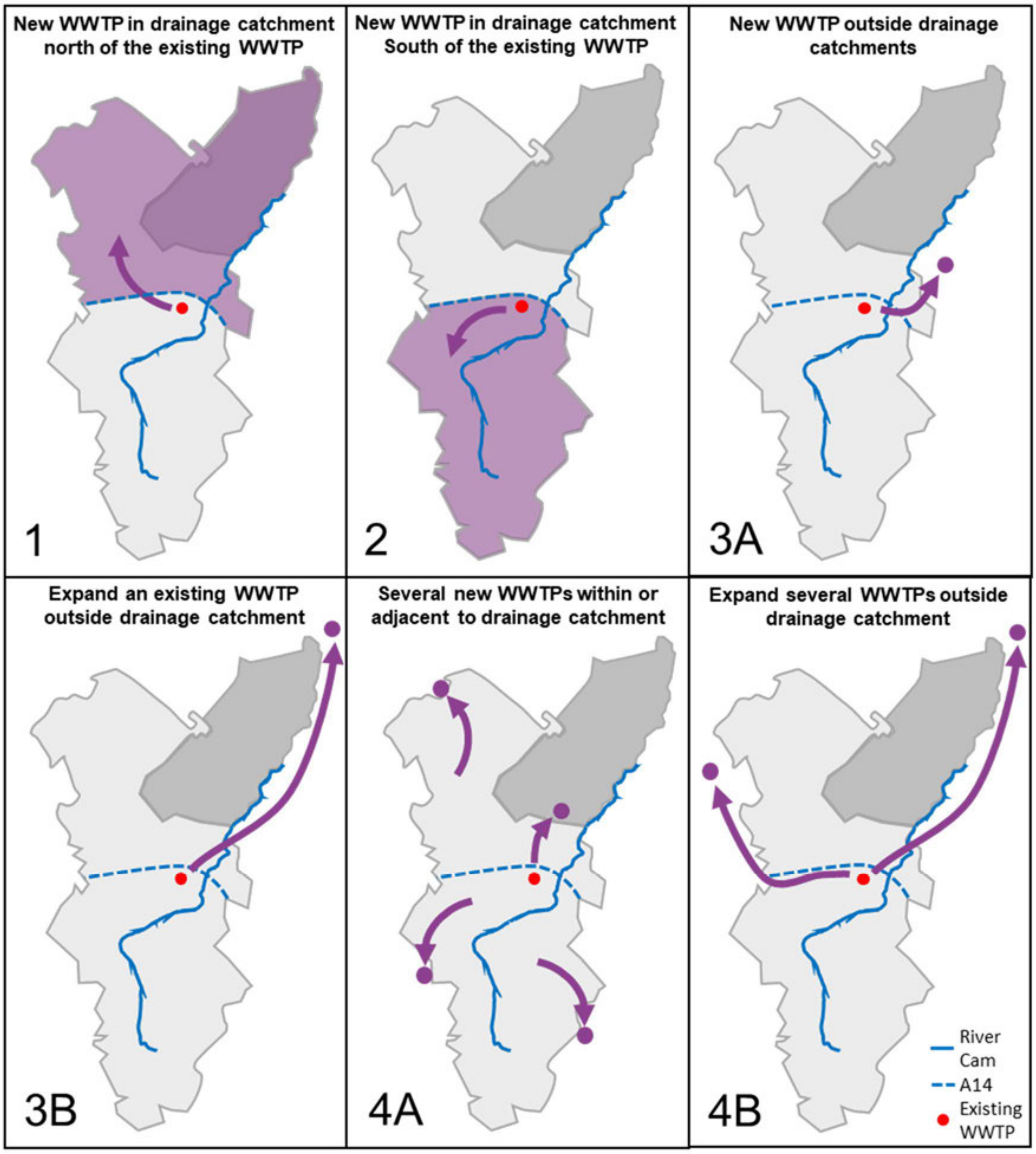
- **Option 4A** comprises multiple new WWTPs in brownfield or greenfield locations. This option assumes that the drainage catchment area would be divided into a number of sub-drainage catchment areas, each draining to a separate WWTP located around the periphery of the existing urban area. Each WWTP would need to pump its treated effluent to the existing WWTP discharge location on the basis that discharges to the River Cam within the drainage catchment area would either not be permitted by the EA or would entail significantly more

[18] The term 'close to' has been assumed to also include discharge locations downstream of the existing location as far as Waterbeach approximately 6km downstream of the existing Cambridge WWTP discharge point).

stringent discharge requirements, in order to minimise potential impacts on river users and residents in the city.

- **Option 4B** comprises the expansion of several existing WWTPs. This option assumes that the waste water flows would be pumped to more distant existing WWTPs around Cambridge which would each need to be expanded to take the increased flows. Potential sites would include the existing WWTP to the south of Ely, and Uttons Drove WWTP, north of Bar Hill.

Figure 2.1: Long list options – schematics



Source: Mott MacDonald

3 Assessment of Options

3.1 Assessment criteria definition

3.1.1 A number of appraisal criteria were developed and used to assess each of the options identified in Section 2.2. RAG scoring definitions were developed for each of the criteria and these are described in the following sections.

3.1.2 It is typical for the criteria used to assess options in major infrastructure projects to cover the following areas:

- Operational considerations (including constructability and maintenance)
- Community (social) considerations
- Economic considerations (including cost, land availability and employment considerations)
- Planning and environmental considerations

3.1.3 Based on these areas, and taking into account the purpose of this initial options appraisal, the following assessment criteria have been selected for this study stage:

- Proximity principle
- Potential environmental impact of effluent discharge location
- Impacts on local communities
- Carbon emissions
- Construction complexity
- Cost (capital and operational).

Proximity principle

3.1.4 As described in Section 2.1.2, planning policy, through the proximity principle, highlights a need to treat and dispose of waste water as close as possible to its point of generation. The principle seeks to minimise the environmental impact of waste water transport and treatment and makes communities responsible for the wastes that they generate.

3.1.5 Based on the proximity principle, locating the new Cambridge WWTP (including the discharge location for treated effluent) within the drainage catchment area would be more appropriate.

3.1.6 The definition used for the assessment of this criterion is presented below.

Table 3.1: Proximity Principle RAG definition

Ref	Criterion	Green	Amber	Red
1	Proximity principle: Proximity of the new WWTP and its treated effluent discharge point to the drainage catchment area	Site is within or predominantly within the drainage catchment area and the discharge location is the same or close to the existing location	Site is outside the drainage catchment area but treated effluent is discharged at or close to the existing discharge location	Site is outside the drainage catchment area and the treated effluent discharge location is not at or close to the existing discharge location

Source: Mott MacDonald

3.1.7 In assessing the suitability of the discharge location under this criterion, the term 'close to the existing location' has been assumed to also include discharge locations downstream of the existing location but still within the drainage catchment area.

Potential environmental impact of effluent discharge location

3.1.8 The existing Cambridge WWTP is permitted by the EA to discharge treated effluent into the River Cam at a point near to the existing WWTP. The EA's permission (in the form of an environmental permit) states specific requirements for the quality and flow quantity of the treated effluent that is discharged and the location of the discharge.

3.1.9 Requests for new or revised environmental permits (e.g. for a change in the discharge point) would usually require a detailed assessment of the potential impacts of such a change on the local river environment. Revisions to existing permits can also result in the EA imposing additional quality and quantity requirements, compliance with which may require additional treatment processes at the WWTP (and hence also additional land requirement for treatment plant as well as increased construction and operating costs).

3.1.10 Some of the options considered in this report would involve new WWTPs in new locations, discharging either to the River Cam or to a different watercourse nearer to the new WWTP. The assessment of the environmental impact of a change in the discharge point, either to a new location on an existing river or to a different watercourse, would need to take into account the quality and quantity of the treated effluent as well as the normal quantity of flow (the base flow) in the receiving watercourse.

3.1.11 Discharges of treated effluent from a WWTP to a small stream would be likely to have a greater adverse impact than discharge of the same effluent (quality and quantity) to a larger river, such as the Cam. Discharges of significant treated effluent flows into smaller watercourses can also create or increase the risk of flooding. Hence, discharges of relatively large flows to smaller streams are unlikely to be permitted, but, if permitted would be likely to have significantly more stringent effluent quality and quantity requirements than discharges to larger watercourses. In some cases, there may be practical difficulties in achieving such standards using current technologies at this scale. Furthermore, the energy requirements and costs of compliance with these more stringent requirements would be so high that pumping of treated effluent to larger but more distant watercourses could be a more cost effective and lower carbon solution.

3.1.12 Historically, WWTPs serving towns such as Cambridge have normally been located near to the urban areas which they serve but on the 'downstream' side of the urban area so that sewage flows are able to generally flow by gravity to the WWTP and treated effluent from the WWTP is discharged to a river (or other suitable watercourse) downstream of the urban area, thus reducing potential adverse environmental impacts on urban residents. This is the case with the existing Cambridge WWTP. Relocation of the Cambridge WWTP further upstream in the drainage catchment area could potentially result in treated effluent being discharged into sections of the River Cam running through urban areas. This may also increase flood risk within urban areas as the treated effluent would increase river flows[19]. Even with stringent quality standards such discharges may be unacceptable to both residents of Cambridge and the EA.

3.1.13 It is therefore considered that continuing to discharge treated effluent to the River Cam downstream of the city would be preferable.

[19] The treated effluent discharges from the existing Cambridge WWTP are reported to constitute approximately 20% of the flows in the River Cam at the discharge point.

3.1.14 For the strategic options that would require a new discharge location and permit, this criterion includes an assessment of the potential impact on the receiving watercourse in terms of flows and water quality.

3.1.15 The RAG definition for this criterion is displayed below.

Table 3.2: Potential environmental impact of effluent discharge location RAG definition

Ref	Criterion	Green	Amber	Red
2	Potential environmental impact of effluent discharge location	Proposed option would keep existing discharge location on the River Cam.	Proposed option would require new discharge point on the River Cam but potential environmental impact l kely to be similar to existing discharge location.	Proposed option would require one or more new discharge points on the River Cam or on another watercourse. New discharge points would have the potential to cause greater impact than current location (water quality, flow regime, amenity, etc).

Source: Mott MacDonald

Impacts on local communities

3.1.16 The environmental and social impacts (such as those on the natural environment and local communities) of specific location options will be considered in detail at later stages of the site selection process as such impacts are predominantly location specific. However, an initial high-level assessment of the potential impacts on communities of the strategic options presented in this report is included here to inform selection of the preferred strategic option (and Study Area). Key factors that could be considered under this criterion include:

- Traffic impacts – during construction and operation
- Odour
- Noise
- Visual impacts

3.1.17 Odour, noise and visual impacts can be mitigated through careful design and any residual risks will be highly site specific, hence it is proposed that these factors are assessed at a more detailed, local scale, during subsequent stages of the site selection process. Traffic impacts can occur over a wider geographical area and although mitigation measures are available (e.g. keeping to specified routes and access hours) there may be residual impacts for some locations that cannot be fully mitigated. Hence, this criterion focusses on traffic impacts.

3.1.18 Apart from the normal traffic impacts associated with construction of a large WWTP there would also be the transport of significant volumes of spoil removed during any tunnel or pipeline construction. Sewer tunnels are usually constructed by a tunnel boring machine travelling uphill from the lowest point of the tunnel[20], hence, spoil would be removed from the location of the proposed WWTP. Traffic impacts during operation would include sludge transport either to or from the new WWTP.

3.1.19 The main differentiators around this criterion will be the number of sites associated with each option and the proximity of major transport links such as the trunk road network which would

[20] To ensure that ground water encountered during tunnelling drains away from the tunnel boring machine (at the excavation face) and hence minimises the need to pump groundwater flows away as well as he risk of the tunnel excavation flooding if groundwater pumps fail.

minimise the use of urban roads. Both of these factors have been incorporated in this criterion as displayed in the table below:

Table 3.3: Impacts on local communities RAG definition

Ref	Criterion	Green	Amber	Red
3	Impacts on local communities	Similar traffic access and numbers of heavy goods vehicle (HGV) movements (allowing for growth) to existing Cambridge WWTP. Good access to major road network reduces need to use urban roads and hence impacts on residents.	Increased numbers of HGV traffic movements **or** more distant from trunk road network (resulting in increased traffic on urban roads or other sensitive roads), compared to existing Cambridge WWTP site.	Increased numbers of HGV traffic movements compared to existing Cambridge WWTP **and** increased use of urban roads or other sensitive roads.

Source: Mott MacDonald

Carbon emissions

3.1.20 There is increasing focus on the reduction of carbon emissions at both local and national levels. For example, the Climate Change Act commits the UK government by law to reduce greenhouse gas emissions by at least 80% of 1990 levels by 2050. The UK Government has recently announced that it intends to go further and commit the UK to being 'carbon neutral' by 2050[21], and water companies such as Anglian Water have announced even more ambitious targets for 2030 (see below).

3.1.21 The National Policy Statement for Waste Water also sets out the Government's key policy objectives for the water sector, which should be considered in project development, relating to sustainable development and climate change mitigation and adaptation. These are as follows:

- **Sustainable development** – to seek waste water infrastructure that allows us to live within environmental limits and that helps ensure a strong, healthy and just society, having regard to environmental, social and economic considerations.
- **Climate change mitigation and adaptation** – in line with the objectives of Defra's mitigation and adaptation plans to help deliver the UK's obligation to reduce greenhouse gas emissions by 80% by 2050 and work to carbon budgets stemming from the Climate Change Act 2008, within the context of the EU Emissions Trading System.

3.1.22 Appraisal processes for infrastructure projects should therefore include the carbon footprint of project options in the selection of the preferred solution.

3.1.23 Over the last decade, Anglian Water has been at the forefront of companies in the UK water industry in taking measures to reduce its carbon footprint – measuring and reducing the carbon emissions from its construction and operation activities. As part of its efforts, Anglian Water has set itself the target of reducing the embodied carbon emissions for new water and waste water assets it constructs over the period 2015 to 2020 by 60% compared to a 2010 baseline[22] and its operational carbon levels by 7% over the same period. These targets have also been incorporated into formal agreements between Anglian Water and its regulator, Ofwat. In addition

[21] https://www.bbc.co.uk/news/science-environment-48596775

[22] For example, a treatment plant project constructed between 2015 and 2020 should be constructed with 60% lower embodied carbon emissions compared to a similar treatment plant project constructed in 2010.

to these targets, in April 2019, Anglian Water, along with other water companies in England, also committed to achieve net zero carbon emissions by 2030[23].

3.1.24 As discussed in some of the criteria above, there would be different environmental impacts associated with different options depending on factors such as scale, location, etc. With regard to carbon emissions in particular, a multiple site option would be associated with higher embodied and operational carbon emissions due to lower economies of scale and also increased operational requirements such as pumping and sludge transport. A single site located further away from the source of waste water and discharge points would also have higher embodied and operational carbon emissions due to the longer tunnel or pipeline lengths and associated increased pumping requirement.

3.1.25 Based on the above, the carbon emissions criterion therefore compares the likely whole life carbon emissions of the various options against a baseline of a single new WWTP located at or near to the existing WWTP location (taking into account embodied and operational carbon for the waste water transfer and treatment infrastructure likely to be required for each option). The definitions used are presented in Table 6.

Table 3.4: Carbon emissions RAG definition

Ref	Criterion	Green	Amber	Red
4	Carbon	Similar or lower embodied and operational carbon emissions compared to a new WWTP at or near to the existing location.	Moderately higher embodied and/or operational carbon emissions compared to a new WWTP at or near to the existing location.	Significantly higher embodied and/or operational carbon emissions compared to a new WWTP site at or near to the existing location.

Source: Mott MacDonald

Construction complexity

3.1.26 Another important factor that should be considered in the assessment of options is the complexity of construction. There are various factors to be considered in this category, however, at this initial stage of assessment it is considered that the main differentiators affecting complexity would mainly be associated with the transfer components (taking waste water to the WWTP and treated effluent back to the river) and more specifically:

- The utilisation of the existing sewerage system connectivity, and
- The length of tunnel or major pipeline, especially through urban areas.

3.1.27 Options utilising the existing system connectivity (e.g. a new single site option close to the existing Cambridge WWTP location) would hold the advantage of requiring fewer and less complex sewer network alterations, compared to, for example, a multiple site option which would require multiple modifications to the existing sewer network and new transfer infrastructure.

3.1.28 The length of tunnels or pipelines would also play a role in terms of complexity. For options where conveyance would be required to go through urban areas the need for tunnel shafts[24]

[23] https://www.water.org.uk/wp-content/uploads/2019/04/Public-Interest-Commitment-2.pdf

[24] Likely to include initial and final shafts for inserting tunnelling equipment and materials, as well as removing excavated material (spoil). Intermediate shafts are also likely to be required for construction purposes as well as for future maintenance access.

within the city and dealing with existing below ground infrastructure could have a significant impact on construction complexity.

3.1.29 These construction stage factors have been incorporated into a 'construction complexity criterion' as described in the table below:

Table 3.5: Construction complexity RAG definition

Ref	Criterion	Green	Amber	Red
5	Construction complexity	Option utilises existing system connectivity, tunnel/pipeline routes are primarily outside urban areas	Option requires either significant changes to system connectivity or large tunnel/ pipeline lengths through urban areas.	Option requires changes to system connectivity and long tunnel/ pipeline lengths through urban areas.

Source: Mott MacDonald

Cost (capital and operational)

3.1.30 Although an important consideration in final site selection, cost, both the initial capital cost and the on-going operational cost of the new WWTP, would normally be brought into the later stages of the site selection process as one of the criteria used to distinguish between specific short list site options. However, given the potentially significant and varying cost impacts of the strategic location options considered in this report, cost has also been included as one of the option appraisal criteria.

- **Capital costs.** With regard to the planned relocation of Cambridge WWTP, it is understood that a fixed grant would be made by Homes England to cover the capital cost of relocating the Cambridge WWTP and hence enable the regeneration of NEC (as described in Section 1.1). There is no operational need for Anglian Water to relocate the existing WWTP and without the proposed regeneration driver and funding from Homes England the WWTP would remain in its current location. Hence, there is no justification under Anglian Water's regulated role as a provider of waste water services to ask customers to fund any part of the relocation. Therefore, a constraint is that the relocation must be achieved within the grant allocated by Homes England. The level of funding offered by Homes England has been predicated on providing a relocated WWTP which is similar to the existing WWTP (i.e. a single plant, using industry standard treatment processes and located in proximity to Cambridge).
- **Operational costs.** Similarly, to the above, as there is no operational need for Anglian Water to relocate its WWTP there is no justification under Anglian Water's regulated role as a provider of waste water services to ask customers to fund additional operating costs that may arise as a result of the relocation. Only additional operating costs arising from growth or enhancement of the service provided may be funded by the customer. Hence, options which do not add to Anglian Water's current levels of operational costs are preferred.

3.1.31 The factors that would be likely to have the greatest impact on costs are as follows:

- **Economies of scale** – single, larger sites are likely to provide greater cost efficiency (capital and operating) than smaller, multiple sites.
- **Transfer infrastructure** – longer waste water transfer infrastructure, such as tunnels and pipelines, to locations away from the current drainage catchment area and treated effluent discharge locations would significantly add to capital costs and would be likely to exceed the grant limit.

- **Vehicle movements** – multiple smaller sites would require additional transport of significant volumes of sludge between the sites and a regional sludge treatment centre, which would normally be located at a larger WWTP (the existing Cambridge WWTP also contains a regional sludge treatment centre).
- **Drainage catchment area connectivity** – a site at a location close to the existing Cambridge WWTP would be able to use the existing sewer system connections without the need for extensive new infrastructure. Conversely, new locations (single or multiple) which are more distant from the current tunnel discharge point are likely to incur greater costs in creating new connections and diverting waste water to new sites.

3.1.32 A criterion has therefore been defined to account for differences in costs as described in the table below:

Table 3.6: Cost RAG definitions

Ref	Criterion	Green	Amber	Red
3	Cost (capital and operational)	Capital and operational costs likely to be similar compared to the costs of a new site at or near the existing WWTP location.	Capital and operational costs l kely to be moderately higher compared to the costs of a new site at or near the existing WWTP location.	Capital and operational costs l kely to be significantly higher compared to the costs of a new site at or near the existing WWTP location.

Source: Mott MacDonald

3.2 RAG assessment

3.2.1 The six criteria described in the previous section have been used to assess the options identified in Section 2.2. The results of the assessment are presented in the following tables. Each table compares the relative performance of the options against one of the criteria.

Table 3.7: RAG Assessment of Planning Policy (Proximity Principle)

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	G	All sites within this area would be within the drainage catchment area and could discharge at or close to the existing discharge point – hence this area fully complies with the proximity principle.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	G	All sites within this area would be within the drainage catchment area and could discharge at or close to the existing discharge point – hence this area fully complies with the proximity principle (the increased complexity of waste water and effluent transfer routes under this option is addressed by other criteria).
Option 3A - New WWTP outside drainage catchment area	A	Sites under this option would be located outside the existing drainage catchment area although treated effluent discharges could still occur at or close to the existing discharge location. Hence, this option is considered to partly comply with the proximity principle.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	G	All sites under this option would be located within or adjacent to the existing drainage catchment area and it is assumed that treated effluent would be discharged at suitable sites within the drainage catchment area. Hence, this option is considered to comply with the proximity principle.
Option 3B – Expand an existing WWTP outside drainage catchment area	R	Sites under this option would be located outside the existing drainage catchment area, possibly some distance away from Cambridge, and hence would not comply with the proximity principle.
Option 4B – Expand several WWTPs outside drainage catchment area	R	Sites under this option would be located outside the existing drainage catchment area and some existing WWTP would be distant (for example, Ely WWTP would be 15 miles away). Hence, this option achieves a red grading.

Source: Mott MacDonald

Table 3.8: RAG Assessment of effluent discharge location

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	G	The new site is likely to be able to discharge at or close to the existing discharge location on the River Cam.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	G	If a new WWTP site is located south of the existing WWTP it is I kely that it would be required and able to discharge at or close to the existing discharge location. It is considered less likely that the EA would permit another discharge location within the urban area of Cambridge Therefore, it is assumed the impact would be similar to Option 1.
Option 3A - New WWTP outside drainage catchment area	A	A location near to the existing WWTP (but on the other side of the River Cam) might be able to discharge at or close to the existing discharge location on the River Cam. However, a site further away might discharge to a different section of the River Cam, though the potential environmental impact may be similar to the existing discharge location. Given the range of potential site impacts and uncertainty of location, this option has been graded as amber.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	R	Depending on their location, the sites would I kely require multiple new discharge points on receiving watercourses and would also have the potential to cause greater impact than the current discharge location (water quality, flow regime, flood risk, amenity, etc). especially if they would result in larger volume discharges to smaller watercourses. The alternative of transferring treated effluent back to the existing WWTP discharge point may not be available for all potential locations (and would require more costly transfer infrastructure)
Option 3B – Expand an existing WWTP outside drainage catchment area	R	Both of these options would be a significant departure from the current discharge regime, removing significant treated effluent flows from the River Cam near Cambridge and discharging them at another section of the river where the environmental impacts would be different. Extensive water quality studies would be required before the EA would have the information needed to consider such a change and there is the risk that it would not be accepted.
Option 4B – Expand several WWTPs outside drainage catchment area	R	

Source: Mott MacDonald

Table 3.9: RAG Assessment of impacts on communities (focus on traffic impacts)

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	A	Depending on where the site will be located in this area, it may or may not have good access to the main trunk road network, however, it is likely that sufficient sites with good access, that do not have major impacts on local communities, can be identified. As a single site option, it will be expected to have similar numbers of traffic movements (HGV and other) to the current Cambridge WWTP.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	R	Depending on where the site will be located, it may or may not have good access to the main trunk road network but as a single site option it will be expected to have similar numbers of traffic movements to the current Cambridge WWTP. However, it is more likely that this option would result in increased HGV traffic in urban areas.
Option 3A - New WWTP outside drainage catchment area	A	As a single site option, it would be expected to have similar numbers of traffic movements (HGV and other) to the current Cambridge WWTP. However, apart from sites located in the south of the area near the A14, access to the main or trunk road network is likely to be poorer than for Option 1.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	R	The option would incur an overall increase in numbers of vehicle movements for the transport of sludge between WWTP and a potential increase in the use of urban roads.
Option 3B – Expand an existing WWTP outside drainage catchment area	A	The option would be associated with similar traffic movements to the existing Cambridge WWTP and existing WWTP downstream of Cambridge, such as Ely WWTP also have good access to the major road network.
Option 4B – Expand several WWTPs outside drainage catchment area	A	This option would be expected to have similar impacts to Option 3B, though with additional HGV traffic movements (due to sludge transport between one site and the sludge treatment centre that would be expected to be located at the other site).

Source: Mott MacDonald

Table 3.10: RAG Assessment of Carbon

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	A	With regard to the treatment element, the embodied and operational carbon emissions for this option are anticipated to be similar to the emissions for a new site at the current Cambridge WWTP location as the option relates to a single site. However, there would be an increase in embodied and operational carbon associated with transfer of waste water from the existing WWTP.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	A	Similar commentary as for Option 1, though depending on the location of the new WWTP within the area of search the transfer distance could be longer and hence carbon impacts greater.
Option 3A - New WWTP outside drainage catchment area	A	Similar commentary as for Option 1, though depending on the location of the new WWTP within the area of search the transfer distance could be longer and hence carbon impacts greater.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	R	A multiple new site option would be associated with higher embodied and operational carbon emissions due to lower economies of scale and also increased operational carbon emissions associated with pumping and sludge transport.
Option 3B – Expand an existing WWTP outside drainage catchment area	R	The embodied and operating carbon emissions associated with this option would be higher due to the need for much longer conveyance infrastructure from the existing Cambridge WWTP location to the expanded WWTP (e.g. at Ely).
Option 4B – Expand several WWTPs outside drainage catchment area	R	This option would have impacts that are similar to those for Option 3B, with the exception that there would be additional operational carbon due to additional sludge transport between sites and as each site would be smaller than in Option 3B, there would be lower economies of scale than for Option 3B hence embodied carbon would be greater.

Source: Mott MacDonald

Table 3.11: RAG Assessment of Construction Complexity

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	G	The site will be located to the north of the current Cambridge WWTP. Therefore, it will largely utilise the existing system connectivity (tunnel conveyance to current Cambridge WWTP location). Furthermore, the conveyance infrastructure from the existing Cambridge WWTP to the new site and from the new site to the (new) discharge location would be mostly outside urban areas.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	A	Depending on where the site will be located it could require long additional transfer tunnel and pipeline lengths. However, it is possible that for the conveyance infrastructure from the existing Cambridge WWTP to the new site and from the new site to the discharge location could be routed around urban areas.
Option 3A - New WWTP outside drainage catchment area	A	Depending on where the site will be located it could require long additional transfer tunnel and pipeline lengths. However, it would be possible for the conveyance infrastructure from the existing Cambridge WWTP to the new site and from the new site to the discharge location to be primarily outside urban areas.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	R	An option involving multiple new sites within or adjacent to the existing drainage catchment area would require additional system connectivity for conveyance including through urban areas.
Option 3B – Expand an existing WWTP outside drainage catchment area	A	The option would require additional system connectivity investments for conveyance. However, the length of this conveyance would primarily be outside urban areas.
Option 4B – Expand several WWTPs outside drainage catchment area	A	Similar impacts to Option 3B.

Source: Mott MacDonald

Table 3.12: RAG Assessment of Cost

Option	RAG	Commentary
Option 1 – New WWTP within drainage catchment area – north of the existing Cambridge WWTP	A	With regard to the treatment element, the capital and operational costs for this option are anticipated to be similar to the costs of a new site at the current Cambridge WWTP location as the option relates to a single site at a moderate distance from the current site. However, there could be higher capital and operational costs associated with longer tunnels for sites further away from the existing WWTP.
Option 2 – New WWTP within drainage catchment area – south of the existing Cambridge WWTP	A	With regard to the treatment element, the capital and operational costs for this option are anticipated to be similar to the costs of a new site at the current Cambridge WWTP location as the option relates to a single site at a moderate distance from the current site. However, there could be higher capital and operational costs associated with longer tunnels for sites further away from the existing WWTP.
Option 3A - New WWTP outside drainage catchment area	A	The option could incur higher capital costs due to the need for longer lengths of conveyance from the existing Cambridge WWTP location. However, the cost for building the works would be similar to building a site close to Cambridge WWTP and therefore overall capital cost is considered as moderately higher. Operational costs could also be higher depending on location and pumping requirements. Therefore, operational cost is considered to also be moderately higher.
Option 4A – Several new WWTPs within or adjacent to drainage catchment area	R	An option involving more than one site would hold the disadvantage of higher capital costs due to economies of scale and also the potential need for long lengths of conveyance from the existing Cambridge WWTP location. It would also l kely require more than one conveyance to separate discharge locations. Operational costs could also be significantly higher due to the need to pump treated effluent from multiple sites to separate discharge locations but also due to larger numbers of vehicle movements for transport of sludge and chemicals.
Option 3B – Expand an existing WWTP outside drainage catchment area	R	The option would incur higher capital costs due to the need for significantly longer lengths of conveyance from the existing Cambridge WWTP location, though the cost for building the WWTP would be similar to building a site close to Cambridge WWTP. Overall, cost impacts are likely to be higher than for option 1.
Option 4B – Expand several WWTPs outside drainage catchment area	R	An option involving more than one site would hold the disadvantage of higher capital costs due to economies of scale and also the need for longer conveyance lengths from the existing Cambridge WWTP location. It would also require more than one conveyance to separate discharge locations. Operational costs could also be significantly higher due to the need to pump treated effluent from multiple sites to separate discharge locations but also due to larger numbers of vehicle movements for transport of sludge and chemicals.

Source: Mott MacDonald

3.3 RAG assessment summary

3.3.1 The results of the RAG assessment for this initial options appraisal are summarised in the table below. For convenience the options descriptions are reproduced below

- **Option 1** – New WWTP within drainage catchment area – north of the existing Cambridge WWTP
- **Option 2** – New WWTP within drainage catchment area – south of the existing Cambridge WWTP
- **Option 3A -** New WWTP outside drainage catchment area
- **Option 4A** – Several new WWTPs within or adjacent to drainage catchment area
- **Option 3B** – Expand an existing WWTP outside drainage catchment area (e.g. Ely WWTP)
- **Option 4B** – Expand several WWTPs outside drainage catchment area (e.g. Uttons Drove and Ely WWTPs).

Table 3.13: RAG assessment summary

Option	Proximity principle	Potential environmental impact of effluent discharge location	Impacts on local communities	Carbon emissions	Construction complexity	Cost
Option 1	G	G	A	A	G	A
Option 2	G	G	R	A	A	A
Option 3A	A	A	A	A	A	A
Option 4A	G	R	R	R	R	R
Option 3B	R	R	A	R	A	R
Option 4B	R	R	A	R	A	R

Source: Mott MacDonald

3.3.2 From examination of the collected RAG assessment results for each option presented in the above table it is possible to come to the following conclusions:

3.3.3 Option 1 performs favourably against a number of the criteria and its overall performance is considered to exceed that of all the other options. Particular benefits of the option are:

- Location within the existing drainage catchment (compliance with the proximity principle)
- Continued discharge of treated effluent to the River Cam at or close to the existing discharge point (hence minimising the risk of water quality impacts in alternative watercourses as well as the extent of any changes to the current discharge permit requirements)
- Reduced need to modify the existing sewer network or cause disruption to urban areas during construction of the plant and waste water transfer infrastructure
- Reduced traffic impacts during operation – due to the availability of a comprehensive trunk road network in the area
- Relatively lower carbon emissions and costs – largely as a result of the transfer and traffic benefits described above.

3.3.4 The next best performing option is Option 2. This option is inferior to Option 1 in terms of the potential impacts on the local community as well as carbon, cost and construction complexity. However, if a suitable site could be identified within the drainage catchment area but outside of the urban area it is possible that the impact on local community and construction complexity would be reduced resulting in a similar score to Option 1.

3.3.5 Option 3A achieved amber RAG results for all criteria but, overall was considered to perform less favourably than options 1 and 2 and hence was not taken forward.

3.3.6 The least favoured options, based on this assessment, are those which require significant longer waste water transfers to existing WWTPs outside of the drainage catchment area (options 3B and 4B) and options that use more than one WWTP (options 4A and 4B).

4 Conclusions

4.1.1 As a first step in the identification of a new location for the existing Cambridge WWTP it is important to confirm that the proposed strategic approach, i.e. transfer of all of Cambridge's waste water from the existing WWTP site to a single, new treatment plant, is the most appropriate solution, and if so, also confirm the most appropriate area in which to search ('Study Area') for a site for the relocated WWTP. This first step should take into consideration policy context, technical, environmental, social and cost factors.

4.1.2 This report describes this first step, an initial options appraisal study, including context, approach, options identification and findings of the assessment.

4.1.3 Subsequent stages of the site selection process will build on the findings of this study in order to arrive at the preferred site or sites to take forward for further detailed assessment and stakeholder consultation.

4.1.4 This initial options appraisal has identified a range of potential options for the relocation of the existing Cambridge WWTP. A number of criteria for evaluating these options have been selected together with RAG assessment definitions.

4.1.5 The results of the RAG assessment of the potential options indicate that Option 1 is the preferred solution (a single new WWTP, within a Study Area covering the existing drainage catchment area, to the north of both the existing Cambridge WWTP site and current Cambridge urban boundary).

4.1.6 Option 1 performs favourably against a number of the criteria and its overall performance is considered to exceed that of all other options. Particular benefits of the option are:

- Location within the existing drainage catchment area (compliance with the proximity principle)
- Continued discharge of treated effluent to the River Cam at or close to the existing discharge point (hence minimising the risk of water quality or flow impacts in alternative watercourses as well as the extent of any changes to the current discharge permit requirements)
- Reduced need to modify the existing sewer network or cause disruption to urban areas during construction of the plant and waste water transfer infrastructure
- Reduced traffic impacts during operation – due to the availability of a comprehensive trunk road network in the area
- Relatively lower carbon emissions and costs – largely as a result of the transfer and traffic benefits described above.

4.1.7 The next best performing option is Option 2. This option is inferior to Option 1 in terms of the potential impacts on the local community as well as carbon, cost and construction complexity. However, if a suitable site could be identified within the drainage catchment but outside of the urban area, it is possible that the impact on local community and construction complexity would be reduced resulting in a similar score to Option 1.

4.1.8 This initial options appraisal therefore concludes that a new single site located within the combined drainage catchment area is the preferred solution. Therefore, both Options 1 and 2 will be taken forward for more detailed assessment, including a site selection process as outlined in Section 1 and illustrated below.

Figure 2: Linkage between Initial Options Appraisal and subsequent site selection studies

Source: Mott MacDonald

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Get in touch

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