Cambridge Waste Water Treatment Plant Relocation Project

Preliminary Environmental Information
February 2022

Climate resilience

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Summary

In developing the Proposed Development plans we have considered both design measures and future operational activities that will mitigate the risks presented by the changing climate. These will allow the Proposed Development to be resilient to the effects of future climate change, including increased flood risk and future storm flows, increased drought risk, and rising temperatures.

Our proposals deliver greater climate resilience than the existing Cambridge waste water treatment plant (WWTP), by embedding a range of measures. In this regard, the overarching resilience aspects of the Proposed Development are:

- site selection as one of the first steps in considering resilience, by selecting a location for the Proposed Development that is outside of the River Cam floodplain;
- preparation of a design that incorporates flexibility and capacity within the Proposed Development, ensuring that in the future we can modify our facility and adapt to the changing climate. This will allow the Proposed Development to manage higher storm flows in the future and reduce the risk of storm spills, and to handle low flows during droughts. Specifically:
    - flexibility within the treatment processes that will allow future influent flow rates to be managed. This flexibility is being achieved both through the process design, and within the choice of technologies. The transfer tunnel terminal pumping station has been designed to be able to convey additional flows during storm conditions and to manage low flows in drought situations
    - capacity for adaptation and change built into the Proposed Development, that will allow us to modify treatment processes in the future based on changing storm flows and increasing temperatures
    - additional capacity within the storm tank storage and transfer tunnel that will serve to help attenuate future stormflows.
- further investment in future resilience measures that can be proposed and delivered through the pre-existing regulated Asset Management Plan (AMP) cycle via our Water Resources Management Plan and the Drainage and Waste water Management Plan; and
- water demand management measures introduced in the region, which will also seek to reduce the volume of waste water being received at the Proposed Development for treatment.

The design of the Proposed Development will meet requirements to at least 2041, the timeline for which population growth projections are available. The flexibility and

capacity within the design will allow future modifications for anticipated climate changes into the 2090s and anticipated future permit limits.

Document purpose

To outline the potential impacts of climate change on the Proposed Development that may occur through its operational phase, and provide the preliminary findings of our climate resilience assessment.

This includes potential impacts to:

- the proposed physical waste water treatment plant assets and ancillary structures;
  - storage tanks and their foundations;
  - utilities infrastructure - water, gas, electricity and communications structures, and their foundations;
  - hardstanding and hard surfaces;
  - ancillary buildings and structures (e.g., internal roads and access areas)
  - other aspects such as fencing, lighting;
- tunnels and pipelines transferring waste water, including those that are buried;
- the final effluent channel and new outfall into the River Cam;
- surface water drainage, including access road drainage;
- landscaping and planting around the Proposed Development;
- the waste water treatment anaerobic digestion function and process at the Proposed Development; and
- the workforce.

The impacts of weather upon construction activities are not within scope of the climate resilience assessment because they will take place in the near future and are not considered to be affected by the changing climate. Impacts in construction arising from severe weather events will be managed by measures outlined in an emergency preparedness plan, a requirement of the Code of Construction Practice (COCP). An outline of the COCP is included within the mitigation pack of the PEI.

This paper considers how the Proposed Development has been designed to be more resilient to the impacts of climate change, and not to how the Proposed Development may affect climate change through greenhouse gas (GHG) emissions. For information on GHG emissions and its impact upon climate change, the reader should refer to the Carbon Paper as part of the Phase Three Community Consultation materials.

Limitations

Limitations of this information paper include the uncertainties surrounding a changing climate and the climate projections themselves. As levels of future GHG emissions are not certain, several possible futures exist and are modelled using climate models. As such, a range of possible future climates exist. This Climate Resilience Environmental Information Paper has been prepared taking a precautionary approach and uses projections of the future climate under the highest emissions scenario available from the UK Climate Projections. This is a more precautious approach than recommended in paragraph 3.6.7 of the National Policy Statement.

Resilience in a changing climate

We have set out our long-term ambitions to make the East of England resilient to the physical risks associated with climate change and its related challenges such as water scarcity, drought and increased risk of flooding through innovation and our climate adaptation planning process[1]. These ambitions are driven both by customer need for stable, clean water supply and waste water treatment as well as the need to undertake urgent action and investment to combat the challenges of climate change via the Environment Agency's River Basin Management Planning process[2].

Climate change will exacerbate existing issues affecting waste water treatment infrastructure such as odour, flooding and storm flow challenges. We are designing our proposals with the changing climate in mind so that once operational, the proposed WWTP will be designed and operated to be more resilient to physical risks from climate change.

Projected changes to the future climate include:

- warmer, wetter winters;
- hotter, drier summers: and
- more extreme weather events.

In relation to waste water treatment, if process plant is not designed and managed appropriately, climate change could potentially lead to:

- structural damage to the built development, including buried structures;
- a reduction in the efficiency of anaerobic digestion;
- flooding of the Proposed Development itself;
- reduced or blocked access to the Proposed Development as a result of flooding;
- a deterioration in water quality of effluent receiving waters, due to reduced river flow levels;
- increased incidences of odour;
- increased discomfort to people at work within the Proposed Development;
- health and safety risks to staff;
- damage to or increased vegetation growth; and
- reduced availability of potable water for staff and facilities at the Proposed Development.

The latest climate projections for the UK are the 'UKCP18' projections provided by the UK Met Office Hadley Centre Climate Programme (UK Climate Projections, 2018b).

In completing assessments, we identify the potential impacts of climate change by considering what the future climate could look like compared to today. Following a

[1] Anglian Water's Climate Change Adaptation Report 2020 available at: https://www.anglianwater.co.uk/siteassets/household/in-the-community/climate-change-adaptation-report-2020.pdf

[2] Environment Agency, 2021, The climate emergency: challenges for the water environment, available at: https://www.gov.uk/government/consultations/river-basin-planning-challenges-and-choices

precautionary approach, a high GHG emissions scenario (referred to as RCP8.5) is used to model the future climate. This goes beyond National Policy Statement (NPS) guidance (paragraph 3.6.7) and is in line with updated Environment Agency guidance on climate change allowances (Environment Agency, 2021), and IEMA climate change guidance on the need to consider climate change and the use of future scenarios (IEMA, 2020).

The NPS also requires consideration of other aspects that may be impacted by climate change, such as future storm flows and discharge consents. The approach for ensuring discharge consent, in line with legislation and the climate change risk assessment element of permitting, will be agreed with the Environment Agency. Modelling has been carried out looking at the impact of future storm events on discharges into the River Cam for both the existing Cambridge WWTP and Proposed Development.

The Proposed Development has been designed to accommodate population growth and changes to permits in Cambridge to 2041 and includes flexibility and capacity to adapt in the future beyond this time horizon, taking both future climate change and population growth into account. How we have designed the capacity of the Proposed Development is set out in the Phase Three Community Consultation Leaflet. As the population increases, the infrastructure to treat waste water needs to be of the right size to be able to manage the quantity of waste water generated from communities, industrial sites, and rainfall that drains from our roads, parks, and pavements. This need for a flexible, modular design that can be increased in the future has co-benefits for climate resilience. As both the population needs and the climate alters in the future, additional resilience measures can be introduced.

Built developments have a design life of a specific minimum duration, however the Proposed Development has been designed with no specified end-of-life date, to be operational into the future and to continue to serve the growing population of Cambridge beyond 2041. As elements of plant and structures within the Proposed Development reach the end of their design life, they will be replaced according to the capacity required during their renewed design life.

Our climate resilience assessment will consider the future to the 2090s (the climate experienced during the period 2080-2099) for an assessment of the operation of the Proposed Development past 2041. It should be noted that the 2090s is the furthest future time-horizon for which UK probabilistic climate projections are available and, as such, are used in this information paper (and will be used in the subsequent full Environmental Statement)[3]. Other work including flood risk modelling is being carried out to understand the impacts of climate change on the Proposed Development and necessary mitigation measures beyond the 2090s, as part of the Water Resources East programme[4].

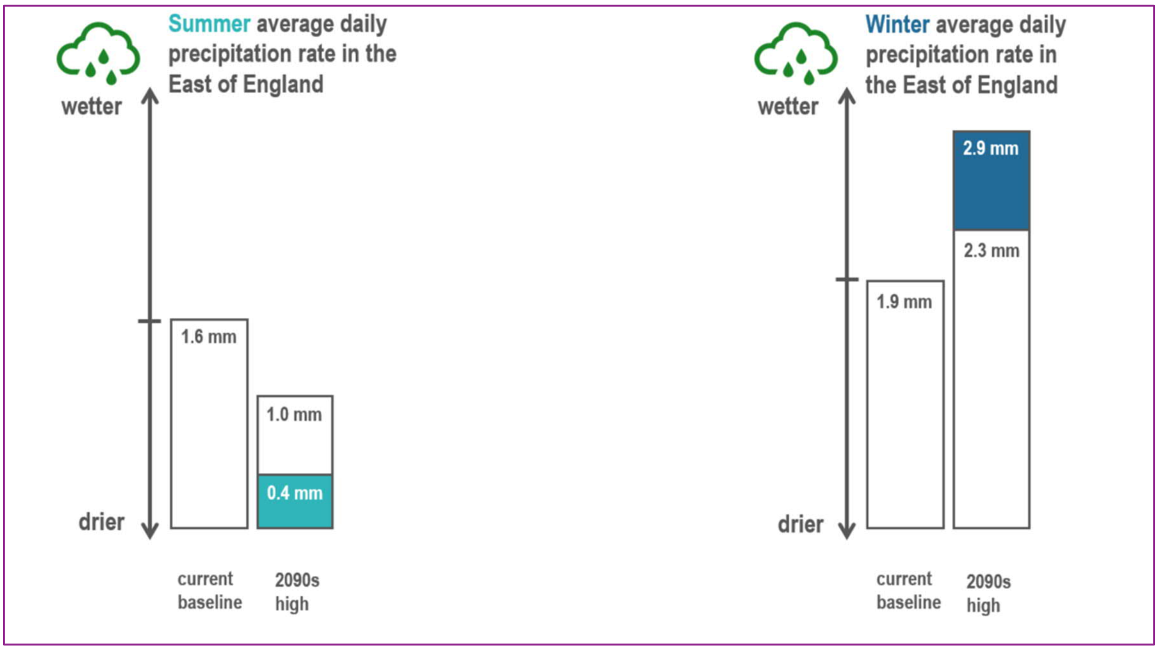
[3] Climate data for the 2080s (2070-2089) was used at the earlier Environmental Scoping stage and has now subsequently been revised to look at the furthest possible future climate data available.
[4] https://wre.org.uk/

How could changing climate affect the proposed relocation of Cambridge Waste Water Treatment Plant?

Climate change will mean changes in annual and seasonal averages as well as an increase in the frequency and intensity of extreme weather events such as storms, high winds, and heavy rainfall. As well as higher average maximum and minimum temperatures, we are likely to see more frequent heatwaves, with the temperature on the hottest days of the year increasing more than the average values. Hotter and drier conditions may increase the risk of drought and reduced river flow rates.

The baseline climate for precipitation and temperature, as well as the projected change in climate by the 2090s under the high emissions scenario (RCP8.5), are illustrated in Figures 1 and 2 respectively.

Figure 1 shows a trend of drier summers and wetter winters. Under the high emissions scenario, by the 2090s, the summer average daily precipitation rate in the East of England may decrease from 1.6 mm to 1.0 mm, or to 0.4 mm under the driest conditions[5]. By contrast, winter average daily precipitation rate for the East of England may increase from 1.9 mm to 2.3 mm or up to 2.9 mm under the wettest conditions[6].



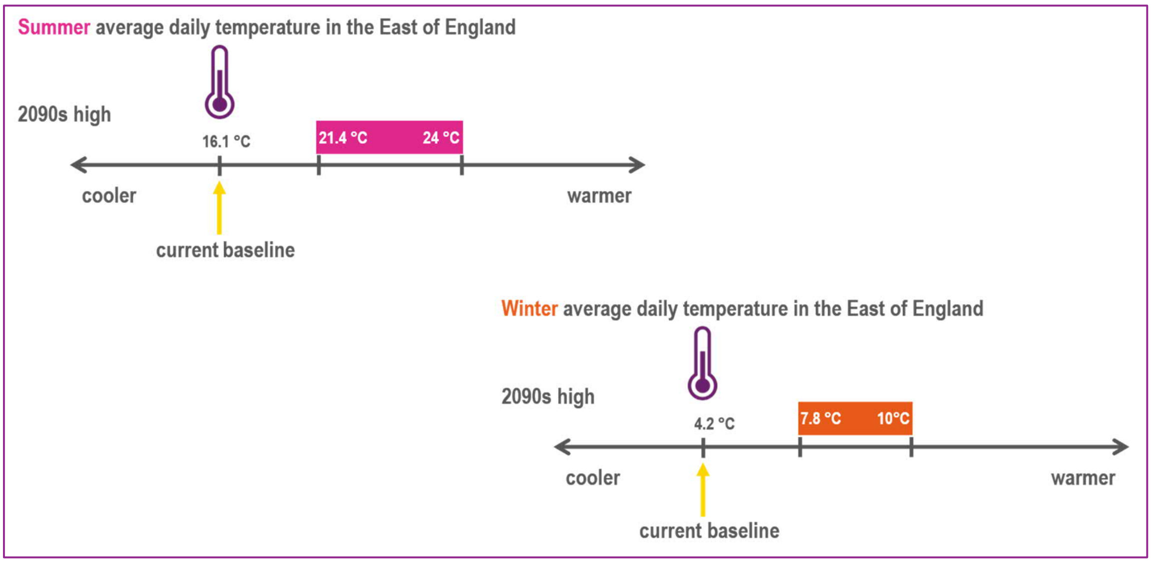
Source: Adapted by Mott MacDonald from UK Climate Projections (2018) Probabilistic Projections, UK Met Office, Crown Copyright.

Figure 1: Baseline and future precipitation in the 2090s (average mm across the season), under the high climate change scenario(RCP 8.5). The shaded area shows the range of the projected change

[5] Summer average daily precipitation rates in the 2090s are taken as the 50th percentile probabilistic estimate (of 1.0 mm) and the 10th percentile for the driest probable conditions (0.4 mm)

[6] winter average daily precipitation rates in the 2090s are taken as 50th percentile probabilistic estimate (2.3 mm per day) and the 90th percentile for the wettest probable conditions (2.9 mm)

Figure 2 shows that temperatures are projected to rise across both summer and winter. By the 2090s, under the high emissions scenario (RCP8.5), summer average daily temperatures in East England may increase from 16.1 °C to 21.4 °C or to 24 °C for the hottest conditions. Winter average daily temperatures in East England are also increasing and by the 2090s may increase from 4.2 °C to 7.8 °C or to 10 °C for the hottest conditions[7].



Source: Adapted by Mott MacDonald from UK Climate Projections (2018) Probabilistic Projections, UK Met Office, Crown Copyright.

Figure 2: Baseline and future summer and winter average daily temperatures in the 2090s, under the high climate change scenario (RCP8.5). The shaded areas show the range in the projected change

The potential impacts of these climate changes are wide and varied, impacting the aspects of the Proposed Development in different ways. The main likely significant effects due to climate change are set out in the next section below.

What might the likely significant effects be in relation to the climate resilience of the proposed relocation of Cambridge Waste Water Treatment Plant?

The preliminary assessment of the likely significant effects due to climate change are summarised in the Table 1. These do not take into account mitigation measures (design and management activities) that are part of our proposals.

[7] Summer and winter average daily temperatures in the 2090s are taken as the 50th percentile probabilistic estimates and the 90th percentile for the hottest probable conditions

Table 1: Summary of likely significant effects from climate change.

Potentially affected part or feature of the Proposed Development	Potential impact identified
	Higher temperatures including increased average temperatures and heatwaves
• structures and equipment within the Proposed Development • utilities infrastructure such as gas, water, and sewage pipelines • the new access road, entrance and the existing road network	• structural damage due to expansion and thermal loading of metallic features and concrete structures and surfaces, causing expansion, buckling and stresses on structural features • increased maintenance costs to address structural damage • overheating and fire risk of mechanical equipment
• waste water treatment processes and function at the Proposed Development	• decrease in anaerobic digestion efficiency • increased septicity • increased odour
• air quality within the Proposed Development and in the surrounding area	• increased odour from treatment works and the new transfer pipeline during these conditions
• workforce	• increased discomfort and health risks to staff
	Heavy rainfall and storms
• waste water treatment plant, structures and equipment within the Proposed Development	• higher receiving flows entering the sewerage network[8] • increased flooding if the drainage network is overwhelmed • increase in sediment load in waste water from soil erosion within the catchment served causing siltation of pipes and increased maintenance

[8] Any increase in projected precipitation is not a linear link to the flows we will experience in the sewers and therefore receive at the Proposed Development.

Potentially affected part or feature of the Proposed Development	Potential impact identified
	• flooding due to surface water • increased water flow from heavy rainfall can erode soils and other materials around structures making them further vulnerable to damage • weakening and washout of the soil and culverts that support primary structural features • water ingress and erosion of surface waste water treatment infrastructure as well as physical damage from the flow of floodwater in or around structures • increased scour and erosion on structural elements from flooding and surface water run-off • increased scour rates in the river and outflow itself leading to more rapid deterioration and need for earlier replacement • increased maintenance costs to address structural damage • increase in damage and degradation of the tunnels and pipelines increasing the likelihood of failures when transferring waste water to the Proposed Development and flows from the Proposed Development to the new outfall
• access road and ancillary structures (e.g., internal roads and access areas)	• surface flooding restricting access to the Proposed Development including limiting access if the sole access road is blocked, or access and mobility in and around the Proposed Development itself • increased potential for pipe failure within network
• connection with the River Cam	• increase in frequency of storm flows into the River Cam
	Combined increased temperatures and rainfall
• structures and equipment within the Proposed Development	• increased vegetation growth surrounding structures limiting access, causing damage and increased maintenance costs
• landscaped areas	• increased vegetation growth affecting landscaped areas and increased maintenance costs

Potentially affected part or feature of the Proposed Development	Potential impact identified
	Dry spells due to decreased rainfall leading to drought
• water utilities	• availability of potable water for offices, staff, welfare facilities at the Proposed Development due to regional water scarcity • changes to influent quality and longer retention time in pipes leading to septicity
• waste water treatment process plant structures and equipment • landscaped areas	• ground movement, such as subsidence, as soils dry out and shrink. This can lead to damage to buried pipes and structure foundations • increased maintenance costs to address structural damage • vegetation dieback affecting soil stability, impacts upon local landscape and visual outline • failure to sustain habitats created to deliver biodiversity net gain
• waste water treatment process plant function	• ability to function under low flow conditions, slowing the movement of water within the transfer tunnel, decreasing dilution and potentially leading to septicity • lower river levels within the River Cam, which would affect the dilution of treated effluent returned to the river • more stringent consent conditions within the environmental permit that the Proposed Development will have to comply with as low flows alter dilution
	High winds including storms and gales
• waste water treatment process plant structures and equipment • ancillary buildings • landscaped areas	• structural damage due to windborne debris and loading of structures • lightning strike causing damage and failure of electrical equipment • damage to ancillary features such as fencing • uprooting of trees and other damage to landscape features • increased maintenance costs to address structural damage

Potentially affected part or feature of the Proposed Development	Potential impact identified
• workforce	• health and safety risk to staff especially on call / emergency response staff working during extreme weather events • loss of access and egress to and from the Proposed Development

How will the proposed relocation of Cambridge Waste Water Treatment Plant take account of the changing climate?

Our site selection stage was one of the first steps in considering resilience by selecting a location for the proposed WWTP that is outside of the floodplain. In progressing our designs, we have adopted a range of measures to ensure that the Proposed Development will have greater resilience to the impacts of the future climate. These measures are split into two categories:

1. Embedded design measures, which include modifications or designing to a wider range of weather and climate-related tolerances from the outset of the design.
2. Secondary measures, which include management plans, monitoring and maintenance activities to ensure continuing effective operation into the future.

Embedded design measures include incorporating flexibility and capacity within the Proposed Development design to ensure that in the future we can modify our facility through the following overarching means:

- flexibility within the treatment processes that will allow future influent flow rates to be managed. This flexibility is being achieved both through the process design and the choice of technologies. For example, process adjustments within the transfer tunnel can be made, adding more water during drought periods and dosing of the influent to avoid septicity;
- flexibility and capacity within the Proposed Development footprint that will enable us to adapt and modify treatment processes in the future. For example, capacity at the pumping station has been included to allow higher future flow rates to be pumped into the inlet, and additional capacity around the digesters has been included for additional water cooling in the future, allowing us to respond to higher future temperatures; and
- capacity of the transfer tunnel that will attenuate future storm flows.

Two overarching secondary measures include the use of regulated management planning and water demand management. The Proposed Development, once operational, will move into the formal Asset Management Plan (AMP) process as soon as possible. The AMP cycle is overseen by the regulator OFWAT and is the main mechanism for change and dealing with future mitigation decisions. Further investment in future resilience measures can be proposed and delivered, if approved by Ofwat, through the AMP process via our Water Resources Management Plan (WRMP) and /or the Drainage and Waste water Management Plan (DWMP).

Water demand management measures introduced in the region will also seek to reduce the volume of waste water discharged for treatment.

Table 2 summarises the key embedded and secondary measures that have been incorporated into the Proposed Development to mitigate each of the identified potential risks due to climate change.

Table 2 Mitigation measures to address potential climate change impacts

Potential impact identified	Embedded design measures	Secondary measures
	Higher temperatures including increased average temperatures and heatwaves	
• structural damage due to expansion and thermal loading of metallic features and concrete structures and surfaces, causing expansion, buckling and stresses on structural features • increased maintenance costs to address structural damage • overheating and fire risk of mechanical equipment • decrease in anaerobic digestion efficiency • increased septicity • increased odour from treatment works and new transfer pipeline during these conditions • increased discomfort and health risks to staff	• cooling measures that include: - adopting a design that allows natural air-flow through openings in the earth bank to assist with passive ventilation of the waste water treatment plant (WWTP) - building design to consider natural ventilation as well as traditional mechanical heating ventilation air conditioning (HVAC) systems - the cooling system design for the digester (to protect anaerobic processes) is inherently modular and the Proposed Development allows capacity for the installation of additional modules that will provide cooling as required in the future • choice of materials and additional measures such as insulation and painting surfaces with lighter and more reflective colours • primary tanks can be automatically or manually turned off which allows for mitigation of septicity risk These will allow the proposed WWTP to operate within a designed temperature range of -10 °C to +40 °C. This will create resilience to the majority of mean daily maximum temperatures likely to be experienced in the 2050s and much of the 2090s. Resilience to extreme summer temperatures and heatwaves over 40 °C will require use of the flexibility in the design to upgrade	• proactive monitoring and maintenance regime of physical assets • provision of appropriate personal protection equipment (PPE) and hydration for outdoor staff

Potential impact identified	Embedded design measures	Secondary measures
	components in the future, scaling up the cooling when needed and working with our supply chain to provide equipment that can operate at temperatures higher that the current design standard of 40 °C.	
	Heavy rainfall and storms	

• higher receiving flows entering the sewerage network[9]
• increased flooding if the drainage network is overwhelmed
• increase in sediment load in waste water from soil erosion within the catchment served causing siltation of pipes and increased maintenance
• site flooding due to surface water
• increased water flow from heavy rainfall can erode soils and other materials around structures making them further vulnerable to damage
• weakening and washout of the soil and culverts that support primary structural features
• water ingress and erosion of surface waste water treatment infrastructure as well as physical damage from the flow of floodwater in or around structures
	Measures included relation to flooding are:
	• siting of the proposed WWTP and access outside of the River Cam floodplain
	• design of the outfall to continue operating during flood conditions. Our design will function during the predicted river levels associated with the 1 in 100 year design flood event plus a 20% allowance for climate change (in line with the latest Environment Agency advice):
	  - river flood modelling is ongoing to inform the detailed design, incorporating the latest peak river projections published by the Environment Agency, as well as the latest UK climate change projections; you can refer to the Water resources information paper for information on river flood risk
	  - design of the outfall is being conducted according to the methods set out within CIRIA Culvert, screen and outfall manual (C786) (CIRIA, 2019) that include provision for climate change using UKCP18 and refer to the Environment Agency guidance
		Measures to address risk of flooding include:
		• use of a proactive inspection and maintenance regime to ensure infrastructure assets are operating adequately; and to identify and address any issues such as physical flood damage or drainage blockages
		• the development of operational phase management and business continuity plans for abnormal operational conditions such as those resulting from extreme weather events
		Measures in relation to increased and extreme precipitation and storm flows are:
		• provision and effective use of early warning systems including Met Office weather forecasts and

[9] Any increase in projected precipitation is not a linear link to the flows we will experience in the sewers and therefore receive at the Proposed Development.

Potential impact identified	Embedded design measures	Secondary measures

• increased scour and erosion on structural elements from flooding and surface water run-off
• increased scour rates in the river and outflow itself leading to more rapid deterioration and need for earlier replacement;
• increased maintenance costs to address structural damage
• increase in damage and degradation of the tunnels and pipelines increasing the likelihood of failures when transferring waste water to the Proposed Development and flows from the Proposed Development to the new outfall
• surface flooding restricting access to the Proposed Development including limiting access if the sole access road is blocked, or access and mobility in and around the Proposed Development itself
• increased potential for pipe failure within network
• increase in frequency of storm flows into the River Cam
	• design of the surface water drainage network within the proposed WWTP to include a 20% allowance for climate change
	• the use of sustainable drainage systems (SuDS) along the new access road.
	• sizing of the drainage network to operate during rainfall events including an allowance for climate change and to greenfield flow rates (modelled peak rainfall runoff on vegetated land cover)
	  - design supported by numerical modelling considering 1 in 100 year design rainfall event with a 20% allowance for climate change in line with Environment Agency guidelines
	  - drainage for the area surrounding the earthwork bank, and particularly for the access road will link into proposed swales[10] that will be designed to the appropriate capacity
	• the drainage network will include SuDS where possible (with any potentially contaminated water flow going back into the treatment works) and will utilise natural mitigation measures where possible such as vegetated cover and landscape design
	• detailed design of structures and ancillary equipment within the proposed WWTP (e.g., electrical equipment) will take into account appropriate levels of water proofing, including
		Environment Agency flood warnings

[10] Shallow, broad, and vegetated channels designed to store and/or convey runoff and remove pollutants.

Potential impact identified	Embedded design measures	Secondary measures
	consideration for increased wintertime precipitation and extreme rainfall events Measures included in relation to increased extreme precipitation and storm flows are: • the terminal pumping station will be designed to handle storm flows in accordance with a 1 in 100 design storm event plus a 20% allowance for climate change: - above ground storm tank storage, plus the transfer tunnel, will together attenuate future storm flows at 68 litres per day - redundancy will be built-in, with standby pumps available to support pumping of larger future storm flows from the transfer tunnel to the stormwater storage / treatment tanks if the duty and assist pumps go offline for any reason; and - in the event of a power supply issue, additional resilience is built into the power supply for the standby pumps through the provision of a twin feed and standby generators • modular design to create built-in redundancy and allow for future expansion and additional treatment capacity to address increased storm flows, which would also include periods of greater sediment loading due to soil erosion within the catchment • design of surface water drainage to 1 in 100 year design rainfall event and to include the 20% climate change allowance to account for higher intensity of	

Potential impact identified	Embedded design measures	Secondary measures
	extreme rainfall events and associated surface water flood risk • technology selection that incorporates the ability to alter processes to cope with changing influent quality and quantity to provide future redundancy and flexibility	
	Combined increased temperatures and rainfall	
• increased vegetation growth surrounding structures limiting access, causing damage and increased maintenance costs		• selection of climate appropriate vegetation and trees • use of a proactive vegetation management regime. The long-term maintenance of the vegetation will be guided by the Landscape, Ecology and Recreation Management Plan (LERMP) outlining the activities required for the establishment and maintenance of the new planting
	Dry spells due to decreased rainfall leading to drought	
• availability of potable water for offices, staff, welfare facilities at the proposed WWTP due to regional water scarcity • changes to influent quality and longer retention time in pipes leading to septicity • ground movement, such as subsidence, as soils dry out and shrink. This can lead to	• industry best practice design standards for pipelines and tunnels will be used:	• use of a proactive inspection and maintenance regime including actions such as re-wetting of the earthwork bank and other earthworks • use of a post-planting maintenance regime (over a

Potential impact identified	Embedded design measures	Secondary measures
damage to buried pipes and structure foundations • increased maintenance costs to address structural damage; • vegetation dieback affecting soil stability, impacts upon local landscape and visual outline • failure to sustain habitats created to deliver biodiversity net gain • ability to function under low flow conditions, slowing the movement of water within the transfer tunnel, decreasing dilution and potentially leading to septicity • lower river levels within the River Cam, which would affect the dilution of treated effluent returned to the river • more stringent consent conditions within the environmental permit that the Proposed Development will have to comply with as low flows alter dilution	- tunnel transfers have shafts at the start and end that could be used to implement dosing[11] in extreme or longer-term drought conditions - additional measures to address dry weather flows within the transfer tunnel including introducing additional water, dosing, and attenuation of the risk of high contamination levels during the first flush (the first rains following a drought period) • low flow section in tunnel transfer to manage dry flows without the need for additional tunnels • design will account for variable soil and groundwater content and associated ground movements • careful selection of drought resistant vegetation and trees. Further details will be set out in the outline LERMP • use of water efficient fittings and water conservation measures within operational offices / welfare areas • selection of technology that incorporates the ability to alter processes to cope with changing influent quality and quantity • primary settlement tanks that can be taken offline, if necessary, during drought periods	thirty-year period to meet biodiversity net gain[12] requirements) including replanting if vegetation dieback occurs and periodic (e.g., bi-annual) inspection and maintenance / re-planting as necessary. The long-term maintenance of the vegetation will be guided by the LERMP outlining the activities required for the establishment and maintenance of the new planting, including consideration that the first five years following planting are often the most critical to establish vegetation • use of Water Quality Management Plan and demand management measures in operation

[11] Chemical dosing is used to treat sewage effluent at waste water treatment plants. The purpose of doing so is to: reduce phosphorus concentration; correct pH levels; treat odour; and aid sludge and solids settlement.
[12] Biodiversity net gain is an approach to development which means that habitats for wildlife must be left in a measurably better state than they were in before the development.

Potential impact identified	Embedded design measures	Secondary measures
	High winds including storms and gales	
• structural damage due to windborne debris and loading of structures • lightning strike causing damage and failure of electrical equipment • damage to ancillary features such as fencing • uprooting of trees and other damage to landscape features • increased maintenance costs to address structural damage • health and safety risk to staff especially on call / emergency response staff working during extreme weather events • loss of access and egress to and from the Proposed Development	• installation of lightning protection in line with the latest industry standards • detailed design to adopt industry standards and include adequate wind loading for future worst case wind conditions and wind protection where appropriate • developing the landscape plan to consider grouping of trees with deep root structures to limit uprooting	• provision and effective use of early warning systems including Met Office weather forecasts and an appropriate hazardous weather plan • a proactive monitoring and maintenance regime to be triggered following extreme events that may have led to damage to Proposed Development's physical infrastructure • use of a proactive inspection and maintenance regime for vegetation management that considers additional damage such as uprooting due to storms, as well as increased vegetation growth rates and maintenance requirements

Completed and planned work to further inform climate resilient design

Network drainage capacity modelling is planned, to be based on the design intent and the surface water flooding climate resilience mitigation measures set out above. A surface water drainage strategy will be produced alongside this.

The Flood Risk Assessment will model and assess river flood levels throughout the River Cam and the relative impact of the new outfall compared to existing conditions.

These models and assessments will all be part of the Development Consent Order (DCO)[13] application. Further river modelling, using a 1 in 100 year design flood event plus a 40% allowance for climate change for after the 2050s, will be conducted as part of the next stage in the assessment process.

[13] This is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects (NSIP), which is required by UK law for this Proposed Development.

References

CIRIA (2019) Culvert, screen and outfall manual (C786F). Available at: https://www.ciria.org/ItemDetail?iProductCode=C786F&Category=FREEPUBS [last accessed December 2021].

IEMA (2020) IEMA EIA Guide to: Climate Change Resilience and Adaptation. Available at: https://www.iema.net/resources/reading-room/2020/06/26/iema-eia-guide-to-climate-change-resilience-and-adaptation-2020 [last accessed December 2021]

IPCC (2014): Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Available at: https://www.ipcc.ch/site/assets/uploads/2019/01/SYRAR5-Glossary_en.pdf [last accessed December 2021]

National Policy Statement (NPS) (2012) National Policy Statement for Waste Water. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69505/pb13709-waste-water-nps.pdf [last accessed December 2021]

UK Climate Projections (2018a), UKCP18 Guidance: Representative Concentration Pathways. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-guidance---representative-concentration-pathways.pdf [last accessed December 2021]

UK Climate Projections (2018b), Probabilistic Projections, UK Met Office, Crown Copyright. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/key-results [last accessed December 2021]

Environment Agency (2021) Flood risk assessments: climate change allowances. Updated October 2021. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [last accessed December 2021]