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6.4 Environmental Statement Appendix 14.2 Climate Change Resilience Assessment

Planning Act 2008

APFP Regulation 5(2)(a)
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009

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6.4 Environmental Statement Appendix
14.2 Climate Change Resilience Assessment

Regulation	5(2)(a)
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1 Climate change resilience assessment

1.1 Climate change resilience (CCR) assessment

1.1.1 This appendix presents the details of the climate change resilience (CCR) assessment undertaken as part of the Environmental Statement (ES). The assessment methodology is described in ES Chapter 14 Climate (Document Reference 6.2).

CCR assessment summary

1.1.2 This section presents a summary of the results from the CCR assessment, including the assessment of consequence and likelihood of each identified risk. Additional mitigation measures are proposed to increase resilience where relevant.

1.1.3 The likelihood and consequence for each risk is qualitatively assessed, as summarised in Table 1-1 and Table 1-2.

Table 1-1 Qualitative five-point scale of likelihood of climate change risks

Likelihood category	Description (probability and frequency of occurrence)
Very high	The event occurs multiple times during the lifetime of the project (60 years) e.g. approximately annually, typically 60 events.
High	The event occurs several times during the lifetime of the project (60 years) e.g. approximately once every five years, typically 12 events.
Medium	The event occurs limited times during the lifetime of the project (60 years) e.g. approximately once every 15 years, typically 4 events.
Low	The event occurs during the lifetime of the project (60 years) e.g. once in 60 years.
Very low	The event can occur once during the lifetime of the project (60 years).

Table 1-2 Qualitative five-point scale of consequences of climate change risks

Consequence of impact	Description
Very large adverse	Operation - national level (or greater) disruption to strategic route(s) lasting more than 1 week.
Large adverse	Operation - national level disruption to strategic route(s) lasting more than 1 day but less than 1 week or regional level disruption to strategic route(s) lasting more than 1 week.
Moderate adverse	Operation - regional level disruption to strategic route(s) lasting more than 1 day but less than 1 week.
Minor adverse	Operation - regional level disruption to strategic route(s) lasting less than 1 day.
Negligible	Operation - disruption to an isolated section of a strategic route lasting less than 1 day.

1.1.4 The overall risk is assessed using the matrix depicted in Table 1-3.

Table 1-3 Significance matrix

		Measure of likelihood				
		Very low	**Low**	**Medium**	**High**	**Very high**
Measure of consequence	**Very large**	NS	S	S	S	S
	Large	NS	NS	S	S	S
	Moderate	NS	NS	S	S	S
	Minor	NS	NS	NS	NS	NS
	Negligible	NS	NS	NS	NS	NS

Note: NS = Not significant; S = Significant

1.1.5 The CCR assessment results are shown in Table 1-4.

Table 1-4 Climate change resilience assessment summary

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
1	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increased number of hot days may increase impact to staff.	Increased heat stress for staff, particularly for outdoor construction and maintenance workers.	Construction and operation	Health and Safety (H&S)	To be incorporated within proposed maintenance regimes. These can be reviewed regularly to ensure H&S requirements within Highways England are met.	Resilience achieved through monitoring and maintenance of asset.	Low	Minor adverse	NS
2	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increased number of hot days may lead to shrinkage of soil and drying out of vegetation.	Extended periods of hot, dry weather may lead to a risk of spontaneous grassland fires in vicinity of the route, affecting safety on the road.	Operation	Road surface	Risk to be sufficiently mitigated through standard emergency procedures. Additionally, the road would act as a firebreak, providing a gap in combustible material that would act as a barrier to slow or prevent the progress of a wildfire from one side to the other.	Resilience achieved through standard measures already in place.	Low	Moderate adverse	NS
3	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increase in number of hot days may impact the road surface increasing the danger to road users.	Asphalt surface may exhibit permanent deformation in long periods of hot, sunny conditions.	Operation	Road surface	This risk would be managed through the selection of suitable road surface material as well as through the proposed maintenance regimes for road surface.	Resilience achieved through design and maintenance.	High	Minor adverse	NS
4	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increase in number of hot days may impact the road surface increasing the danger to road users.	High temperatures increase the risk of surfacing rutting leading to water ponding in the ruts. Higher temperatures also increase the risk of reduced skid	Operation	Road surface	This risk would be managed through the selection of suitable road surface material as well as through the proposed maintenance	Resilience achieved through design and maintenance.	Low	Moderate adverse	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
				resistance due to fatting and chipping embedment. This increase the risk of vehicle accidents.			regimes for road surface.				
5	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increased number of hot days may impact the bitumen binder hardening rate.	Inability to flex under traffic loads. Increased risk of road surface cracking and fretting with age.	Operation	Road surface	This risk would be managed through the proposed maintenance regimes.	Resilience achieved through maintenance of the asset.	Medium	Minor adverse	NS
6	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increased number of hot days may impact the bitumen binder hardening rate.	Risk of being unable to lay road surface layers in hot weather.	Construction	Road surface	Risk to be mitigated by following procedures to be detailed in the Environmental Management Plan (EMP).	Resilience achieved through management plan monitoring environmental impacts.	Low	Minor adverse	NS
7	High temperatures	Mean and maximum temperatures in winter and summer projected to increase significantly.	Increased impact of diesel spills.	Decreased viscosity in heat leads to greater spreading of diesel in a smaller timeframe. Higher temperatures and increased number of hot, dry days increase the likelihood of ignition of this diesel leading to road and forest fires.	Operation	Road surface	Risk to be sufficiently mitigated through proposed maintenance procedures.	Resilience achieved through maintenance of the asset.	Low	Moderate adverse	NS
8	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding of road surface.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) Climate change allowance in critical	Resilience achieved through design.	Very low	Moderate adverse	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
							drainage areas increased to +40%.				
9	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding of access roads and/or road infrastructure.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%.	Resilience achieved through design.	Very low	Moderate adverse	NS
10	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increase risk of sewage overflow in floodwater causing damage and impacting health of maintenance workers.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%.	Resilience achieved through design.	Very low	Moderate adverse	NS
11	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increased risk of scouring of culverts.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%.	Resilience achieved through design.	Low	Minor adverse	NS
12	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Flooding causing damage to fibre optic cables running near to site.	Operation	Drainage	Attenuation ponds designed for 1/100 year event +20% for climate change (check performed for 40% increase) Climate change allowance in critical drainage areas increased to +40%.	Resilience achieved through design.	Very low	Negligible	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
13	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increased pore water pressure in embankments/cuttings.	Construction and operation	Earthworks	To be mitigated through drainage design Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Very low	Large adverse	NS
14	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increased erosion at toe of embankment.	operation	Earthworks	To be mitigated through drainage design Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Low	Large adverse	NS
15	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Water ingress to critical construction equipment.	Construction	Drainage	Drainage on site to be suitably managed, to be specified within the EMP.	Resilience achieved through management plan monitoring environmental impacts.	Very low	Minor adverse	NS
16	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Water ingress to signalling, lighting and other operational electrical equipment.	Operation	Electrical equipment	Watertight cables housed in plastic ducts. No water ingress to underground cables.	Resilience achieved through design.	Very low	Minor adverse	NS
17	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Change in ground water level affecting earth pressures and foundation settlement causing possible large ground movement.	Operation	Drainage	To be mitigated through drainage design. Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Very low	Large adverse	NS
18	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increased risk of debris deposit from water seeping up to the surface through the pavement e.g. calcium sulphate leading to reduced skid resistance.	Operation	Road surface	Weather and weather effects on traffic considered within pavement design.	Resilience achieved through design.	Low	Moderate adverse	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
19	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Construction site flooding during construction phase, excavations flooded and site roads impassable. Safety risk of slips, trips and falls to construction workers.	Construction	Drainage	Drainage on site to be suitably managed, to be specified within the EMP. H&S procedures to be further specified within the EMP.	Resilience achieved through management plan monitoring environmental impacts.	Low	Moderate adverse	NS
20	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased risk of flooding from river/streams, surface and groundwater sources.	Increased ground water level in winter may lead to flooding of underpasses.	Operation	Drainage	To be mitigated through drainage design.	Resilience achieved through design.	Low	Minor adverse	NS
21	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased soil moisture levels.	Increased risk of earthworks failure and landslides. Exacerbated by variance between high and low precipitation events and soil moisture levels.	Construction and operation	Earthworks	To be mitigated through geotechnical and drainage design. Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Low	Large adverse	NS
22	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increase likelihood of debris and sediment run-off.	Reduced capacity of attenuation ponds due to sediment build-up.	Operation	Drainage	Risk to be mitigated through the monitoring and maintenance procedures specified for the relevant attenuation ponds.	Resilience achieved through monitoring and maintenance of asset.	Medium	Minor adverse	NS
23	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increase likelihood of debris and sediment run-off.	Increased risk of debris washing into drainage gullies, blocking them. A blockage may result in flooding and resulting effects.	Operation	Drainage	Mitigated through drainage design and monitoring and maintenance procedures proposed for drainage systems.	Resilience achieved through design and monitoring and maintenance of asset.	Low	Moderate adverse	NS
24	High precipitation	+5% (2020s) & +23% (2080s) in winter	Increase in number of wet days may impact the damage to road surface.	Increase stripping rate of the road surfaces.	Operation	Road surface	This risk would be managed through the proposed maintenance	Resilience achieved through maintenance.	Low	Minor adverse	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
		precipitation rate.					regimes for road surface.				
25	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increase in number of wet days may impact the damage to road surface.	Wetter surface may lead to reduced skid resistance.	Operation	Road surface	This risk would be managed through the selection of suitable road surface material as well as through the proposed maintenance regimes for road surface.	Resilience achieved through design and monitoring and maintenance of asset.	Low	Moderate adverse	NS
26	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increase in number of wet days may impact the damage to road surface.	Increased likelihood of potholing, rutting and cracking from moisture entering and remaining in road surfaces.	Operation	Road surface	This risk would be managed through the proposed maintenance regimes for road surface.	Resilience achieved through maintenance.	High	Minor adverse	NS
27	High precipitation	+5% (2020s) & +23% (2080s) in winter precipitation rate.	Increased flow of groundwater.	Increased flow of groundwater causing accelerated weathering effects, weakening the embankment.	Operation	Earthworks	Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Very low	Large adverse	NS
28	Low precipitation	-6% (2020s) and -37% (2080s) in summer precipitation rate.	Increased risk of soil shrinkage around foundations of structures.	Potential risk of soil shrinkage impacting foundations, including bridges and other structures. Possible ground movement (check differential settlement due to different types of foundations).	Operation	Earthworks	To be confirmed. Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Very low	Large adverse	NS

Risk ID	Climate hazard	Trend or likelihood of climate hazard	Potential climate change impact	Potential climate change risk to scheme	Construction/ operation stage	Asset type	Existing or embedded mitigation measure	Result of mitigation measure on resilience	Hazard impact likelihood	Hazard impact consequence	Risk rating (NS = not significant; S =significant)
29	Low precipitation	-6% (2020s) and -37% (2080s) in summer precipitation rate.	Dry weather for extended periods of time could lead to increased desiccation of soils.	Reduced slope stability and potential earthworks failure during or immediately after summer storm events falling on desiccated soils.	Construction and operation	Earthworks	To be confirmed. Risk likely to be absorbed by conservative assumptions made during design.	Resilience achieved through design.	Low	Large adverse	NS
30	Low precipitation	-6% (2020s) and -37% (2080s) in summer precipitation rate.	Reduced inflow into attenuation ponds.	Anaerobic conditions may occur, risking die back of sediment collecting species, reducing attenuation pools functional capacity.	Operation	Drainage	Risk to be mitigated through the monitoring and maintenance procedures specified for the relevant attenuation ponds.	Resilience achieved through monitoring and maintenance of asset.	Medium	Minor adverse	NS