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6.4 Environmental Statement
Appendix 14.3 In-Combination Climate Change Impacts Assessment

Planning Act 2008

APFP Regulation 5(2)(a)
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1 In-combination climate change impacts assessment

1.1 Purpose of this document

1.1.1 This appendix presents the outcomes of the in-combination climate change impact (ICCI) assessment of the scheme where the focus is on those effects of the scheme identified by an environmental aspect that are also affected by climate change. The assessment does not identify any new or different significant in-combination effects as a result of the scheme's effects combining with future climate conditions.

1.2 Assessment of in-combination climate change impacts

1.2.1 The Environmental Statement (ES) considers effects related to climate change as per the requirements of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017. The assessment of effects considers the combined effects of the impacts of the scheme and potential climate change impacts on the receiving environment during construction and operation. The future climate conditions have been reviewed as part of the assessment, including changes to long term seasonal averages and extreme weather events as projected by the UK Climate Projections 2018 as presented within section 14.7 Baseline conditions of ES Chapter 14 Climate (Document Reference 6.2). The assessment outcomes for each environmental aspect are set out below.

Air quality

1.2.2 Potential effects which could arise due to air quality impacts from the scheme in combination with future projected climate conditions on air quality receptors include the following:

- An increase in hotter and drier conditions and increased frequency of droughts and heatwaves could exacerbate dust generation during construction. Mitigation measures are included in the Environmental Management Plan (EMP) (ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4) to limit the generation and dispersion of construction dust. This climate change effect would therefore not affect the significance of the air quality assessment.
- Increased wind speed could influence dispersion of pollutants during construction and operation. There is considerable uncertainty in projecting wind changes, from wind speed to wind direction, and studies show statistically insignificant variation in wind speed. Construction dust mitigation measures are included in the EMP (ES Appendix 2.1 Environmental Management Plan (Document Reference 6.4) which would mitigate any further impacts due to climate change impacts.
- An increase in hotter and drier conditions could increase concentrations of air pollutants such as ozone and nitrogen oxides (NOx). Vehicle emissions are predicted to reduce based on Defra's national fleet projections. Therefore, the consequence of hotter and drier conditions is low due to overall reductions in total emissions.
- Increased frequency and intensity of heavy rainfall events and flooding could reduce dust and pollutant concentrations due to wet deposition. This climate

change effect would therefore not affect the significance of the air quality assessment.

1.2.3 While the impacts of climate change are likely to affect air quality in general terms, no significant in-combination effects with the scheme have been identified and no mitigation is proposed.

Cultural heritage

1.2.4 Potential effects which could arise due to heritage impacts from the scheme in combination with future projected climate conditions on heritage receptors have been considered. It is considered that while the impacts of climate change are likely to affect the heritage resource in general terms, no significant in-combination effects with the scheme have been identified, and no mitigation is proposed.

Landscape and visual effects

1.2.5 Climate change may have an impact on local landscape character and views as follows:

- drier/drought conditions may lead to loss of vegetation and defoliation and receptors could become more vulnerable to stress. This could further disrupt views to and from the scheme;
- drought tolerant trees may become more prevalent (therefore also changing landscape character);
- wetlands may disappear (also dependent on elevation and soil type) and certain soil types may be less readily available;
- hotter and wetter conditions could lead to an increased spread of pests and diseases leading to loss of vegetation and defoliation, making species more susceptible to external stress;
- increase in frequency and intensity of heavy rainfall events/flooding could cause the loss of species in certain areas, because soils become water-saturated and can no longer support existing species;
- hotter and wetter conditions may lead to a longer growing seasons and increased rate of growth of vegetation. This could constitute a beneficial impact, as increased growth rate could allow trees to sequestrate more carbon at a faster rate; and
- increased wind speed could impact the landscape through potential tree losses. This could further disrupt views to and from the scheme.

1.2.6 While the impacts of climate change are likely to affect landscape character, views and visual resource in general terms, no significant in-combination effects with the scheme have been identified. However, a range of tree species that would be better adapted to climate change are included within the detailed mitigation design planting proposals. This is to provide a balance between the native species planting that would fit with the existing landscape character and non-native plant species that would better adapt to climate change over time.

Biodiversity

1.2.7 The combined effects relating to ecological impacts of the scheme and potential climate change on receptors include the following:

- Drier and potentially drought-like conditions could occur as a result of global climate change leading to changes in hydrological and groundwater

conditions. There would be an increased risk of impact on water quantity in the headwaters of the River Frome and tributary of Norman's Brook as a result of the scheme due to the limestone geology of the area. Bushley Muzzard fen grassland Site of Special Scientific Interest (SSSI) is spring fed and is reliant on groundwater. This site is not anticipated to be affected by the scheme and therefore no in-combination effects are likely within the SSSI.

- Impacts on groundwater as a result of the scheme could affect the calcareous grasslands and woodland of Crickley Hill and Barrow Wake SSSI and potentially the Cotswolds Beechwood Special Area of Conservation (SAC). Tree species such as beech, which is a common component of existing woodlands in proximity to the scheme, would be increasingly vulnerable to drought, especially on areas of free draining soil. The composition of woodland could therefore be altered by drier drought like conditions as a result of climate change.
- Increases in wind speed, temperature variations and rainfall patterns associated with climate change and the increase in extreme weather events such as storm events have the potential to cause habitat loss and degradation due to impacts such as defoliation, soil erosion from wind or water, structural damage to trees or tree loss, especially of mature or veteran trees. Habitat loss and fragmentation would also occur as a result of the scheme. The in-combination effect has the potential to result in large scale habitat degradation, habitat loss and loss of connectivity between habitats. However, temperature changes are expected to be within the tolerance of habitats within the scheme and not to have a significant impact upon local species of flora and fauna over the expected operational life of the scheme.
- Increases in intensity and frequency of rainfall and likelihood of flooding would have an effect on groundwater, surface waterbodies and consequently the protected species that live in or rely on them. Increases in water volume within rivers due to flooding could cause riparian habitat loss and changes in food resource which would affect riparian mammals such as otters. Such impacts could cause species to relocate to other habitats or in a worst-case scenario cause mortality.

1.2.8 While the impacts of climate change are likely to affect habitats and consequently species in general terms, no significant in-combination effects with the scheme have been identified. However, a number of measures are included in the detailed mitigation design planting proposals to increase the resilience of the habitat to climate change as follows:

- Landscape planting would include a diverse mix of native tree species to ensure resilience to the effects of climate change including pest and disease;
- Species selection would include trees that may be more tolerant of drought conditions or those that would be adaptable to an increase in frequency and intensity of heavy rainfall events or longer growing seasons. Non-native tree species would be considered where appropriate to increase resilience;
- Woodland planting would be designed to include edge habitat comprising a diverse mix of species of varying structure. Edge habitat would create a buffer for the existing woodland against additional stresses from variable environmental factors such as exposure to wind and increased airborne pollutants; and
- The landscape planting design aims to connect previously isolated habitats, providing habitat corridors to enable species to disperse across the landscape

in immediate response to extreme weather events (such as flooding) or gradually in response to climate change.

Geology and soils

1.2.9 Potential effects which could arise due to impacts from the scheme in combination with future projected climate conditions include:

- Increasing frequency and severity of precipitation and storms may accelerate the erosion of soil and engineered slopes, and result in increased runoff of sediments;
- Increasing frequency and intensity of drought periods may result in increased soil erosion, surface cracking and the formation of infiltration pathways into slopes;
- Increased temperatures and occurrence of heat waves may enhance breakdown of organic matter resulting in increased ground gas production rate (but this may be ameliorated by lower moisture content associated with dry weather) and increased volatility of organic compounds, if present, causing unpleasant odours locally;
- Increasing repeated cycles of drying and re-wetting may result in increased fracture propagation within the bedrock;
- Increasing frequency and intensity of drought periods may increase the frequency of shrink-swelling of the soils, potentially leading to significant volume reductions and differential settlement; and
- Increasing long spells of hot weather and wildfires may result in soils developing water repellence, which may reduce or temporarily impede water infiltration, leading to preferential flow and increased surface runoff.

1.2.10 While the impacts of climate change are likely to affect geology and soils in general terms, no significant in-combination effects with the scheme have been identified, and no mitigation is proposed.

Material assets and waste

1.2.11 The potential combined effects relating to material assets for the scheme and potential climate change on receptors includes the risk of contamination through increased heavy rainfall events and flooding which may result in a reduced capacity at both non-hazardous waste landfill facilities and hazardous waste landfill facilities. Additionally, wetter conditions could lead to excavated material being classed as unsuitable for re-use, therefore, requiring disposal off-site or treatment to reduce the water content. Conversely, material that is too dry may be unsuitable for re-use, therefore, the material may need to be wetted. The increase in frequency of extreme weather events may result in a reduction in quality of available material assets and therefore further reduce capacity at waste landfill facilities.

1.2.12 While the impacts of climate change are likely to affect material assets and waste in general terms, no significant in-combination effects within the scheme have been identified and no mitigation is proposed.

Noise and vibration

1.2.13 The main consequence of climate change with regard to noise would relate to changes in humidity and temperature leading to a greater number of people sleeping with windows open. The thresholds used in the assessment for night-time noise are based on World Health Organisation (WHO) Night Noise

Guidelines[1] which are set assuming that people should be able to sleep with bedroom windows open. Therefore, no significant in-combination effects with the scheme have been identified, and no mitigation is proposed.

Population and human health

1.2.14 There are a range of in-combination effects related to climate change that have been considered including raised temperatures, increased rainfall and storm events. These are likely to result in people changing their behaviour such as spending more time outdoors or sleeping in their homes with windows open during warmer periods. Alternatively, during wetter or stormier periods, people may choose not to spend as much time outdoors enjoying green and open spaces than they otherwise would. These behavioural variations would also reflect on the frequency with which people may choose to visit social gathering places such as tourist attractions or sports facilities.

1.2.15 It is considered that while the impacts of climate change are likely to affect population and human health receptors in general terms, no significant in-combination effects with the scheme have been identified and no mitigation is proposed.

Road drainage and the water environment

1.2.16 Future climate conditions derived from the UK Climate Projections 2018 (UKCP18) indicate that the study area may undergo climatic changes including higher temperatures, increase in heat waves, reduced precipitation in summer and increased precipitation in winter.

1.2.17 These conditions are likely to reduce the amount of recharge to the groundwater which may have impacts upon features in the study area and cause some perennial features to become ephemeral. Abstractions, springs, groundwater fed watercourses, areas of flooded ground and Bushley Muzzard SSSI are likely to be particularly sensitive to these impacts. Groundwater quality is also likely to be affected by a reduction in the flushing of aquifers, which may increase the residence time of groundwater within them.

1.2.18 Surface water flows are likely to become more variable, with more frequent extremes including wetter winters and drier summers.

1.2.19 Increasing long spells of hot weather and wildfires may result in soils developing water repellence, which may reduce or temporarily impede water infiltration, leading to preferential flow and increased surface runoff.

1.2.20 While the impacts of climate change are likely to affect the water environment, no significant in-combination effects are predicted as a result of the scheme with future climate conditions. The scheme design incorporates embedded mitigation such as climate change allowances in the drainage design, as identified within ES Appendix 13.3 Flood Risk Assessment (Document Reference 6.4).

[1] World Health Organisation, “Night Noise Guidelines for Europe,” Copenhagen, 2009