Essex Highways

Essex Highways Climate Adaptation Strategy

2024

RINGWAY JACOBS | Essex County Council

Essex County Council Essex Highways Climate Adaptation Strategy

Foreword - adapting to climate change in a warming world.

We recognise the vital role that the highways network plays in the lives of the residents as well as the travelling public and local businesses, especially as the county strives to respond to the cost-of-living crisis and other global issues.

While we celebrate the benefits of our transport network in providing movement for people, goods, and services essential to support our way of life and plans for prosperity, however, we must also plan to ensure the transport network remains safe, accessible, serviceable, and sustainable in a warming world.

The Council recognises the importance of reducing its carbon footprint and is striving to achieve net zero by 2050. The success or otherwise of the Council and wider global efforts to reduce emissions, however, will have a profound impact on the UK's climate in the second half of this century – whereas the level of climate change projected up to 2050 is now largely fixed.

The gap between the level of climate risk and climate adaptation is increasing, and urgent action is needed now for climate adaptation to reduce irreversible climate change impacts and lower the future costs from climate change. Only by preparing for the coming changes can the Council deliver its strategic objectives, which include protecting its residents, its assets, its natural environment, and its economy.

It is essential that decarbonisation and climate adaptation are progressed simultaneously with the same sense of urgency, however, for it is only through climate adaptation that net zero ambitions can be realised. Decarbonisation alone cannot prevent all climate change impacts because climate change is already happening due to past emissions of greenhouse gases. Similarly, adaptation alone would not restrict carbon emissions, with the result that global warming would increase to the point where adaptation would become ineffective or prohibitively expensive.

Early adaptation action is recommended strongly – before impacts occur – as this will reduce vulnerability to current climatic variability and will build in resilience where decisions have long lifetimes or long planning processes, such as with major infrastructure projects. Failing to do this will lead to 'lock-in' where delayed decisions, or decisions that don't consider the long-term climate risks, result in irreversible changes, increased climate change damages, or higher costs when larger and faster action is required later.

To some degree, the Council is already 'locked in' to highways network infrastructure asset maintenance and renewals processes, for some of these assets have very long service lives and were built at a time when environmental sustainability was not a primary consideration. While there is much that we can do to reduce carbon emissions arising from asset maintenance and renewals, however, improving the climate resilience of our assets must now also be a key consideration.

People, nature, infrastructure, and business are already vulnerable to a range of climate change risk impacts which is set to increase. The general pattern of change in the UK is towards warmer and wetter winters, hotter and drier summers, with high variability. These

changes will increase the exposure of the highways network infrastructure assets to weather-related hazards. The Council must rise to these increasing environmental challenges, to sustain a safe, accessible, serviceable, and sustainable highways network, to avoid disruption from cascading impacts to the multitude of services that are dependent upon it.

This 'Essex County Council Essex Highways Strategy for Climate Adaptation', along with 'Essex County Council Essex Highways Strategy for Managing its Green Estate' and 'Essex County Council Essex Highways Decarbonisation Strategy', is at the heart of the Council's environmental planning for its Highways assets.

Essex Highways has a long and successful history of working collaboratively with others to improve the benefits of outcomes, and this Strategy sets out how Highways embraces a unique opportunity to make a positive contribution to the environment.

This Strategy also verifies how the environment is a key consideration in all Highways related decision making, thereby supporting the Council's strategic priorities documented in Everyone's Essex, as well as promoting the Council's vision for 'Safer, Greener and Healthier Travel', and contributing towards achieving the County's target of net zero by 2050.

Cllr. Tom Cunningham

Portfolio Holder for Highways, Infrastructure and Sustainable Transport

Essex Highways' assets are currently managed via the Essex Highways strategic partnership, which is a collaboration between Essex County Council (ECC) and contractor Ringway Jacobs, which was formed on the 1st of April 2012.

This Strategy is a supplementary strategic document to the Highways Infrastructure Asset Management Plan (HIAMP) which forms the keystone of the Essex Highways Strategic Partnership whose objective is to deliver the Council's strategic priorities. This Strategic Partnership makes us very flexible and adaptive to change – such as the need to respond to the current environmental challenges. It also positions us well to realise the potential benefits from the Council's emerging plans to transform its services.

Both Essex County Council and Ringway Jacobs are committed to exploring the opportunities presented through this Strategy for improving the environment. At the same time, the partnership remains committed to the efficient and cost-effective management of Highways' assets, to deliver a transport system that supports sustainable economic growth and promotes the very best quality of life for the residents of Essex, not just for today but for the long term.

Tom Blackburne-Maze
Director Highways and Transport

Simon Butt
Operations Director

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1. Summary

The ability of a transport system to be resilient to extreme weather events caused by climate change is a key component of a well-adapted transport system. Only by preparing for the coming climate changes can the Council deliver its strategic objectives, which include protecting and caring for its residents, its assets, its natural environment, and its economy.

The ability of a transport system to be resilient to extreme weather events is broader than the ability of highways network infrastructure assets being climate resilient. However, highways network infrastructure assets are a salient aspect of the transport system in Essex, and this document is aimed at highways network infrastructure assets. A separate climate adaptation strategy tailored to the broader aspects of the transport system in Essex, may be developed in due course to support the emerging LTP(4).

The success or otherwise of the Council and wider global efforts to reduce carbon emissions will have a profound impact on the UK's climate in the second half of this century. However, the level of climate change projected up to 2050 is now largely fixed due to the volume of carbon emissions previously emitted.

As the Council strives to achieve net zero, therefore, it must also be ambitious in terms of climate adaptation to ensure the Council is resilient to the challenges of a warming world, for the gap between the level of climate risk and climate adaptation is increasing.

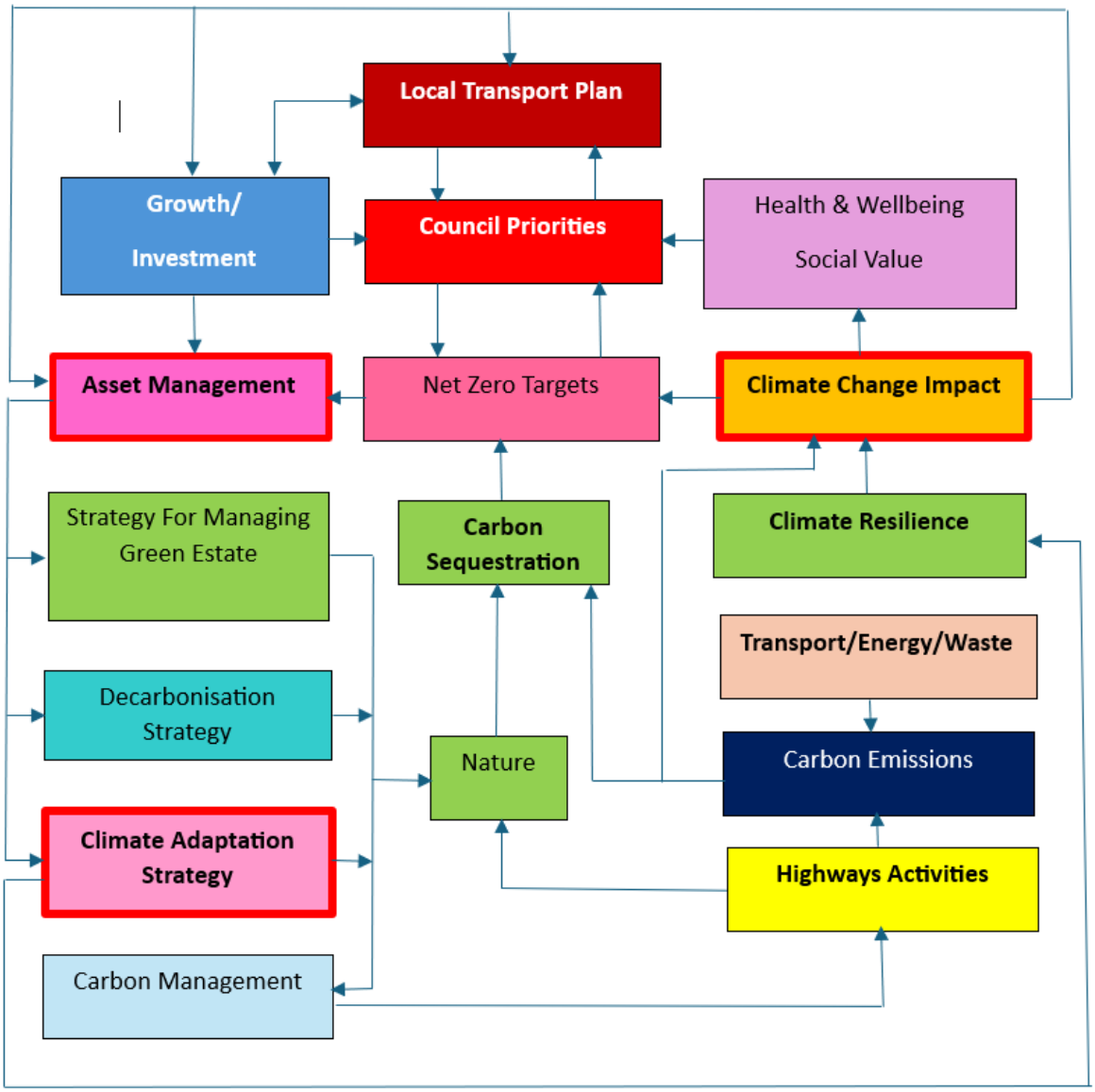
Climate adaptation is the adjustment to actual or expected climate change and its effects. In the context of Essex Highways (which hereafter will be referred to as Highways), climate adaptation is achieved through making its assets climate resilient; able to absorb, accommodate, and rapidly recover from the impacts of adverse and extreme weather conditions and gradual or erratic changes in weather patterns due to climate change.

Early adaptation action – before impacts occur – is recommended strongly, for it reduces vulnerability to current climatic variability and builds in resilience where decisions have long lifetimes or long planning processes, such as with major infrastructure projects. Failing to do this leads to 'lock-in' where delayed decisions, or decisions that don't consider the long-term risks from climate change, result in irreversible changes, increased climate change damages, or higher costs when larger and faster action is required later.

However, it is essential that decarbonisation and adaptation are progressed simultaneously with the same sense of urgency, for it is only through climate adaptation that net zero ambitions can be realised. Decarbonisation alone cannot prevent all climate change impacts because climate change is already happening due to past carbon emissions, and adaptation alone cannot prevent all climate change impacts because if carbon emissions are not reduced, adaptation may become ineffective or prohibitively expensive - especially at higher levels of global warming.

Chart 1 below summarises the Climate Change Activity Relationships between Asset Management, Decarbonisation, Climate Adaptation, Nature, Carbon Emissions, Carbon Sequestration, and Council Priorities.

Chart 1 Climate Change Activity Relationships



1.1 Summary – Recommended Climate Adaptation Activities

A climate change risk evaluation has been undertaken for all highways network infrastructure assets of material value. A weighted average climate change risk evaluation has been calculated for each corresponding Asset Group (group of assets/components which provide related services), proportioned on the respective gross replacement cost of the assets/components in question.

There is currently no set down process for Local Highway Authorities for this type of risk evaluation, but the methodology employed has been based broadly on the methodology for climate change risk evaluation undertaken routinely by National Highways. For detailed information on the risk evaluation process undertaken, please refer to, 'Section 5: Essex Highways Climate Change Risk Impact Assessment and Climate Adaptation Activities and Priorities'. For a summary of the recommended climate adaptation activities that have been indicated through the risk evaluation process, together with their associated timescales, please refer below:

ECC Essex Highways Climate Adaptation Activity and Time Line: 1 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Asset Management Planning	High Climate Change Risk Asset Group	Drainage Infrastructure	→ Review the current Surface Water Alleviation Scheme (SWAS) process and implement improvements to facilitate scheme submissions and improve site information.	2024/25
			→ Review current approach to environmental/cyclical maintenance of drainage assets to ensure fitness of purpose is sustained.	2025/26
			→ Undertake condition assessment of drainage infrastructure and determine programme to restore asset condition.	2025/26
			→ Rehabilitate grip drainage maintenance.	2025/26
			→ Work with external organisations and local communities to identify sites for sustainable urban drainage systems and natural flood management techniques.	Ongoing from 2025/26
			→ Draft business case for required investment. Explore external funding opportunities/submit to ECC Highways Commissioning. In first instance, investment for asset survey/condition assessment.	October 2025/26
Asset Management Planning	High Climate Change Risk Asset Group	Embankments/ Cuttings	→ Undertake an asset survey to identify location and extent of all embankments and cuttings, undertake condition survey to establish condition of assets.	2026/27
			→ Identify programme over time for those assets that require maintenance or additional geotechnical works to sustain stability.	2026/27
			→ Prioritise assets where there are condition concerns and implement monitoring regime.	2026/27
			→ Draft business case for required investment. Explore external funding opportunities/submit to ECC Highways Commissioning. In first instance, investment for asset survey/condition assessment.	October 2025/26
Asset Management Planning	High Climate Change Risk Asset Group	Roads	→ Within existing roads capital maintenance funding envelope, review current treatments with a view to making high priority routes more climate resilient.	2025/26
			→ Undertake appropriate lifecycle planning to identify the best combination of treatments over time that results in best value or least carbon emissions (may need to be a trade-off between the two).	2025/26
			→ Employ technical working group to investigate vulnerability of concrete roads, and also to investigate the resilience of current bituminous surfaces and sealants in high temperatures.	2025/26 for first assessment report
			→ Employ Technical Working Group to review operating procedures and treatment materials for flexible asphalt to ensure pot hole repairs are climate resilient.	2025/26 for first assessment report
			→ Work with drainage engineers to dovetail in with plans to restore drainage condition and rehabilitate grip drainage as well as implement sustainable urban drainage solutions and natural flood management techniques.	2025/26

ECC Essex Highways Climate Adaptation Activity and Time Line: 2 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Asset Management Planning	High Climate Change Risk Asset Group	Structures	Identify structures most at risk from scour and implement/review current monitoring regime to ensure appropriate.	2025/26
			Develop a shrink-swell layer ground related hazard map to identify structures most at risk from ground movement and investigate possibility of improving resilience.	2026/27
			Identify structures where expansion joints and bearings may not have been designed for anticipated extreme temperatures and carry out risk assessment to identify what actions may be required over time.	2026/27
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2026/27.	October 2025/26
Asset Management Planning	High Climate Change Risk Asset Group	Footways/ Cycleways	Undertake appropriate lifecycle planning to identify the best combination of treatments over time that results in best value or least carbon emissions (may need to be a trade-off between the two).	2025/26
			Increase capital funding for footways to address current condition concerns and review treatment programme to make priority hierarchies more climate resilient.	2025/26
			Increase revenue funding for footways to address current localised condition concerns.	2025/26
			Complete cycleways asset register and undertake condition assessment. Verify required condition with ECC Highways Commissioning/Cabinet Member and determine corresponding capital maintenance investment requirements over time.	2025/26
			Work with drainage engineers to dovetail in with plans to restore drainage condition and rehabilitate grip drainage as well as implement sustainable urban drainage solutions and natural flood management techniques.	2025/26
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2025/26.	October 2024/25
Asset Management Planning	High Climate Change Risk Asset Group	Essex Highways Green Estate	Asset Management Plans to reference Local Nature Recovery Strategy Opportunity Mapping to improve connectivity of habitat.	2025/26 for first planning report
			Install animal tunnels, gully grate ladders, recessed kerbs, otter shelves and the like to improve safe animal migration. Include in all new schemes where appropriate and retro fit at existing locations where appropriate.	2025/26 for first planning report
			Explore verge maintenance to encourage connectivity and wildflower growth.	2025/26 for first planning report
			Manage water resources better to retain water to release back into the environment, through exploring sustainable urban drainage systems and natural flood management techniques to prevent flooding. Key reference document: ECC Water Strategy - changing land use for water.	2025/26 for first planning report
		Essex Highways Green Estate	Explore potential for rain gardens, green bridges, and green walls/roofs to promote biodiversity and contribute to green infrastructure growth targets.	2025/26 for first planning report
			Work with ECC to ensure trees that are planted under Tree Plan are climate resilient species and that none is planted close to high-speed roads.	2025/26 for first planning report
			Work with external organisations and local communities to identify sites for implementing sustainable urban drainage systems and natural flood management techniques.	2025/26 for first planning report
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined by Essex Highways Climate Adaptation Work Group.	Funding year to be determined

ECC Essex Highways Climate Adaptation Activity and Time Line: 3 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Highway Lighting (including illuminated bollards and illuminated highway signs)	→ Monitor sensitivity to climate change, i.e. assess likely impact on asset service lives from increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, incidence of power outages, effects of high winds, impact of any rise in sea levels, and review/update asset replacement programme	First report by 2025/26
			→ For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			→ Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding Year to be determined
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Traffic Management Systems (including Zebra Crossings, Bus Telematics and Speed Cameras)	→ Monitor sensitivity to climate change, i.e. assess likely impact on asset service lives from increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, incidence of power outages, effects of high winds, impact of any rise in sea levels, and review/update asset replacement programme.	First report by 2025/26
			→ For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			→ Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding year to be subject to
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Vehicle Restraints (safety barriers)	→ Complete asset register and record results of detailed inspections in electronic format.	2025/26
			→ Determine asset condition and identify capital maintenance/asset replacement programme over time.	2025/26
			→ Monitor sensitivity to climate change, i.e. determine if increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, effects of high winds, impact of any rise in sea levels are impacting on asset service lives, and review/update strategy for detailed inspections.	Ongoing from 2025/26
			→ Liaise with suppliers to identify temperature range included in effective operation, to investigate potential impact of higher temperatures on containment performance. Sensitivity may be an issue for some older assets.	2025/26
			→ Review re-tensioning programme to ensure tensioned assets are maintained appropriately for higher temperatures.	2025/26
			→ Liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			→ Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2026/27.	October 2025/26

ECC Essex Highways Climate Adaptation Activity and Time Line: 4 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Winter Management Infrastructure (salt bins and weather stations)	Monitor sensitivity to climate change, i.e. assess likely impact on asset service lives from increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, incidence of power outages, effects of high winds, impact of any rise in sea levels, and review/update asset replacement programme.	Ongoing from 2025/26
			For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding year to be subject to be determined
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Public Rights of Way Infrastructure	Complete Public Rights of Way Improvement Plan to include support for Local Nature Recovery, Biodiversity Gain, and better management of water.	2027/28
			Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. This will require rehabilitation of condition assessment survey.	Ongoing from 2025/26
			For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding year to be determined
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Passenger Transport Infrastructure	Monitor sensitivity to climate change, i.e. assess likely impact on asset service lives from increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, incidence of power outages, effects of high winds, impact of any rise in sea levels, and review/update asset replacement programme.	Ongoing from 2025/26
			For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding year to be determined
Asset Management Planning	Low to Moderate Climate Change Risk Asset Group	Other Asset Groups: Cycle Monitoring Sites, Pedestrian Guard Rail, Vehicle Activated Signs, Non-Illuminated Traffic Signs, and other Street Furniture	Monitor sensitivity to climate change, i.e. assess likely impact on asset service lives from increased precipitation, ground movement, drought, high summer temperatures, more frequent storms, incidence of power outages, effects of high winds, impact of any rise in sea levels and review/update asset replacement programme.	Ongoing from 2025/26
			For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements.	Ongoing from 2025/26
			Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined through investigation.	Funding year to be determined
Asset Management Planning	Data Collection, Analysis and Reporting	Climate Change Impact	Investigate ways of recording climate related events so impact can be measured over time to reveal climate change, so the impacts of projected future weather trends are understood, supporting ongoing resilience of the system and proportioning investment. If possible, data should also identify cost of responding to events.	2025/26
		Weather Data	Use Met Office climate projections to help build a better understanding of the different scenarios which may occur due to global warming.	Annual report commencing 2025/26
		Traffic disruption data	Measure traffic disruption due to climate related events, including time taken to recover from events. If possible, measure impact in terms of costs.	Annually from 2025/26

ECC Essex Highways Climate Adaptation Activity and Time Line: 5 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Asset Management Planning	Data Collection, Analysis and Reporting	Adaptation Reporting to Central Government	→ Work with ECC Climate Action Team and others to fulfil climate adaptation reporting requirements to central government.	First reporting for Highway Authorities anticipated in 2024/25
		Adaptation Standards	→ Work with ECC Climate Action Team and others to fulfil climate adaptation standards required by central government: Process standards, which embed resilience into planning and decision-making processes; Service-level standards, which agree the performance or level of service of the system; Engineering/technical standards, which set requirements for how infrastructure should be built and maintained.	Central Government Guidance Pending
		Climate Risk Assessments	→ Undertake climate change risk assessment in accordance with government guidance (when published) and undertake reviews as required to ensure ongoing relevance.	Central Government Guidance Pending
		Government Tools to manage Climate Risks	→ Keep apprised of Government tools and metrics to assess and manage relevant climate-related risks and opportunities and develop implementation in required timescales.	Central Government Guidance Pending
Asset Management Planning	Data Collection, Analysis and Reporting	Understand Interdependencies	→ Work with other Transport Infrastructure Operators and external organisations to develop understanding of interdependencies to assess and mitigate risk of cascading failures. Join forums and Work Groups to expand knowledge and share best practice.	2025/26
		Asset Management Policy and Strategy	→ Local highway authorities have a duty under Section 41 of the Highways Act 1980 to maintain the highways network. Assess potential impact of climate change on maintenance and renewals policy and strategy and review/amend where applicable. Ensure the highways network is developed, managed, and maintained so it can withstand weather related risks, in an economically efficient manner.	Ongoing from 2025/26
		Respond to Incentivised Challenges	→ The Department for Transport (DfT) has plans to incentivise climate adaptation through funding agreements. Respond to any incentivised challenges, to maximise funding levels.	Central Government Guidance Pending
		Climate Adaptation Indictors	→ Explore the possibility of developing climate adaptation indicators to measure adaptation outcomes. Government guidance likely to be provided for this.	Central Government Guidance Pending
Developing a Climate Adaptation Culture	Communications	Raise Awareness	→ Implement a programme of communications to raise awareness of the need for climate adaptation. Promote benefits of climate adaptation: reduced disruption, environmental and social benefits, reduced maintenance costs, reduced legal claims, improved safety for highway users and staff.	Ongoing from 2025/26
		Minimise Impact of Climate Event	→ Develop a clear and effective communication strategy to highway users before, during and after an extreme climate event to minimise the impact of disruption on people and businesses.	Ongoing from 2025/26
	Asset Management	Training	→ Identify training collateral to raise awareness of requirement for climate adaptation, then roll out organisation wide. Training to include need for adaptive capacity.	Ongoing from 2025/26
		Collaborative Working	→ Work with other organisations such as Water Companies, Utility Companies, Local Communities, Environment Agency, as well as Parish, District & City Councils, to implement climate resilience.	Ongoing from 2025/26
		Coastal Implications	→ Work with ECC Environment Officer and Environment Agency, and other external organisations, to establish predictions in terms of sea level rise from climate change. Assess risk impact and promote awareness.	Ongoing from 2025/26

ECC Essex Highways Climate Adaptation Activity and Time Line: 6 of 6

Category	Sub Category	Division of Sub Category	Climate Adaptation Activity Description	Timeline
Maintenance & Construction	Design	New Schemes	Encourage design team to 'over design' drainage capacity for schemes, to account for future increases in precipitation.	Ongoing from 2025/26
		Maintenance and Asset Replacement	Encourage design team to ensure maintenance works and asset replacement are appropriately climate resilient.	Ongoing from 2025/26
	Procurement	Materials and Asset Replacement	Liaise with suppliers to obtain climate resilient materials and climate resilient asset replacements.	Ongoing from 2025/26
Health and Safety	Risk Assessment	Service Delivery Operatives	Assess climate change risk on safety of service delivery operatives and mitigate as far as practicable. Adapt business and operations to the changing climate, building the response into 'business as usual'.	Ongoing from 2025/26
		Climate Related Safety Incidents	Record and Monitor safety related incidents that are climate related, to review/amend climate change risk mitigation measures.	Ongoing from 2025/26
		Project Management	Project management to include assessments of climate risk to ensure continuity of service delivery as far as practicable.	Ongoing from 2025/26
		Premises	Undertake a climate change risk assessment of premises to determine impact on productivity and mitigate where practicable and affordable, i.e. implement measures to mitigate heat stress.	Ongoing from 2025/26
	Impact Monitoring	Health and Wellbeing/Social Value	Record and monitor impact of climate change on Health and Wellbeing of staff. Implement mitigation as far as practicable - links with 'Operational Delivery/Business Continuity/Productivity' and 'Plant & Fleet'.	Ongoing from 2025/26
Plant & Fleet	Risk Management	Fleet	Assess climate change risk to operational vehicles to support requirement to operate in high temperatures, as well as to cope with surface water, storms and high winds.	Ongoing from 2025/26
		Plant & Equipment	Assess climate change risk to plant and equipment to support requirement to operate in high temperatures, as well as cope with high winds.	Ongoing from 2025/26
Organisational Management	Risk Management	Senior Leadership: ECC Highways Commissioning and Essex Highways	Make climate risk management a leadership priority and integrate it into risk management governance. Use risk assessment to promote understanding and to integrate adaptation into long term planning and investment decisions.	2025/26
			Identify senior ownership of climate risks, and demonstrate accountability for managing climate risks.	2025/26
			Ensure wherever possible, that when extreme weather and associated impacts are experienced, people and goods continue to move safely and reliably.	2027/28
			Include adaptation and climate resilience in organisation objectives and asset management plans, to promote climate risk management	2027/28

2. Impact of Climate Change (*with reference to the publication 'June 2021 Independent Assessment of UK Climate Risk Advice to Government, For the UK's third Climate Change Risk Assessment (CCRA3)'.*)

2.1 Climate Change to 2050

Global and UK average land temperatures have risen by around 1.2 degrees C since the 1850-1900 period. UK sea levels have risen by 16cm since 1900. Episodes of extreme heat are becoming more frequent, with the chance of a hot summer like 2018 (the joint hottest summer on record) now up to 25% per year.

People, nature, infrastructure, and business are already vulnerable to a range of climate impacts which is set to increase. The UK is likely to experience around an additional 0.5 degrees C increase in annual average temperature by 2050, even under ambitious global scenarios for cutting greenhouse gas emissions. Key impact considerations include:

- **Continued change in the UK's climate should be expected.** In all scenarios for global emissions the UK's climate continues to change over the coming decades.

- **Changes in the UK's climate out to 2050 are largely insensitive to the trajectory of global greenhouse gas emissions.** Changes in the UK's climate to 2050 are not strongly sensitive to how successful the world is in cutting emissions.

- **Very long-lasting policy and investment decisions being made today need to consider a wide range of changes in climate for the second half of the century**. Some investments being made today (e.g. housing new build, major transport infrastructure projects) is expected to still be around in 2100. Future pathways of global emissions have a strong effect on the range of possible climates after 2050.

The general pattern of change in the UK is towards warmer and wetter winters, hotter and drier summers, with high variability. These changes will increase our exposure to weather-related hazards:

- Increases in average and extreme temperatures, in winter and summer. It is expected that a summer heatwave like that experienced in 2018 will occur on average one year in two by 2050.
- Changes to rainfall patterns, leading to flooding in some places at some times and water scarcity in others.
- Increased coastal flooding and erosion, alongside increasing sea temperatures and ocean *acidification.
- **Increased frequency and intensity of wildfires.
- Potential changes to other weather variables including wind strength and direction, sunshine and Ultraviolet (UV) levels, cloudiness, and sea conditions such as wave height.

*Ocean acidification is sometimes called “osteoporosis of the sea.” Ocean acidification can create conditions that eat away at the minerals used by oysters, clams, lobsters, shrimp, coral reefs, and other marine life to build their shells and skeletons.

**Subject of on-going investigation by Essex County Fire & Rescue Service.

2.2 Climate Change After 2050

After 2050, the extent of further climate change will depend on future global emissions of greenhouse gases. If the world cuts emissions rapidly to Net Zero, there is a good chance of limiting global temperature increase below 2ºC. If not, we will see higher levels of warming and much more extreme impacts. Uncertainties over the response of the climate system add further risks of very high temperature increases.

A 2ºC rise in global temperature above preindustrial levels by 2100 would see relatively small additional changes in many (but not all) aspects of UK climate beyond those already expected by 2050.

However, global warming reaching 4ºC above preindustrial levels by 2100 would see significant further changes to the UK’s climate beyond the changes by 2050. For example:

2.2.1 (scenario 4ºC above preindustrial levels by 2100): Much warmer and wetter winters:

The UK’s average winter could be around 1 - 3^{o}C warmer (depending on the location across the UK) than it was on average over 1981- 2000 and around 10 - 30% wetter. Wetter winters are expected due to both an increase in the number of wet days and the intensity of rainfall when it is raining.

2.2.2 (scenario 4ºC above preindustrial levels by 2100): Much drier and hotter summers with frequent and intense heatwaves

The UK’s average summer could be around 3 – 5^{o}C warmer (depending on the part of the UK considered) than it was on average over 1981- 2000 and around 20 - 40% drier. A summer as hot as in 2018 for the UK as whole would now be significantly cooler than the average summer. In a 4ºC scenario, a summer as hot as in 2018 would occur in every nine years in ten by 2100. Over 50% of days could have ‘very high’ fire risk in the peak months of the summer.

2.2.2.1 (scenario 4ºC above preindustrial levels by 2100): Much higher sea levels.

UK sea levels could continue to rise reaching around 55 – 80 cm above their levels in 1981-2000 (depending on the location across the UK).

Overall, these changes would see an increase in the rate of climate change compared to the recent decades. The faster rates of climate change can also create additional risks in themselves, particularly on ecosystems.

3. Key UK Climate Risks

Without further adaptation even in a 2ºC scenario, key Government and societal goals will become more expensive to achieve at best, and impossible to achieve at worst.

The UK faces risks from climate change to its natural environment, its food and water supplies, its infrastructure, the health and wellbeing of its population and disruption to its business.

Many of the risks are already material and all are expected to worsen under warming of 2 degrees C (by 2050), with escalating impacts in a 4ºC scenario (by 2100) even with high levels of adaptation.

Key Government and societal goals will be harder to meet because of climate change. These include ensuring a healthy and safe society with natural and cultural heritage protected; having a reliable and safe supply of food, water, transport, energy, and digital services; sustainable businesses; thriving plants, wildlife and ecosystems that underlie human life and economic activity; and reducing UK emissions of greenhouse gases to Net Zero.

4. Context: Purpose of this Climate Adaptation Strategy

Effective climate adaptation is essential for delivering the priorities of the Council. The impact of failing to adapt to climate change has the potential to be catastrophic.

The ability of a transport system to be resilient to extreme weather events is broader than the ability of highways network infrastructure assets being climate resilient. However, highways network infrastructure assets are a salient aspect of the transport system in Essex, and this document is aimed at highways network infrastructure assets. A separate climate adaptation strategy tailored to the broader aspects of the transport system in Essex, may be developed in due course to support the emerging LTP(4).

Climate adaptation, along with other activities to address environmental sustainability, is a maturing journey. Highways' current activities relating to climate adaptation may be regarded as being 'in its infancy', as we await adaptation guidance from central government along with climate adaptation reporting requirements. Highways recognises the urgency and importance of this matter, however, and is acting now.

This Strategy sets out how Highways has undertaken a provisional climate change risk evaluation assessment for each highways network infrastructure asset of material value, and

how it has identified a raft of recommendations for climate change risk mitigation. It also sets out how it will promote these recommendations, explore opportunities for investment, and how it will review the effectiveness of mitigation measures when implemented to ensure this strategy remains relevant.

This Strategy also sets out how risk evaluation will be reviewed at regular intervals, not only to comply with pending climate change risk assessment guidance from central government, but to align as far as practicable with the anticipated variabilities associated with climate change, i.e. as our learning and understanding increase so this Strategy will be refined.

The risks relating to climate change are not just limited to the resilience of Highways' assets. Highways' operational service delivery, operational premises, and business continuity are all subject to climate change risk, and recommendations to mitigate these aspects of climate change risk are included in this Strategy. Please refer to '1.1 Summary – Recommended Climate Adaptation Activities'.

Also included in this Strategy are recommendations for investigating the collection and use of data. It is envisaged that data collection and analysis will provide insight not only into how the climate is changing over time but into the impacts of climate change over time. This will assist with understanding and reviewing the effectiveness of mitigation measures when implemented, to ensure the highways network infrastructure assets remain climate resilient.

Note that the management of Highways assets in respect of new developments, is set out in the Essex Design Guide published on the ECC website and will therefore not be included in this Strategy.

4.1 Climate Adaptation Financial Challenges – unlocking additional funding.

This Strategy has the potential to support Incentivised Funding from Central Government, as well as unlock new funding opportunities and harness new resources.

This Strategy acknowledges the current financial challenges faced by the Council, which are influenced by global political events that are resulting in a cost-of-living crisis. However, Highways acknowledges how actions to address environmental sustainability will be a priority requirement from central government going forward, and how being able to evidence this Strategy will likely be linked to the availability of funding. In short, it is suspected that those Local Highways Authorities that can evidence how climate adaptation is part of their strategic planning are likely to be favoured for any incentivised government funding.

For example, the Department for Transport (DfT) Incentive Fund, which provided financial incentives to Local Authorities who could evidence sound asset management practices, was an initiative implemented by the DfT between 2015/16 to 2020/21. It is not currently clear

whether the DfT is preparing to rehabilitate the Incentive Fund in a different format. This Strategy therefore places ECC in a favourable position for evidencing continued sound asset management practices, including how it deals with the climate adaptation, thereby safeguarding any future Incentivised Funding from the DfT.

The DfT is also placing significant emphasis on business cases that address environmental challenges, therefore this Strategy will contribute to supporting bids to the DfT and other organisations for additional funding.

This Strategy, therefore, has the potential to unlock additional funding external to ECC as well as to harness the resource and commitment of local groups, external organisations, and businesses, to address climate change, for collaborative working will be key to achieving desired outcomes.

4.2 Financial Challenges – funding the cost of Climate Adaptation as well as any increases in Highways' maintenance costs.

The costs relating to Climate Adaptation are likely to be significant, both in terms of broad scoped capital funded asset maintenance and replacement as well as for ongoing environmental and reactive maintenance. The potential costs to the Council associated with failing to adapt to climate change, however, are likely to be far greater.

While it anticipated that much can be achieved through working efficiently within existing resources, the financial capacity of Highways to fund climate adaptation within existing budgets is extremely limited. In the first instance, Highways will explore opportunities to secure investment and any required additional resource from external sources. However, where increases in costs and resources cannot be secured from external sources, then these will be the subject of business cases submitted to ECC to determine if members wish to provide support. Given that investment and ongoing maintenance costs are likely to be significant, there will NOT be a presumption that funding, or resource will be forthcoming. However, Highways will explore fully data which will provide insight into the costs relating to the impact of climate change, with a view to demonstrating that the cost of climate adaptation is likely to be significantly less than the costs of climate impact to the Council.

Collaborative working with external organisations, such as Water Companies, Utility Companies, Local Communities, Environment Agency, as well as Parish, District & City Councils, to implement climate resilience, will be a key requirement for climate adaptation. It is also likely to unlock opportunities for additional funding and resource. Highways has a long and successful history of working collaboratively with others and will be continuing to investigate fully opportunities through this way of working.

4.3 Net Zero by 2050

The achievement of successful implementation of climate adaptation is viewed as a critical requirement if the Council's net zero ambitions are to be realised.

Recently, there has been heightened awareness in political and public perception of the impacts from climate change and environmental decline. The urgency for action has been universally agreed with the COP21 Paris Agreement, and the UK is the first country to enshrine in law a commitment to reducing greenhouse gas emissions to net zero by 2050.

However, it is essential that decarbonisation and adaptation are progressed simultaneously with the same sense of urgency, for it is only through climate adaptation that net zero ambitions can be realised.

This Strategy supports the Council's net zero ambitions through setting out how Highways has undertaken a climate change risk evaluation assessment for its highways network infrastructure assets and from this has identified a raft of recommendations relating climate adaptation.

4.4 'Everyone's Essex, our plan for levelling up the county, 2021-25'.

This Strategy supports 'Everyone's Essex'.

The document 'Everyone's Essex, our plan for levelling up the county, 2021-25' sets out the Council's twenty strategic priorities that will make Essex a stronger county, not just for us, but also for our children and their children. These priorities fall into four categories: Economy, Environment, Health, and Family.

Under the Environment category, the Council pledges to work to hit our net zero targets, by ensuring the council significantly reduces its carbon footprint, whilst also supporting an acceleration in the progress towards active and alternative forms of travel across the county. This includes a step change in sustainable travel across the county, by growing passenger transport and active travel. The Council also pledges to help all our communities to enjoy a high-quality environment, by making them more resilient against flooding, heat stress and water shortages, by enhancing our county's green infrastructure and by reducing air pollution. These objectives are referenced in the Essex Climate Action Plan 2021-25:

One of Essex County Council's four strategic aims is a core commitment to a High-Quality Environment. This includes objectives to:

1. Deliver on net zero targets,
2. To deliver a step change in sustainable travel, helping to support our transition to net zero and climate resilient housing developments,
3. To reduce waste and deliver a more circular economy,

4. To work with communities and businesses providing advice and support to enable them to take action to reduce greenhouse gas emissions and build their own climate resilience,
5. To help our communities enjoy a high-quality environment, by making them more resilient against flooding, heat stress and water shortages, by enhancing our county's green infrastructure and reducing air pollution,

ECC is therefore committed to ambitious climate action and is embedding this across every aspect of its service delivery. Climate action and 'Levelling Up Essex' are key organisational priorities. Whilst they are distinct in definition, they are fundamentally interconnected due to the potential risk impacts posed by climate change. It is viewed as imperative that ECC plans to tackle climate change and improve the environment also address inequalities and support the Levelling Up agenda.

This Strategy promotes 'Everyone's Essex', by setting out how Highways has identified and potentially will implement recommendations relating to climate adaptation which will support these priorities and pledges. For example, it will contribute to protecting the natural environment, through sustainable urban drainage systems and natural flood management techniques. These activities will also support the Essex Water Strategy, in particular the aspect relating to 'changing land use for water'.

The publications 'ECC Green Infrastructure Strategy' and the 'Essex Green Infrastructure Standards', champion for the enhancement, protection, and creation of an inclusive and integrated network of green spaces. Observing the principles within these publications will assist with ensuring quality and consistency in the provision, management, and stewardship of Green Infrastructure, which is an essential part of creating and sustaining green spaces for the benefit of people and wildlife. Sustaining an integrated network of green spaces is also essential for supporting net zero ambitions through the sequestration of carbon emissions. The principles within these publications are supported by this Climate Adaptation Strategy.

The publication 'Net Zero: making Essex Carbon Neutral by 2050', by the Essex Climate Action Commission, states: "The natural world is our best ally in reversing climate change – it is key to absorbing and storing carbon." This Climate Adaptation Strategy, therefore, also supports the Essex Climate Action Commission, through promoting Local Nature Recovery and biodiversity and through improving connectivity between habitats. In addition, through completion of its Public Rights of Way Improvement Plan (a statutory undertaking), Highways will improve access to open green spaces. All these activities will also promote health and wellbeing and add social value.

4.5 The Local Transport Plan(4)

This Strategy has the potential to promote every key outcome objective within the emerging LTP(4).

The Local Transport Act 2008 requires Transport Authorities such as Essex County Council to develop a Local Transport Plan (LTP) that covers all aspects of transport. The current LTP, which is the third iteration of this strategy, was adopted in 2011 and sets out the Council's aspirations for improving travel in the county, demonstrating the importance of meeting these aspirations to achieving sustainable long-term economic growth in Essex and enriching the lives of our residents. To enable delivery of this vision, the LTP contains a suite of 15 transport policies that apply throughout Essex.

A revised LTP(4) is currently being developed that will replace LTP(3). LTP4 will be evidence led and focussed upon the delivery of strategic themes linked to the delivery of wider Essex and Government priorities, including actions to address environmental challenges. LTP4 will include updated policies that will govern how ECC addresses the environmental impacts of travel and ensure long term sustainability. The LTP will also consider mitigation necessary to ensure resilience to the impacts of climate change.

In August 2022, an Essex Transport Policy Note was published as an addendum to the LTP. This stated the position of ECC regarding decarbonisation of transport, with reference made to proposed development of the policy to support the transition to sustainable zero carbon transport. The note also stated the adoption of ECC's 'Safer, Greener and Healthier Travel' vision, as well as its support for the Essex Climate Action Commission's Report: 'Net Zero, Making Essex Carbon Neutral'.

The emerging LTP(4) promotes the need for a transport network that is safe and 'feels safe' for users and has a secure, long term future. It also advocates longer term planning to ensure the long-term security of the transport network, which is essential for strategic connectivity to support business, to support growth hubs that connect to rural hinterlands, and to support connections to urban areas.

This Strategy for climate adaptation will promote every key objective within the LTP(4), through its recommendations which are aimed at sustaining a safe, accessible, serviceable and sustainable highway network, through making it resilient to the impacts of climate change now and in the future.

4.6 The Essex Highways Strategic Partnership, and the 'Safer, Greener and Healthier Travel' Vision

ECC owns a vast network of highways network infrastructure assets. The ways in which these assets are maintained and renewed to make them climate resilient, including its green estate, will have a significant impact on the safety, accessibility, serviceability, and sustainability of the highways network. It will also have a significant impact on the Councils ambitions for achieving net zero and making Essex greener. This Strategy, therefore, supports the 'Safer, Greener and Healthier Travel' vision.

ECC owns and maintains a vast network of highways and transportation assets: over 5,000 miles of roads, together with a footway network of 4,000 miles, and 4,000 miles of Public Rights of Way. In addition, there are over 1,500 bridges and other highways structures, over 130,000 streetlights, 11,700 illuminated signs, 1,900 beacons and wall lights, and over 2,700 lit bollards, and over 500 Traffic Signals and Crossings. There are also other asset groups such as cycle tracks, highway gullies and drains, vehicle restraint systems, traffic signs, passenger transport infrastructure and bus telematics.

These assets are currently managed via the Essex Highways strategic partnership which is a collaboration between ECC and contractor Ringway Jacobs. (The exception to this is passenger transport infrastructure and bus telematics infrastructure which is managed wholly by ECC). The strategic partnership contract was established via the Highways Strategic Transformation, and commenced on the 1st April 2012 and is currently set to terminate on 31st March 2027. Arrangements for the Future Highways Programme (Highways services from 1st April 2027) are currently the subject of planning being undertaken by ECC Transformation Team and have yet to be finalised.

The delivery of maintenance, asset renewals, and improvement works on this vast network of assets, therefore, has the potential for enormous impact on climate resilience as well as impact on the environment. However, rather than waiting until commencement of new highway service arrangements, Highways is acting now in terms of reviewing its potential to support actions to make assets resilient to climate change. This Strategy is therefore in keeping with the Council's vision for 'Safer, Greener and Healthier Travel' for current and future users of the transport network.

4.7 United Nations Sustainability Development Goals, and Essex Social Value

The United Nations Department of Economic and Social Affairs, 2030 agenda for sustainable development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership. They recognise that ending poverty and other deprivations must go hand-in-hand with strategies that improve health and education, reduce inequality, and spur economic growth – all while tackling climate change and working to preserve our oceans and forests.

Social value is defined through the Public Services (Social Value) Act 2012 which came into force in January 2013 and requires all public sector organisations (and their suppliers) to look beyond the financial cost of a contract and consider how the services they commission and procure might improve the economic, social, and environmental well-being of an area.

The perspective of Essex County Council is that social value is the view beyond price that looks at the additional value organisations can bring to our communities, and it works with its suppliers to produce wider benefits for Essex.

The recommendations within this ECC Essex Highways Climate Adaptation Strategy will support all forms of social value.

5 Essex Highways Climate Change Risk Impact Assessment

A climate change risk impact assessment has been undertaken for all highways network infrastructure assets of material value. From this information, a weighted average risk impact assessment has been calculated for each Asset Group, based on the Gross Replacement Cost value of the asset in question with reference to the overall Gross Replacement Cost for the Asset Group. This is explained in more detail in the risk assessment process set out in 'Appendix A. Risk Assessment Methodology and Outcomes'. The outcome of the risk evaluation in terms of recommendations for climate adaptation activities are detailed in '1.1 Summary – Recommended Climate Adaptation Activities'.

The key climate change risks to highway network infrastructure assets are detailed below. For a summary of climate change risk assessment outcomes for each asset group, please refer to '6. Summary of Climate Change Risk Assessment Outcomes on the Service Lives of Highways' Asset Groups'. For more information, however, including a climate change risk impact posed by each Asset Group to each key Council Risk, please refer to 'Appendix A. Risk Assessment Methodology and Outcomes'.

5.1 Drainage Assets

The reliability of the drainage assets is a key internal interdependency as the overwhelming of the drainage system can cause the pavement and the underlying geotechnical assets to become and remain water-logged, leading to its premature deterioration.

The risks and impacts to our assets and functions result from the interaction of two different climate variables: temperature and rainfall. Summers are projected to become hotter and drier, and an increased likelihood of extreme storms will result in higher intensity precipitation. This is likely to be particularly evident in the southeast where higher temperatures, higher intensity rainfall, and winter rainfall is projected and there are more clay soils present, which increase the sensitivity of the region.

In hot, dry conditions, soil shrinks and cracks. Subsequent rainfall is then able to penetrate deeper into the soil, which increases the speed at which soil becomes saturated, increases pore pressure, and causes slope defects and failure. These impacts will be most acute in the high plasticity soils of Southeast England.

During prolonged hot, dry periods, soil dries out and shrinks, which can destabilise and damage underground assets. For drainage assets, this will be a particular issue for outfalls which may become dislodged, or pipes which may crack and leak. Damage to drainage assets will exacerbate the impact of precipitation when it does occur, especially if the precipitation event is sudden and heavy.

Fluvial flooding and increased river levels also impact the effectiveness of drainage assets where outfalls to rivers are not able to discharge effectively. This localised problem can lead the drainage system to back up, resulting in the highway not draining properly and inundating the road. It may also have structural integrity consequences on the drainage assets themselves.

It may be beneficial to investigate the risks to the existing drainage asset to identify and prioritise specific locations that may need proactive intervention in near future years. This should include evaluating natural flood management to inform a review of nature-based solutions as a form of adaptation.

There will also be merit in monitoring the longer-term trends of severe storm impact on drainage resilience (i.e. the percentage of carriageway that does not have a significant susceptibility to flooding). In turn, this will offer the potential to track asset performance against the current design specification and can inform future asset performance requirements.

5.2 Geotechnical Assets

Approximately one third of defects in geotechnical assets are related to excess water. In the worst case, slopes can fail and deposit material on the carriageway, which can be dangerous and disruptive while the issue is resolved. This risk is exacerbated when earthworks are constructed across an existing landslip. Drainage is key to earthwork stability, but drainage systems are often not well maintained.

If the drainage assets are overwhelmed, then standing water may remain at the toe of earthworks which are not designed to be submerged. This risk could become more frequent in the future if drainage capacity is not sufficient to allow for higher precipitation levels.

It would be useful to review the impact of drainage on ground related and geotechnical assets.

Managing the maintenance of highways geotechnical assets includes a risk-based approach to asset management and maintenance, encompassing a range of factors including flood risk. It is recommended that Essex Highways undertakes a climate change adaptation assessment relating to its geotechnical assets.

Note that over the last twenty years, Essex Highways has experienced numerous, unexpected, and costly embankment failures. The extent and condition of geotechnical assets such as embankments is currently unknown.

5.3 Structures

Water is the main cause of deterioration of structures.

5.3.1 Scour

Fluvial flooding is a major risk to bridges, leading to scour (which is the main cause of bridge failure in the UK) and damage due to the impact of debris carried by flood waters.

Scour is the erosion of soil or rock below or near the foundation of a structure due to hydraulic effects. Increased scour at bridges could potentially compromise structural integrity, which could ultimately lead to failure. Scour and other hydraulic failures mostly occur at older structures with shallow foundations and structures at tidal locations. Structures built alongside watercourses, particularly tidal rivers, are at the highest risk. Masonry arch bridges are particularly susceptible to failure due to scour and other hydraulic actions. Even the lower projection for potential rise in mean sea levels could increase scour potential along the coastline.

Storm surges can lead to scour and damage due to impact from debris carried by water and could become more common in the future due to sea level rise and changes to wind patterns.

Design of highway structures for hydraulic action, includes scour assessment requirements and guidance including requirements to apply climate change allowances. Since many Highways structures were built in previous times, it is recommended that Highways undertakes a climate change adaptation review relating to the design of its highway structures which are subject to scour, to ensure that adequate allowance has been made for climate change, and to determine a plan of mitigation for assets at significant risk.

5.3.2 Risk of Ground Heave

Changes in annual precipitation will impact groundwater levels and therefore earth pressure exerted on structure foundations. The increased difference between wetter winters and drier summers could result in increased ground movement and heave, reducing headroom and causing differential settlement and potentially the failure of components; it may also lead to a need for increased drainage and stronger foundations. It is recommended that a shrink-swell layer ground related hazard map is developed, and for those structures' assets considered most at risk, an investigation is carried out into their climate resilience, from which a corresponding improvements and investment plan be produced.

It is also recommended that research is undertaken into different soil types to understand which are more sensitive to impacts affecting structures so the interdependency between structures and geotechnics can be better understood.

5.3.3 Expansion Joints and Bridge Bearings

Expansion joints may fail if the temperature exceeds that for which they are designed. This impact is a particular concern regarding older structures, or those which have been built

with errors. Bridge bearings are also vulnerable to temperature change. The bearings are designed to accommodate the movement of the bridge for a temperature range which is set at the time of installation. Climate change could potentially result in the range being exceeded which could lead to the bearings failing. Thermal movements can be caused by changes in the overall temperature of the structure as well as the temperature difference within each component.

5.3.4 Thermal Effects and Wind Loading

Thermal effects and wind loads could influence other structures' behaviour, such as gantries or tunnels.

Structures are often exposed to high winds, and wind is the most common cause of closure for critical bridges. Bridges are often in open, exposed locations, and smaller structures such as gantries are vulnerable to wind action due to their height. Smaller structures are also more vulnerable to increases in wind loading, particularly if errors have been made in their design or construction.

5.4 Roads

During rainfall events, water soaks into the porous upper layers of the pavement surface and percolates downwards. This weakens the asphalt and causes it to degrade, leading to faults and potholes. Prolonged water saturation will also have adverse effects on the stability of granular foundation layers and can result in substantial deformation. This both decreases the support from the lower layers and weakens the material and can lead to rutting.

When the temperature dips below freezing point, water pores in the pavement freeze and expand, exerting pressure on the pores and causing them to increase in size. This allows more water to enter the pavement during subsequent rainfall events, which once again freezes and expands when the temperature falls below freezing. This causes premature pavement failure. This impact is caused by a combination of precipitation and variable temperatures, particularly in winter when the temperature is low. This problem is most frequently encountered after extreme or prolonged precipitation events. Whilst mean temperatures are projected to increase in winter, so is precipitation.

In high temperatures, concrete slabs expand and can cause structural failure. Roads with a concrete surface course are a particular problem, although those with concrete sub-layers overlain with asphalt also incur this risk. National Highways plans to phase out existing concrete roads by 2045, including those with an asphalt overlay.

In high temperatures, asphalt softens, ruts, and, in extreme cases, melts. This leads to an uneven road surface and early replacement of the surface course. Although the exact relationship between air temperature and road surface temperature is unclear, surface temperatures of 50°C have been recorded on sunny days with air temperatures approaching 30°C.

Sub-optimal conditions in summer, for example very hot, sunny conditions, pose difficulties for laying conventional hot-mixed asphalt. Freshly laid asphalt retains heat and remains soft for longer and is therefore susceptible to rutting if the road is opened before it has fully cooled. As the cooling process takes longer, this also leads to longer road closures and more disruption due to the resurfacing process. Warm mix asphalts take less time to cool and may prove to be a useful solution for highway maintenance in hot ambient temperatures.

Weather conditions impact the quality of new and replacement surfaces that are laid, and some road surfacing materials have temperature and weather restrictions. If asphalt is laid in particularly cold or windy conditions, the quality of the result can be poorer, since the asphalt cannot be sufficiently worked on site prior to cooling, and the lifespan of the resulting surface can be shorter. Climate change has the potential to make these conditions more common, meaning that the window of opportunity for surfacing works during winter may be shorter and/or replacement cycles may become shorter.

With regard to rutting, National Highways gathered feedback from surfacing contractors through liaison with the Mineral Products Association (MPA) on the current surfacing material of choice: Thin Surface Course Systems (TSCS). It found that the TSCS have a low propensity to rut, compared to the other predominant material type: Hot Rolled Asphalt (HRA). This matter may be investigated by the Essex Highways Technical Working Group, along with investigation into joint sealants, to ensure it is appropriate for the period up to 2050s. This Work Group should be commissioned to monitor operational feedback regarding problematic weather conditions for laying pavement materials and the applicability of current standards and specifications.

Jointed rigid pavements require joint sealants. The material employed may need to be reviewed to ensure it is climate change resilient and therefore will not melt under increased road surface temperatures. The confidence of sealants being within the bounds of extreme temperature rises, may vary depending on the concrete pavement asset type. The confidence may be higher for concrete pavements designed to current standards (CD 226) but may reduce within the legacy concrete pavement assets (e.g. 30-year-old jointed pavements). The Essex Highways' main road resurfacing contractor, Eurovia, is already making progress in ensuring its bituminous products are climate resilient.

UV light is damaging to the surface course of roads, as it causes degradation and premature aging of the surface course. However, the impact of climate change on the amount of UV radiation reaching the ground is complex and uncertain. Climate projections suggest that the UK is likely to receive more solar radiation due to less cloud cover, and therefore more UV radiation, particularly during summer may occur.

5.5 Green Estate

The potential increase in wind speed as well as the increased occurrence and frequency of storms, combined with the planned tree planting for carbon offsetting – and hence a larger number of trees in the soft estate - could lead to increased damage to and resultant loss of trees. This could lead to a resultant risk to customer disruption and workforce maintenance

regimes. When specifying tree species for nature recovery or carbon emissions absorption, species needs to be adaptive to the effects of long-term climate change.

5.6 Traffic Management Systems

Near surface wind speeds are predicted to increase for the second half of the 21st century and is most likely to occur during winter season. Installations such as signs or electronics, which are an increasingly important element of traffic management, may be damaged or blown away in strong winds.

5.7 Wildfires

This risk is greatest in absolute terms in the south and southeast and will continue to increase. The potential risk is that wildfires either start directly on Essex Highways or on third party land and subsequently spread on to the soft estate bordering the road network. This not only damages the road network itself, requiring more management, but the smoke resultant from wildfires would cause unsafe driving conditions.

Essex County Fire and Rescue Service is continuing to investigate climate change risk.

6. Summary of Climate Change Risk Assessment Outcomes on the Service Lives of Highways' Asset Groups.

The outcome of the climate change risk assessments on the service life of each Asset Group, for each of the time periods included in the assessment process, is categorised as per Table 1. below and is detailed in Table 2 below.

Table 1 Risk Evaluation Category

Risk Category	Risk Category Item Number	Comments/Conditional Formatting
Nill	1	Category of least risk
Negligible	2	
Slight	3	
Moderate	4	
Strong	5	
Major	6	
Severe	7	Category of greatest risk

Table 2: Climate Change Risk to Service Life of Asset Group (prior to mitigation)

Asset Group	Climate Change Risk To Service Life of Asset Group (weighted average of risk for all assets/components per Asset Group, based on Gross Replacement Cost)		
	Current Risk 2024/25 (baseline)	**Estimated Risk 2050 compared to baseline**	**Estimated Risk 2100 compared to baseline** (assuming high emissions scenario. Note, a low emissions scenario will be similar to Estimated Risk 2050)
Cycle Monitoring Sites	Negligible	Negligible	Moderate
Drainage Infrastructure	Slight	Moderate	Severe
Embankments/Cuttings (including A130)	Slight	Strong	Severe
Essex Highways Green Estate (including A130 but excluding verges and Public Rights of Way)	Negligible	Slight	Strong
Footways/Verges/Cycleways (including A130)	Slight	Moderate	Severe
Highway Lighting (including illuminaed bollards and illuminated highway signs)	Negligible	Slight	Strong
Passenger Transport Infrastructure	Negligible	Slight	Strong
Pedestrian Guard Rail	Negligible	Slight	Moderate
Public Rights of Way Infrastructure	Negligible	Slight	Moderate
Roads Including A130 (but excluding embankments/cuttings)	Slight	Strong	Severe
Structures (excluding A130)	Slight	Strong	Severe
Traffic Management Systems (including Zebra Crossings, Bus Telematics and Speed Cameras)	Negligible	Slight	Strong
Vehicle Activated Signs	Negligible	Slight	Moderate
Vehicle Restraints (safety barriers)	Negligible	Slight	Strong
Winter Management Infrastructure (salt bins and	Negligible	Slight	Strong
Structures A130	Negligible	Moderate	Major
A130 Street Furniture (excludes structures, roads, footways, verges, embankments, etc.)	Negligible	Slight	Strong

Appendix A:

Essex Highways' Approach to Climate Change Risk Assessment

1. Introduction to Climate Change Risk Assessment Methodology.

There is no current guidance to Local Authorities on how a climate change impact risk assessment should be undertaken for Highways Network Infrastructure Assets. However, a provisional climate change risk impact assessment has now been undertaken for all Essex Highways Network Infrastructure Assets of material value. In broad terms it follows the methodology employed by National Highways, which is documented in their publication, 'Preparing for climate change on the strategic road network - third adaptation report under the Climate Change Act', published in January 2022.

The approach to the Essex Highways risk assessment process is detailed below, but please note that it is a provisional risk assessment, and therefore the details below will be subject to change to ensure relevance, either following review or following clear government guidance on how a risk impact assessment must be undertaken.

2. Climate Change Risk Assessment Methodology: 8 Steps

2.1 Risk Assessment Methodology Steps:

Step 1: Identification of highways Asset Groups within scope and each corresponding asset/component of material value,

Step 2: Identification of relevant climate variables and their associated risks,

Step 3: Identification of Risk Assessment Time Periods (climate change risk is generally expected to increase with time, at least up to 2050).

Step 4: Assessment of Likelihood (Vulnerability); and Assessment of Consequence (Impact) relating to the **climate change risk impact to the service life** of each asset/component identified in Step 1 above.

Step 5: Assessment of Risk Evaluation (Likelihood X Consequence) for each material asset/component of each Asset Group identified in Step 1.

Step 6: Weighted average Risk Evaluation (Likelihood X Consequence), for each Asset Group.

Step 7: Identify key Council Risks relating to Essex Highways Network Infrastructure Assets and evaluate the **Climate Change Risk Impact of each Asset Group on each key Council Risk.**

Step 8: Climate Change Risk Evaluation Results and corresponding Adaptation Activities.

With reference to Steps 1 – 7 above, risk evaluation was undertaken on two different levels:

- Steps 1 – 6 above detail the climate change risk evaluation to the service life of each highway infrastructure network asset/component of material value. The asset registers employed were those associated with the Highways Network Infrastructure Asset Valuation, which included financial information relating to Gross Replacement Cost (GRC) relating to the inventory of each asset/component. A weighted average risk evaluation for each Asset Group was also calculated, based on the Gross Replacement Cost of each asset/component as a % of Gross Replacement Cost for the Asset Group. For more information, please refer to '2.8 Step 6: Weighted Average Climate Change Risk Evaluation Category for each Asset Group'.

- Step 7 above, relates to the Climate Change Risk Impact of each Asset Group on each key Council Risk. For example, the climate change risk impact of the Roads Asset Group to the key Council Risk 'Accessibility, Serviceability and Sustainability of the highways network'. While this is different to the risk evaluation of the service life of the asset/component in question, it is reasonable to assume that if climate change risk to the service life of the asset is significant, this will likely have a related significant impact on key Council risks.

- Step 8 above, shows the results of the risk evaluation, and details subsequent risk mitigation measures and activities. The climate change risk evaluation has identified the assets/components most at risk in terms of service life and corresponding maintenance liability, as well as the impact that unmitigated risk would have on key Council Risks. Adaptation measures and activities have been identified with a view to mitigating Council risk through making assets/components more resilient to climate change. For more information, please refer to '1.1 Summary – Recommended Climate Adaptation Activities'.

2.2 Step 1: Highway Network Infrastructure Assets/Components within Scope

- **Drainage** (e.g. gullies, outfalls and culverts, soakaways, interceptors, attenuation tanks, ponds, pipes, ditches, grips, and channels)
- **Geotechnical Assets** (e.g. embankments and cuttings)
- **Roads** (e.g. road surface and underlying structural layers)
- **Footways and Cycleways** (surface and underlying structural layers)

- **Structures** (including bridges, footbridges/cycle bridges, culverts, signals gantries, retaining walls, cellars, and tunnels)
- **Highway Lighting Assets** (including lighting columns and high mast columns, lanterns, feeder pillars, tele cells, base stations, lit signs, bollards, sub way units, beacons, wall lights, pole mounted lights and roof mounted lights, and private cable network).
- **Highway non-illuminated signs** (including poles)
- **Intelligent Traffic Management Systems (ITS)** (including traffic signal junctions and crossings, school crossing flashing lights and emergency vehicle access, variable message signs, closed circuit t.v. systems, car park monitoring systems, automatic number plate recognition systems, bus gate cameras, over height detector systems, trafficon video detection systems, dambarch signs and controllers, green wave demand units, traffic counters, vivacity sensors, air quality sensors, cycle monitoring sites, Zebra Crossings, Bus Telematics assets and Information Kiosks and totems)
- **Passenger Transport Infrastructure** (including bus shelters, poles, flags, information boards and timetable cases)
- **Public Rights of Way Infrastructure** (including bridges, board walks, bollards, handrails, finger posts, safety barriers, gates, steps, stiles, way marker signs, motor bike inhibitors)
- **Vehicle Restraints, Pedestrian Guard Rails and Other Fences**,
- **Vehicle Activated Signs**
- **Safety Cameras**
- **Green Estate** (including trees and hedgerows)

2.3 Assets/Services Not in Scope.

This climate change risk assessment is focused on Highways Network Infrastructure Assets as well as the impact these can have on related key Council risks. It is recognised, however, that climate change risk extends beyond physical assets and the services to which they provide access. The risks below will be referenced in the overarching Climate Adaptation Strategy Activities to ensure they are included in recommended mitigation measures.

- **Health and Safety: Operational Delivery** (estimated risk to the highways service delivery staff, of a high or dangerous impact incident occurring). Note: the impact of climate change on assets can accentuate the risks to road workers during service delivery. For example, increased incidence of surface water flooding or exceptionally high winds. By identifying and implementing actions to reduce these risks, we will have systems in place which document and better prepare Essex Highways for weather and climate-related threats.

- **Business Delivery/Continuity** (estimated risk of disruption to the provision of Highways Services due to an incident occurring). Note that the work we do can be affected by climate change. Project management needs to include assessments of climate risk to ensure that delivery is not compromised. People, including our workforce, suppliers and road users may all be faced with climate related risks, from increased levels of flooding to the wellbeing and productivity impacts of high summer temperatures. We must understand these risks to ensure they are mitigated as far as practicable.

2.4 Step 2: Identification of relevant climate change variables and their associated risks

The baseline risk evaluation process identified the following climate hazards:

- Increase in mean summer temperature,
- Increase in extreme summer temperature,
- Change in extreme winter temperature; likely decrease,
- Increase in winter precipitation,
- Increase in mean annual precipitation,
- Change in extreme precipitation; likely increase,
- Change in wind and storminess; likely increase in wind strength and frequency of storms,
- Rise in sea level,
- *Change in fog; likely decrease in this variable.
- *Change in solar radiation exposure; possible increase in UV,
- *Change in snowfall; likely decrease,
- *Change in freeze-thaw cycles; possible decrease.

*The impact of change is excluded in the risk assessment, either because the risk is reducing compared to current risk levels or there is insufficient information on this hazard (such as possible increase in UV).

The above were distilled down into the following six categories:

- Likely increase in extreme summer temperature; increase in mean summer temperature,
- Likely increase in winter precipitation; increase in mean annual precipitation; likely increase in extreme precipitation,
- Likely increase in wind strength and frequency of storms,

- Risk from power outages due to storms,
- *Risk from Rise in sea level,
- Risk of ground movement, heave

The above six climate categories, reflect the main risks for highways network infrastructure assets which will likely result from: changes in precipitation (flooding as well as drought) and increases in temperatures and prolonged and more frequent hot spells. Of particular relevance will be risks around ground saturation affecting the stability of assets, destabilisation of earth works due to standing water, scour damage to structures, the overwhelming of pavements and other impermeable surfaces due to fluvial and pluvial flooding, and structures' expansion joint failure. It is also possible that some structures' bearings may not be appropriate for operation in higher temperature ranges. It is also possible that under a high emissions scenario, in the latter half of the century, concrete roads may incur such heat expansion stresses that they may be prone to structual failure. National Highways is to replace all their concrete roads by 2045.

*Note that little information currently exists on prediction of sea level rise for Essex, due to climate change. The environment officer for ECC does not have data on this aspect of climate change. However, this climate risk category has been included in the risk assessment process. Monitoring the prediction of sea level rise and its impact are also included in climate adaptation recommendations.

2.5 Step 3: Identification of Relevant Time Periods to be included in Risk Assessment.

It is generally acknowledged that global warming will likely increase to no more than 2 degrees C above pre-industrial levels by 2050, regardless of efforts to reduce carbon emissions, due to the greenhouse gas emissions which have already occurred. This represents a 0.5 degree increase on current global temperatures, which suggests that the effects of climate change can be expected to intensify up to 2050.

The extent to which global warming increases after 2050 will depend upon the success or otherwise of the efforts to reduce global carbon emssions and achieve net zero by 2050. If net zero is achieved globally by 2050, it is anticipated that global warming may not increase much beyond the 2 degrees expected by 2050, in which case increases in climate change risk are likely to be marginal. However, if behaviour of high carbon emissions continues at the current extent, it is estimated that under such a high emissions scenario global warming could increase to 4 degrees C above preindustrial levels by end of the century. The time periods included in the risk assessment process are:

1. **2024/25 (baseline), i.e. Risk Assessment for current period** (global warming 1.5 degress C above pre-industrial levels).

2. **2050, i.e. Risk Assessment for increased climate risk** (associated with 2 degrees C above pre-industrial levels). This time period also assumed to represent the 2100 time period under a low carbon emissions scenario (net zero globally by 2050).

3. **2100 under esimated high emissions scenario, i.e. risk assessment for heightened increase in climate risk.** It is estimated that the high emissions scenario could result in global warming of 4 degrees C above pre-industrial levels by 2100. A low emissions scenario for this time period was assumed to be similar to the global warming being held at 2 dgrees C above pre-industrial levels scenario, in which case the climate risk would likely be very similar to the scenario for 2050 to which we are largely locked in to due to greenhouse gas emissions previously released.

2.6 Step 4: Assessment of Likelihood (Vulnerability) Score and Assessment of Consequence (Impact) Score

2.6.1 The Likelihood (Vulnerability) assessment Rating for 2024/25 baseline.

2.6.1.1 The Likelihood (Vulnerability) assessment considered the *exposure* and *sensitivity* of assets.

Likelihood (Vulnerability) = extent to which an asset is exposed to a climate hazard X sensitivity (the inherent characteristics of the asset which may makes it more or less vulnerable to a particular change in climate)

Exposure was rated for each asset/component on a 6-point scale from nil (score of 0) to high (score of 5) based on the level of its exposure to the climate change risk.

Sensitivity for each asset/component was rated on a 6-point scale, being either nil (score of 0) to high (score of 5).

Sensitivity at this stage of the maturing journey, ignored area and/or District variations in soil types and frequency of previous climate risk incidents, to reduce complexity. The County was viewed as a single area.

An additional Sensitivity Score was added in relation to Service Life Risk (risk that long asset lives 'lock in' climate change risk). Where asset service lives are relatively short, to some degree climate adaptation can be incorporated into future asset replacement, as it allows more climate resilient assets to be deployed as part of the natural asset replacement cycle. Given that some highways assets have long service lives - structures for instance are generally regarded as having a design service life of 120 years from original construction – an additional score for sensitivity was included, ranging from 0 (for assets with short service lives) to 3 (for assets with long service lives, such as structures).

Note that the sensitivity assessment considered the inherent characteristics of the asset which may make it more or less vulnerable to a particular change in climate. These scores were based on the current state of the assets, prior to any mitigation measures. For example, an asset/component may be very exposed to a climate change risk but may not be very sensitive to it. Conversely an asset/component may not be very exposed to a climate change risk but may be relatively sensitive to it.

2.6.1.2 Likelihood (Vulnerability) Assessment Ratings for 2024/25 baseline.

With reference to 2.6.1.1, the final Likelihood Rating was then categorised based on the Vulnerability scores (exposure x sensitivity), with Rating categories ranging on a scale from 1 (for low vulnerability score) to 10 (high vulnerability score). The 10 category ratings were based on the Vulnerability score ranges, calculated with reference to equal numeric divisions based on the maximum possible Vulnerability score. For example, see below:

Maximum Exposure Score	30
Sub Total Sensitivity Max Score	30
Sub Total additional max Sensitivity Score based on service life	3
Total Sensitivity Score	33
Max Likelihood score (expsoure x sensitivity)	**990**

Likelihood Category Rating	Likelihood score range from	Likelihood score range to	Equal Numeric Division (Max Likelihood Score)
1	0	99	99
2	100	198	99
3	199	297	99
4	298	396	99
5	397	495	99
6	496	594	99
7	595	693	99
8	694	792	99
9	793	891	99
10	892	990	99

2.6.1.3 Likelihood (Vulnerability) Assessment Ratings for the 2050 and 2100 (high emissions scenario).

To calculate the Likelihood score category Rating for the time Period 2050 (global warming 2 degrees C above pre-industrial levels), an automated increase of 3 points was added to the 2024/25 baseline Likelihood score Category Rating. For example, if the 2024/25 baseline Likelihood Category Rating was 4, then the addition of 3 points would bring the Rating for the 2050 Time Period to 7.

To calculate the Likelihood score category Rating for the time Period 2100 (high emissions scenario with global warming 4 degrees C above pre-industrial levels), an automated increase of 3 points was added to the 2050 Likelihood score category Rating. For example, if the 2050 Time Period Likelihood score Category Rating was 7, then the addition of 3 points would bring the Rating for the 2100 Time Period to 10.

2.6.2 The Consequence (Impact) Assessment

2.6.2.1 Consequence (Impact) Assessment for 2024/25 baseline.

The consequence (impact) assessment captured the magnitude of impact of climate change on the asset/component in question, for each of the time periods, starting with the 2024/25 baseline. An initial consequence rating of 1 to 10, from minimal (score 1) to high (score 10) was given for each each asset/component for the base line time period 2024/25.

Additional impact scores were then added for the base line time period 2024/25, based on the following:

Effective risk assessments need to consider interacting risks (those that act in such a way as to have an effect on each other) and threshold effects (a point above which something will take place, such as disproportionate increase in risk impact). Interacting risks pose one of the biggest challenges when assessing climate risks. A single hazard, such as a flood, will often have knock-on impacts across a range of sectors, amplifying the resulting risk and impact.

In view of this, three additional characteristics were assessed for each asset/component, where these could be expected to increase the impact of the risk. Accordingly, these additonal impact scores were added to the original consequence rating for each asset/component.

The three additional characteristics, each of which could add a score of 0 to 2 to the original risk rating, were:

- **Interdependence/Cascading Risk** (interdependencies refer to systems or organisations which are connected to, or rely on, another system or organisation to fully operate). Note, vulnerabilities within transport infrastructure can cause problems in other infrastructure systems. Events such as flooding on the road network can lead to delays and disruptions on other transport networks or the inability for essential vehicles such as emergency service vehicles to travel. Cascading risks are those whereby climate change impacts can propagate as cascades, compounding impacts across infrastructure categories. Example: extreme precipitation events can lead to flooding, resulting in blockages and congestion of the road network. This could prevent goods, passengers, or staff from reaching sites, airports or ports on time. Storm events can cause power outages, resulting in communication failures and safety risks on the road network due to lack of lighting and visible signage.

- **Capacity**. Assets such as drainage assets will be subject to damage from ground movement from climate change, but even those in good condition may have limited capacity which will be a key factor in assessing the impact of climate hazards such as increased precipitation and more frequent intense rainfall events. The impact will further be compounded if the asset condition is compromised.

- **Asset condition**; climate risks are likely to have a greater impact for assets which are in poor condition, especially assets that have capacity issues or cascading impacts, such as drainage assets.

2.6.2.2 Consequence (Impact) Assessment for the time periods 2050 and 2100 (high emissions scenario).

To calculate the Consequence (Impact) Assessment for the Time Period 2050 (global warming 2 degrees C above pre-industrial levels), an automated increase of 3 points was added to the 2024/25 baseline score assessment.

To calculate the Consequence (Impact) Assessment for the time Time Period 2100 (high emissions scenario with global warming 4 degrees C above pre-industrial levels), an automated increase of 3 points was added to 2050 Consequence (Impact) score assessment.

2.7 Step 5: Assessment of risk evaluation against Climate Change Risks

2.7.1 Climate Change Risk Evaluation Category for 2024/25 baseline.

Assessment of Risk Evaluation (Likelihood X Consequence) was calculated for each material asset/component of each Asset Group identified in Step 1 for the 2024/25 base line time period. This included the additional impact scores explained in 2.6.2.1 above.

The risk evaluation score for each assset/component, was then categorised as follows:

The 7 risk evaluation score categories for the 2024/25 basline were calculated with reference to equal numeric divisions based on the maximum possible risk evaluation score. For example, see below:

Baseline Risk Evaluation Score Categories

Total Likelihood Score max	10
Sub Total max additional Consequence (Impact) Score	6
Sub Total standard Consequence (Impact) Score	10
Total Max Consequence (Impact) Score	16
Max Risk Evaluation score	**160**

Division	Risk Evaluation score range from	Risk Evaluation score range to	Equal Numeric Division (Max Risk Evaluation Score)	Risk Evaluation Score Category
1	0	0	0	Nill
2	1	27	27	Negligible
3	28	53	27	Slight
4	54	80	27	Moderate
5	81	107	27	Strong
6	108	133	27	Major
7	134	160	27	Severe

2.7.2 Climate Change Risk Evaluation Category for 2050 and 2100 (high emissions scenario) Tme Periods.

Assessment of Risk Evaluation (Likelihood X Consequence) was calculated for each material asset/component of each Asset Group identified in Step 1 for the Likelihood and Consequence Ratings for the time periods 2050 and 2100 (high emissions scenario) – refer

to ‘2.6 Step 4: Assessment of Likelihood (Vulnerability) Score and Assessment of Consequence (Impact) Score’. The resultant risk evaluation score for each asset/component for each of the time periods was categorised as per 2.7.1 to show change over time.

2.8 Step 6: Weighted Average Climate Change Risk Evaluation Category for each Asset Group

With reference to the risk evaluation score for each asset/component of each Asset Group, for each time period, referenced in 2.7 above, a weighted average for each Asset Group was calculated for the 2024/25 baseline and subsequently for the 2050 and 2100 time periods.

The average risk impact evaluation for each Asset Group was weighted on the basis of Gross Replacement Cost of the asset/components in question. For example, if Traffic Signal Junctions represented 50% of GRC value of the Total GRC for the Traffic Management Systems Asset Group, then the risk evaluation score for Traffic Signal Junctions would be multiplied by 50%, and so on for each asset/component within the Traffic Management Systems Asset Group.

Weighted average for Asset Group =

Summation of:

(Gross Replacement Cost of each asset/component as the % of Total GRC for Asset Group) **X** the Risk Evaluation score for each asset/component.

Note there was a risk evaluation score for each asset/component, for each of the three time periods, therefore the GRC % weighting was applied to each of the three risk evaluation scores respectively to produce a weighted average score for each of the three time periods, with total scores being categorised as per 2.7.1 above, to show change over time for Asset Group risk category.

2.9 Step 7 Identification of key Council Risks relating to Essex Highways Infrastructure Assets, and subsequent Climate Change Risk Impact Evaluation for each Asset Group on each key Council Risk.

The overall risks to the Council relating to Highways Network Infrastructure Assets have been identified, and a corresponding assessment of each Asset Group in terms of risk to each key Council Risk has been undertaken.

The key Council Risks identified are:

- **Road Safety: Vision Zero** is the aspiration that there should be no deaths or serious injuries on the roads by 2040. Vision Zero is the ethical position that deaths and serious injuries are not an acceptable consequence of human error on public roads.

Note: the climate risks to assets can have serious, negative impacts for road safety for highway users.

- **Legal Risk** (estimated risk of failing to meet statutory obligations, or legal action against the Council arising from an incident occurring).

- **Performance** (estimated risk of failing to meet corporate performance targets or public satisfaction targets due to an incident occurring).

- **Customer: Risk of Accessibility, Serviceability and Sustainability of Highway Network** (the highway network is the key transport network for the county, for movement of goods, people and services, and its failure would have catostrophic cascading impacts for the county, especially for vulnerable people and for remote communities).

- **Financial Risk** (estimated risk of being unable to fund a 'spend now to save in future option' with the result of escalating capital and revenue maintenance costs in the future; i.e. building up a legacy of maintenance liability due to an incident occurring). Note, potential risks to spend could occur as a result of climate change. While adaptation itself may incur some costs, these are likely to be far less than the costs of recovery from climate impacts.

- **Risk of Reputation for Council** (estimated risk of adverse public or political reaction arising due to an incident occurring). Note that climate change presents risks to many of our highways network assets not just in the longer term, but increasingly we see probable climate change related events occurring now. In these cases, failure to either avoid risk or recover quickly could lead to reputational damage for the Council.

- **Customer: Risk to Business Investment/Growth** (the highway network is the key transport network for the county, for movement of goods, people and services, and its failure would have catostrophic cascading impacts for business investment and growth).

- **Environment** (estimated risk of damage to the environment due to an incident occurring, having negative impact on nature recovery which would impact negatively on Council ambitions for Net Zero). Note, further deterioration of the environment can result from impacts to the resilience of the highways network due to climate related risks. If we fail to recognise the value of the environment in managing climate risk, an opportunity to build resilience will be compromised.

- **Well Being/Social Value,** (estimated risk impact on people's wellbeing through impact of climate change on highways assets, such as the safety, accessibility, serviceability, and sustainability of the highways network. Failure of highways network would have impact for access to social services, health care, education, sport, leisure, recreation, and travel).

A risk impact of each Asset Group to each of the key Council risks above, was determined for each time period. A score range of 1 – 10 was applied, with 1 being the lowest risk and 10 being the highest risk. These overall risk evaluation scores were then used to create a 2024/25 baseline as well as to evaluate risk for the time periods 2050 and 2100 (high emissions scenario), enabling change in risk categorisation to be compared over time. Note that for this risk assessment there was no automated increase in risk score applied to the 2024/25 baseline to produce risk evaluation for the other time periods, a risk score (1 to 10) was attributed for each time period respectively.

The 7 risk evaluation score categories for each time period were calculated with reference to equal numeric divisions based on the maximum possible risk evaluation score. For example, see below:

Maximum Climate Risk Score for each Asset Group = 9 x 10 =90				
Risk Evaluation Score Category	**Risk Evaluation score range from**	**Risk Evaluation score range to**	**Equal Numeric Division (Max Risk Evaluation Score)**	**Division**
Nill	0			1
Negligible	1	15	15	2
Slight	16	30	15	3
Moderate	31	45	15	4
Strong	46	60	15	5
Major	61	75	15	6
Severe	>=	76	15	7

2.10 Climate Change Risk Evaluation Results and Recommendations for Mitigation Measures/Activities

2.10.1 Climate Change Risk Evaluation relating to Service Life of Each Asset Group

The Climate Change Risk Evaluation relating to the service life of Each Asset Group, for each time period, is detailed in Table 1 below. For information relating to risk evaluation categories, please refer to '2.7 Step 5: Assessment of risk evaluation against Climate Change Risks'.

Table 1: Climate Change Risk to Service Life of Asset Group (prior to mitigation)

Asset Group	Climate Change Risk To Service Life of Asset Group (weighted average of risk for all assets/components per Asset Group, based on Gross Replacement Cost)		
	Current Risk 2024/25 (baseline)	**Estimated Risk 2050 compared to baseline**	**Estimated Risk 2100 compared to baseline** (assuming high emissions scenario. Note, a low emissions scenario will be similar to Estimated Risk 2050)
Cycle Monitoring Sites	Negligible	Negligible	Moderate
Drainage Infrastructure	Slight	Moderate	Severe
Embankments/Cuttings (including A130)	Slight	Strong	Severe
Essex Highways Green Estate (including A130 but excluding verges and Public Rights of Way)	Negligible	Slight	Strong
Footways/Verges/Cycleways (including A130)	Slight	Moderate	Severe
Highway Lighting (including illuminaed bollards and illuminated highway signs)	Negligible	Slight	Strong
Passenger Transport Infrastructure	Negligible	Slight	Strong
Pedestrian Guard Rail	Negligible	Slight	Moderate
Public Rights of Way Infrastructure	Negligible	Slight	Moderate
Roads Including A130 (but excluding embankments/cuttings)	Slight	Strong	Severe
Structures (excluding A130)	Slight	Strong	Severe
Traffic Management Systems (including Zebra Crossings, Bus Telematics and Speed Cameras)	Negligible	Slight	Strong
Vehicle Activated Signs	Negligible	Slight	Moderate
Vehicle Restraints (safety barriers)	Negligible	Slight	Strong
Winter Management Infrastructure (salt bins and	Negligible	Slight	Strong
Structures A130	Negligible	Moderate	Major
A130 Street Furniture (excludes structures, roads, footways, verges, embankments, etc.)	Negligible	Slight	Strong

The key risk categories for Asset Group service life (Strong, Major, Severe) in the 2100 time period (high emissions scenario), are the focus of recommendations for mitigation with a view to ensuring key Asset Groups remain climate resilient.

Risk categories that are not classed as ‘key’ because they reflect risk evaluation scores that fall within the categories Negligible, Slight, or Moderate, were also captured through the risk assessment process. Activities for these Asset Groups have also been identified, and these Asset Groups will still require to be monitored regularly.

For more information on climate adaptation recommendations for each Asset Group, please refer to ‘1.1 Summary – Recommended Climate Adaptation Activities’.

2.10.2 Climate Change Risk of each Asset Group to key Council Risks

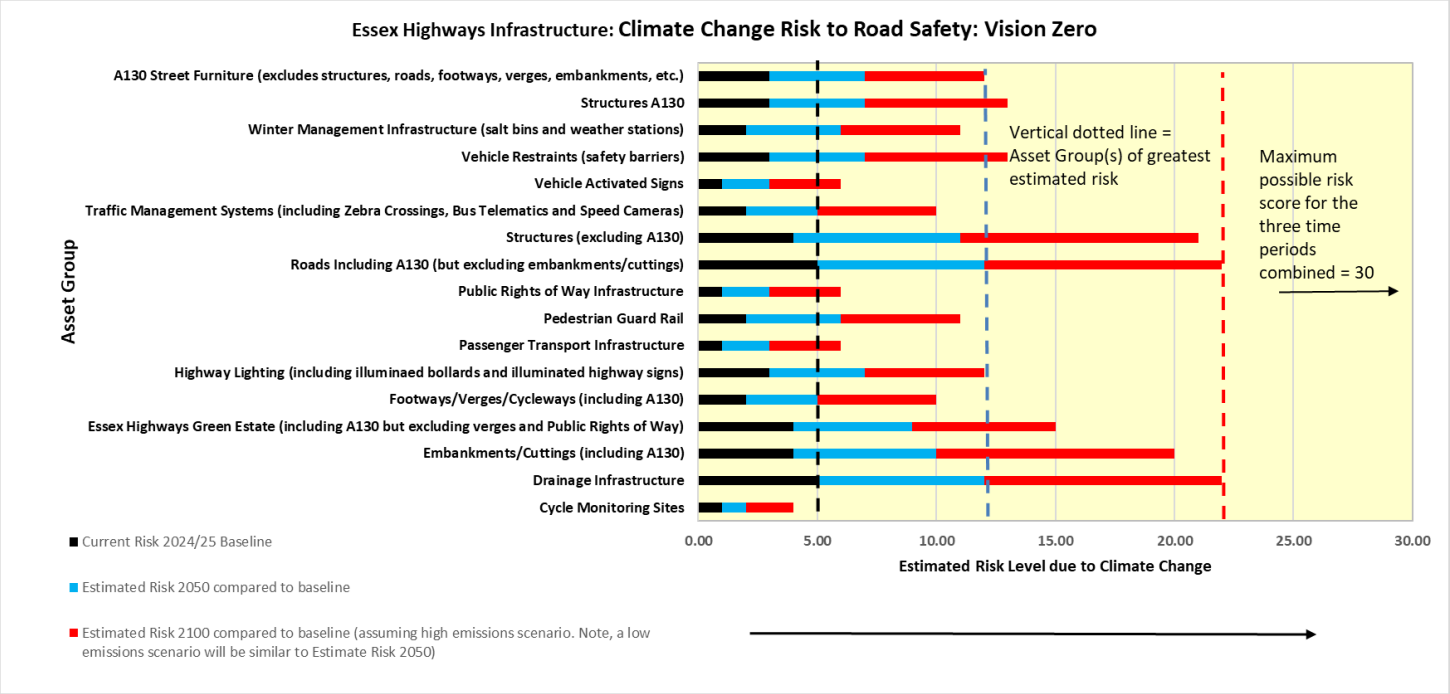
The Climate Change Risk Evaluation relating to the risk of Each Asset Group to key Council Risks, for each time period, is detailed in Table 2 below. For information relating to risk evaluation categories, please refer to ‘2.9 Step 7: Identification of key Council Risks relating to Essex Highways Infrastructure Assets, and subsequent Climate Change Risk Impact Evaluation for each Asset Group’.

For more detailed information relating to the risk score of each Asset Group for each key Council Risk, together with the characteristics of risk upon which the scores were based, please refer to Table 3 below.

Table 2: Climate Change Risk of each Asset Group to key Council Risks

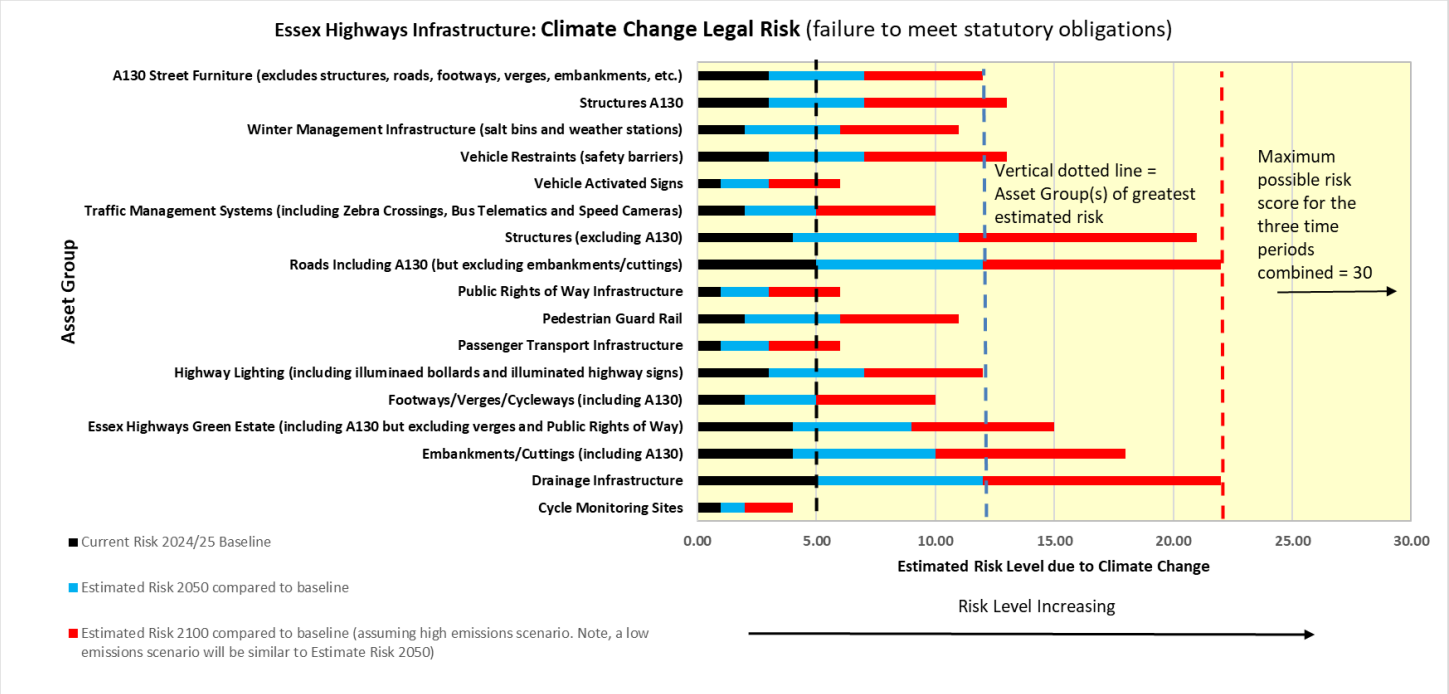
Estimated Risk to Council For Each Asset Group			
Asset Group	**Current Risk 2024/25 Baseline**	**Estimated Risk 2050 compared to baseline**	**Estimated Risk 2100 compared to baseline** (assuming high emissions scenario. Note, a low emissions scenario will be similar to Estimate Risk 2050)
Cycle Monitoring Sites	Negligible	Negligible	Slight
Drainage Infrastructure	Moderate	Major	Severe
Embankments/Cuttings (including A130)	Moderate	Strong	Severe
Essex Highways Green Estate (including A130 but excluding verges and Public Rights of Way)	Moderate	Moderate	Strong
Footways/Verges/Cycleways (including A130)	Slight	Moderate	Strong
Highway Lighting (including illuminaed bollards and illuminated highway signs)	Slight	Slight	Moderate
Passenger Transport Infrastructure	Negligible	Slight	Moderate
Pedestrian Guard Rail	Slight	Slight	Moderate
Public Rights of Way Infrastructure	Negligible	Slight	Moderate
Roads Including A130 (but excluding embankments/cuttings)	Strong	Major	Severe
Structures (excluding A130)	Moderate	Major	Severe
Traffic Management Systems (including Zebra Crossings, Bus Telematics and Speed Cameras)	Slight	Slight	Moderate
Vehicle Activated Signs	Negligible	Slight	Slight
Vehicle Restraints (safety barriers)	Slight	Moderate	Strong
Winter Management Infrastructure (salt bins and weather	Slight	Moderate	Strong
Structures A130	Slight	Moderate	Strong
A130 Street Furniture (excludes structures, roads, footways, verges, embankments, etc.)	Slight	Moderate	Moderate

Table 3/1: Climate Change Risk score for each Asset Group for each key Council Risk



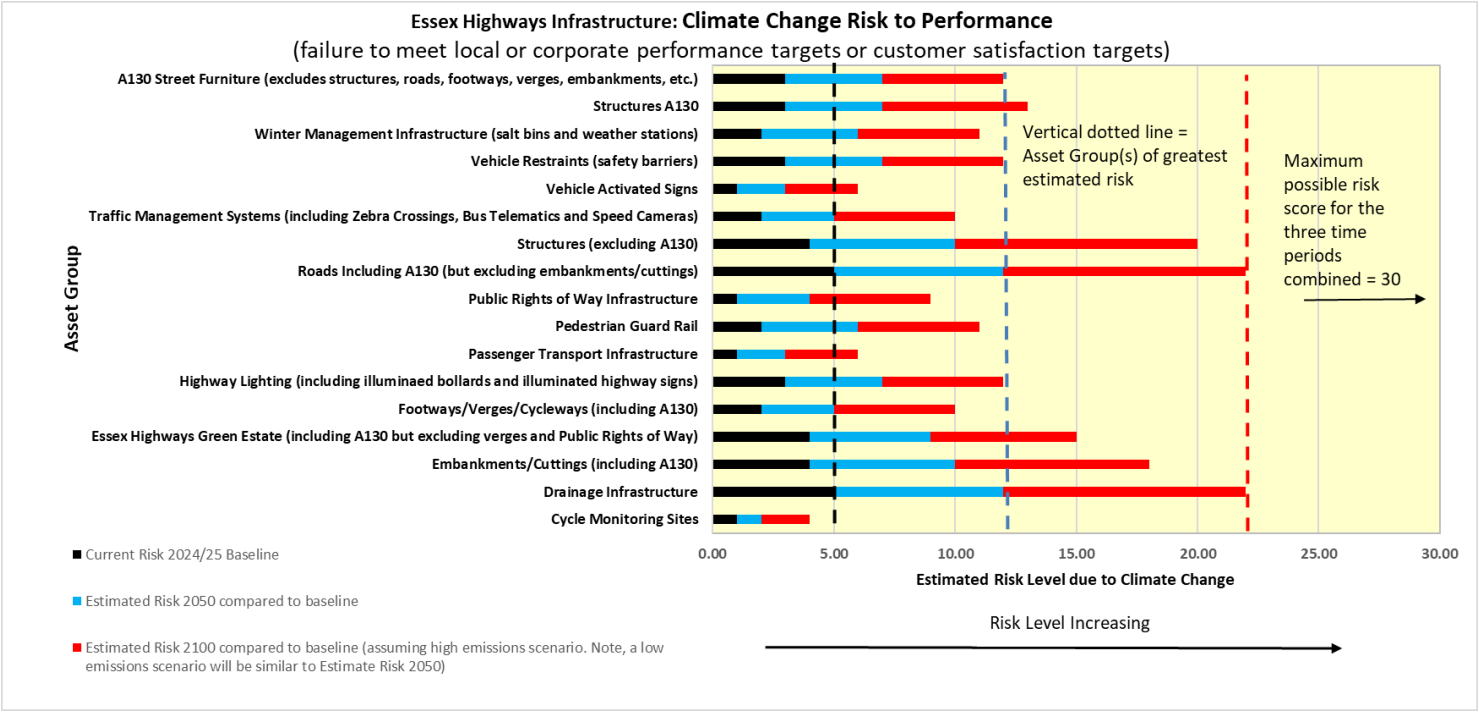
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Road Safety: Vision Zero	Road Safety: Vision Zero is the aspiration that there should be no deaths or serious injuries on the roads by 2040.	• Incapacity of drainage assets likely to result in increased road and property flooding, exacerbated by poor condition of drainage assets. • Extent and condition of embankments/cuttings unknown but several collapses have occurred in recent years. Ground movement will make assets prone to failure. • Vehicle restraints containment likely to be compromised by temperature extremes. Climate change which will also accelerate deterioration. Age and condition already a concern for many of these assets. • Planting of trees close to high-speed roads as part of ECC Tree Plan will create road safety risk. • Condition or roads will decline from exposure to surface water and ground movement. Possibility that concrete roads will fail structurally due to expansion under high temperatures. (National Highways is to replace its concrete roads by 2045). • Condition of footways and cycleways will decline from exposure to surface water and ground movement, and this may have negative impact on active travel resulting in increased traffic congestion. Already significant condition concerns for footway assets. Cycleways assets register not yet complete, condition of these assets is unknown. • Structures will decline in condition from exposure to surface water and scour and other hydraulic actions (masonry arch bridges in particular) as well as heave from ground movement. Expansion joints and bearings may fail if temperatures exceed original design range. Around 30% of structures assets already in poor or very poor condition.

Table 3/2: Climate Change Risk score for each Asset Group for each key Council Risk



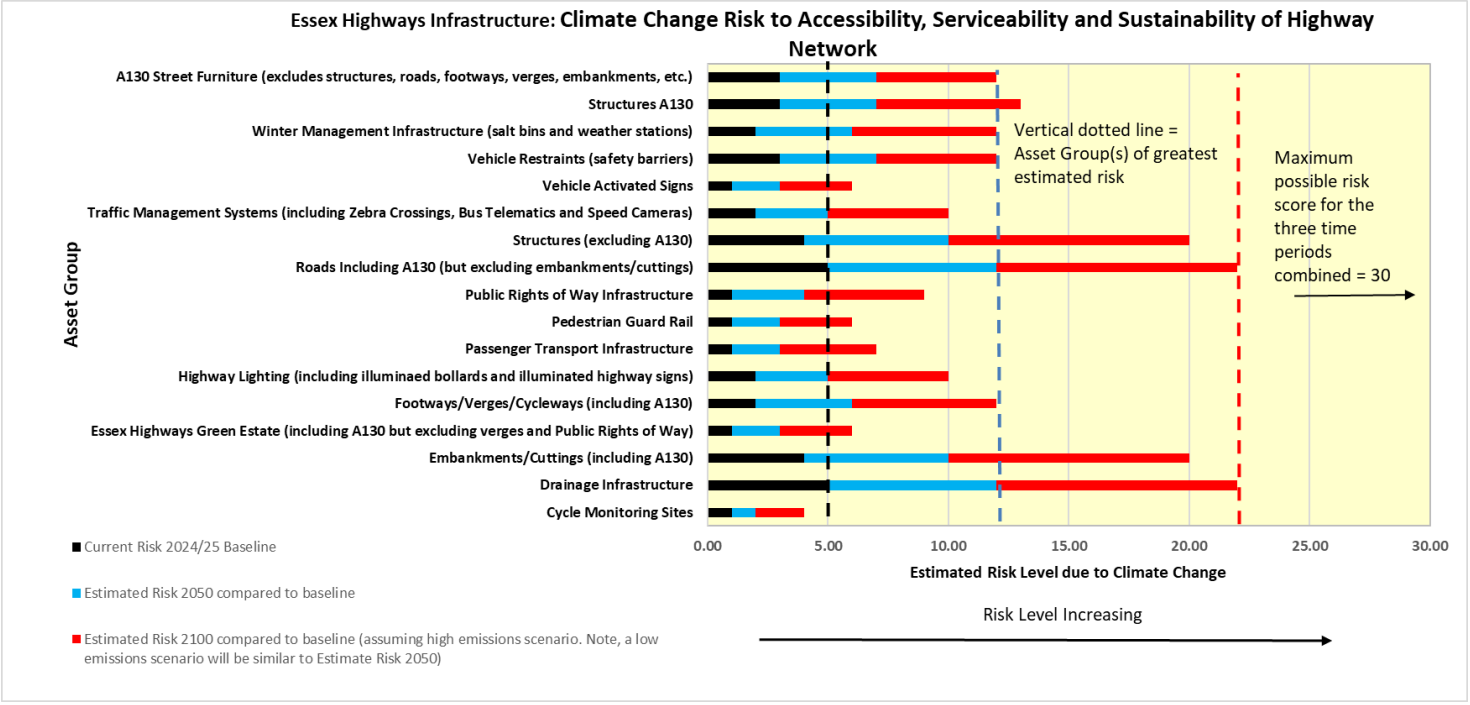
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Legal Risk	Estimated risk of failing to meet statutory obligations, or legal action against the Council arising from an incident occurring as a result of climate change risk to the Asset Group in question.	• Increased road, footway and cycleway, and property flooding. • Accelerated condition decline of roads, footways, and cycleways. Already condition concerns for footways. Condition of cycleways assets unknown. • Collapse of embankments/cuttings due to ground movement. Extent and condition of assets largely unknown. There have been several collapses in recent years. • Containment performance of Vehicle Restraints likely to be affected by extreme temperatures, and climate change will accelerate condition decline.

Table 3/3: Climate Change Risk score for each Asset Group for each key Council Risk



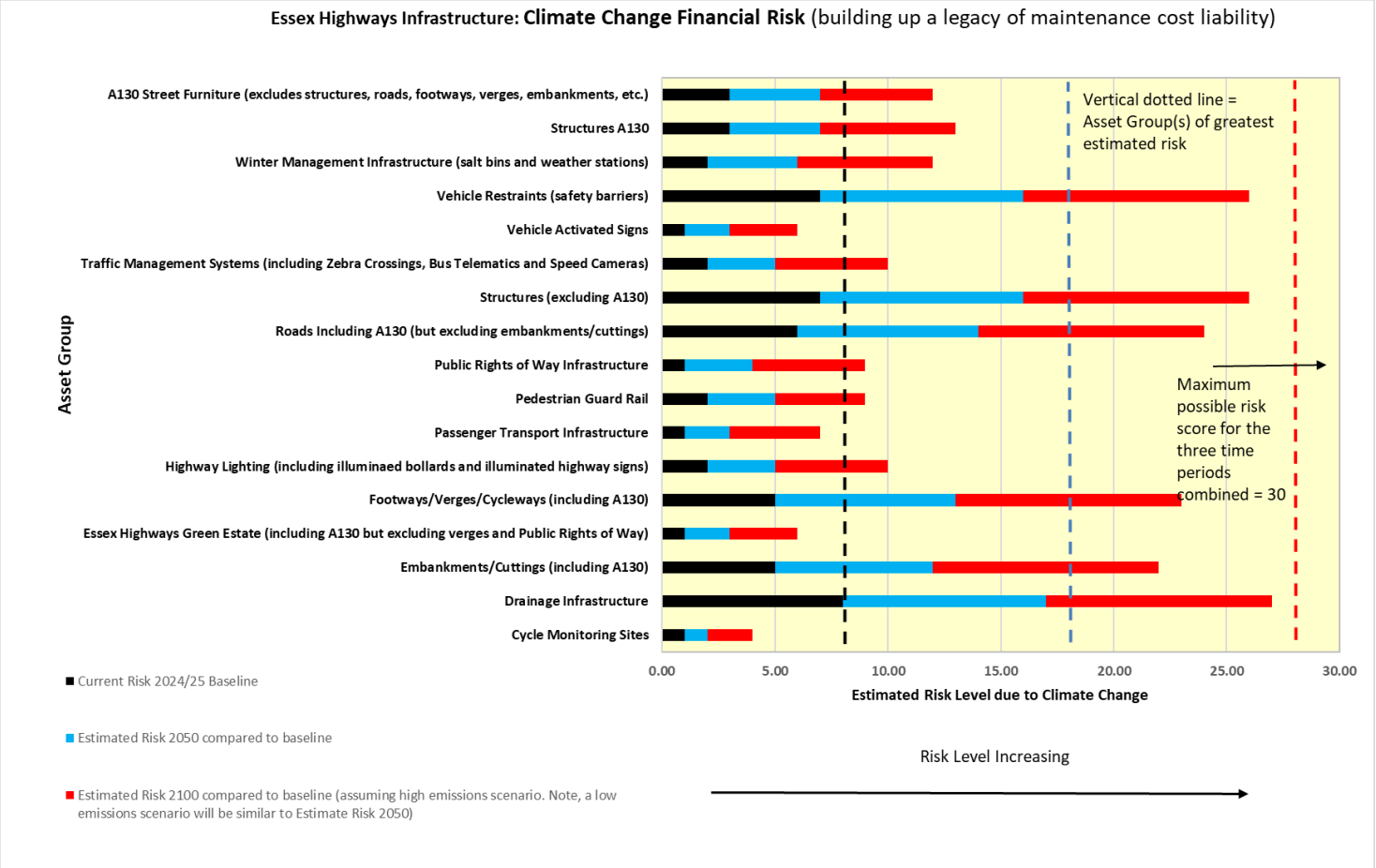
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Performance Risk	Estimated risk of failing to meet corporate performance targets or public satisfaction targets due to climate change risk to the Asset Group in question.	• Increased asset and property flooding increases deterioration of all assets such as roads, footways and cycleways and structures, and will have negative impact on performance targets, especially for customer satisfaction. • Possibility that roads may need to be closed due to flooding which will have a negative impact on accessibility to Council services and for traffic flows which will have significant impact on cascading risks.

Table 3/4: Climate Change Risk score for each Asset Group for each key Council Risk



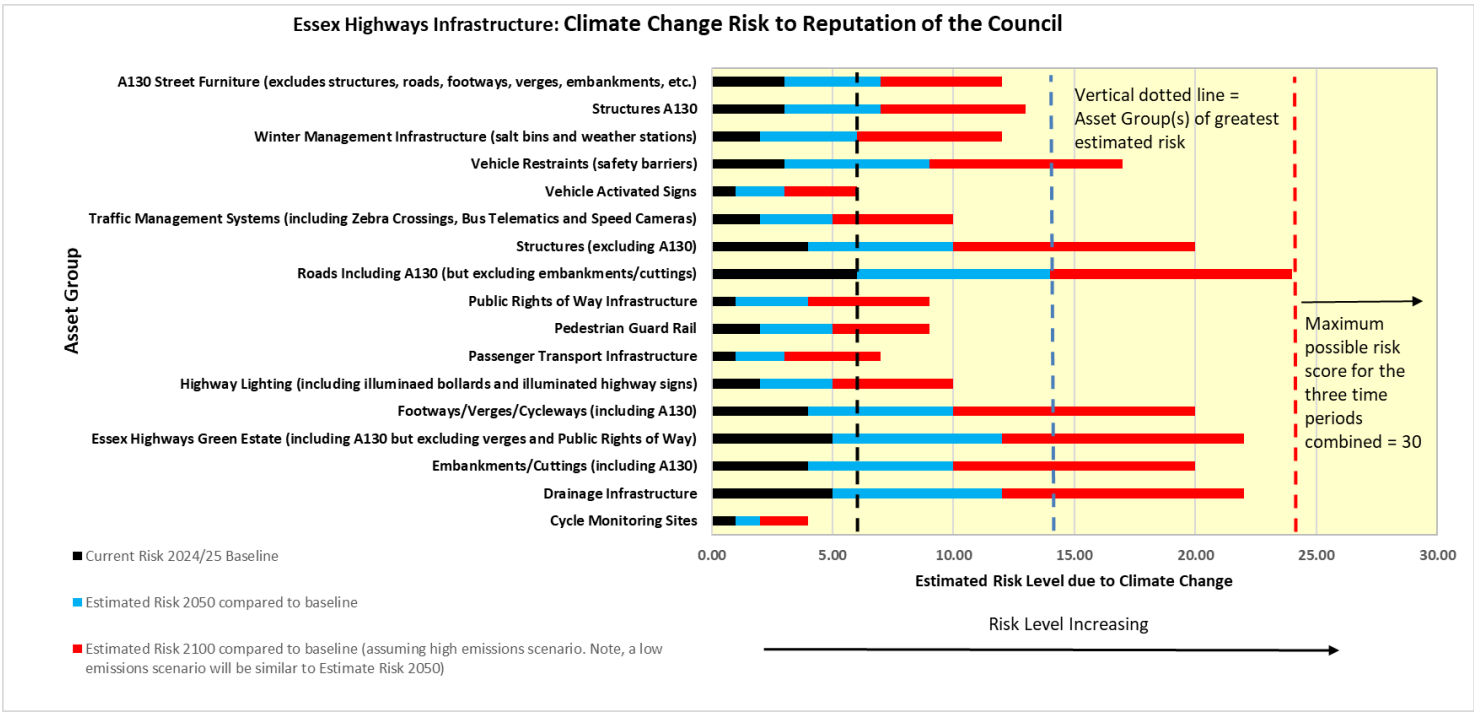
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Risk of Accessibility, Serviceability and Sustainability.	The highway network is the key transport network for the county, for movement of goods, people and services, and its failure would have catastrophic cascading impacts for the county, especially for vulnerable people and for remote communities.	• Increased road, footway and cycleway and property flooding has negative impact on accessibility, serviceability, and sustainability of assets, i.e. possibility of roads becoming impassable. Possibility that concrete roads will experience structural failure during high temperatures. (National Highways is to replace its concrete roads by 2045). • Increased rainfall and ground movement likely to result in geotechnical failures of embankments/cuttings which will have impact for accessibility to network with cascading impacts for accessibility to Council services and traffic flows around county. • Structures exposed to scour, ground movement and increase in wind strengths which will likely result in increased number of closures. • Impact for all above will be greatest for vulnerable people and people in remote communities. Impact of risk will be cascaded to services dependent upon the highways network.

Table 3/5: Climate Change Risk score for each Asset Group for each key Council Risk



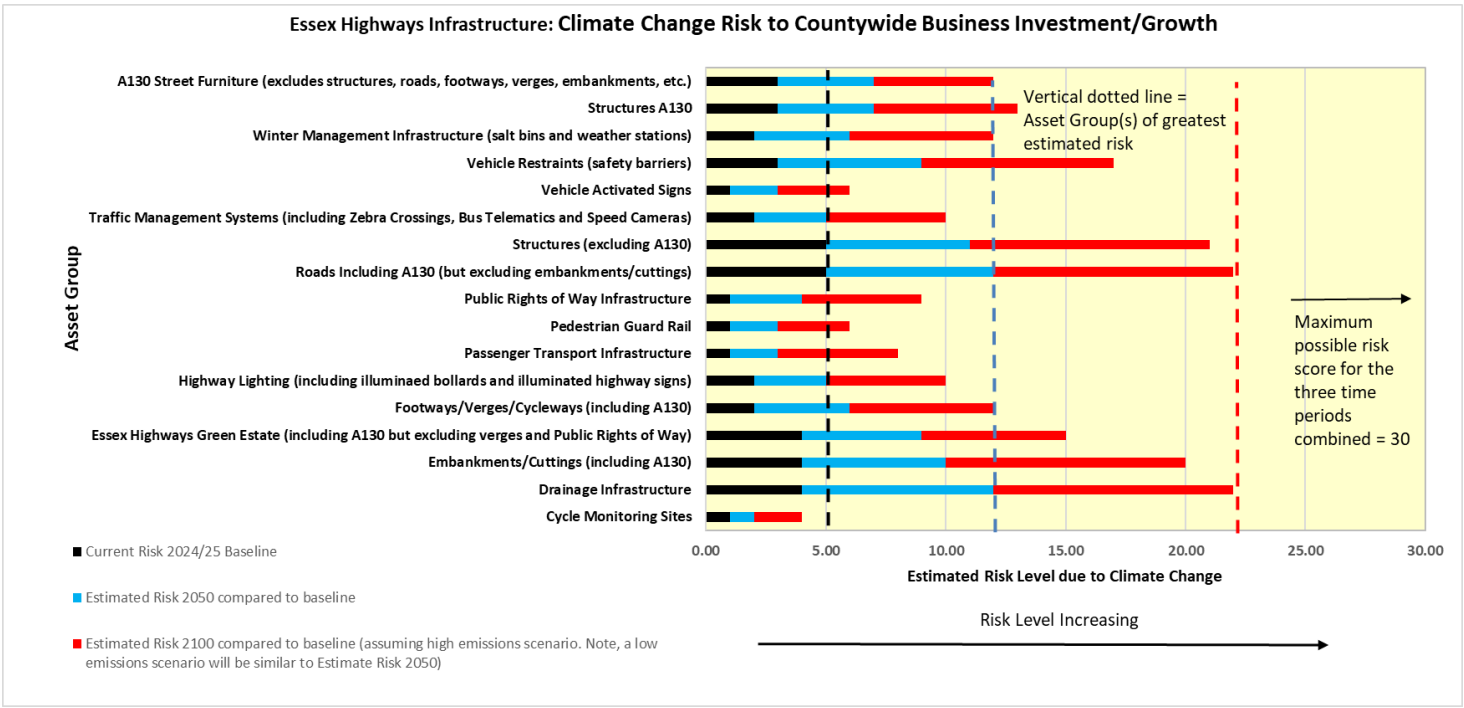
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Financial Risk	Estimated risk of being unable to fund a 'spend now to save in future option' with the result of escalating capital maintenance costs in the future, i.e. building up a legacy of maintenance liability, due to climate change risk to the Asset Group in question.	• Increased road, footway and cycleway, and property flooding increases deterioration of all assets which will have significant financial consequences for maintenance. The requirement to improve the current poor condition of drainage assets will also be a financial burden to the Council. • Possibility that concrete roads will experience structural failure during high temperatures and will require replacement. • Potential failure of embankments and cuttings due to ground movement, will have significant financial consequences. • Significant investment already required for Vehicle Restraints due to age and condition of assets, and climate change will accelerate need for asset replacement. • Around 30% of structure already in poor or very poor condition. Bridges over rivers are at risk of increased scour from rainfall; expansion joints and bearings may not be designed to operate within increased temperatures from climate change. Ground movement will have negative impact on the foundations of structures.

Table 3/6: Climate Change Risk score for each Asset Group for each key Council Risk



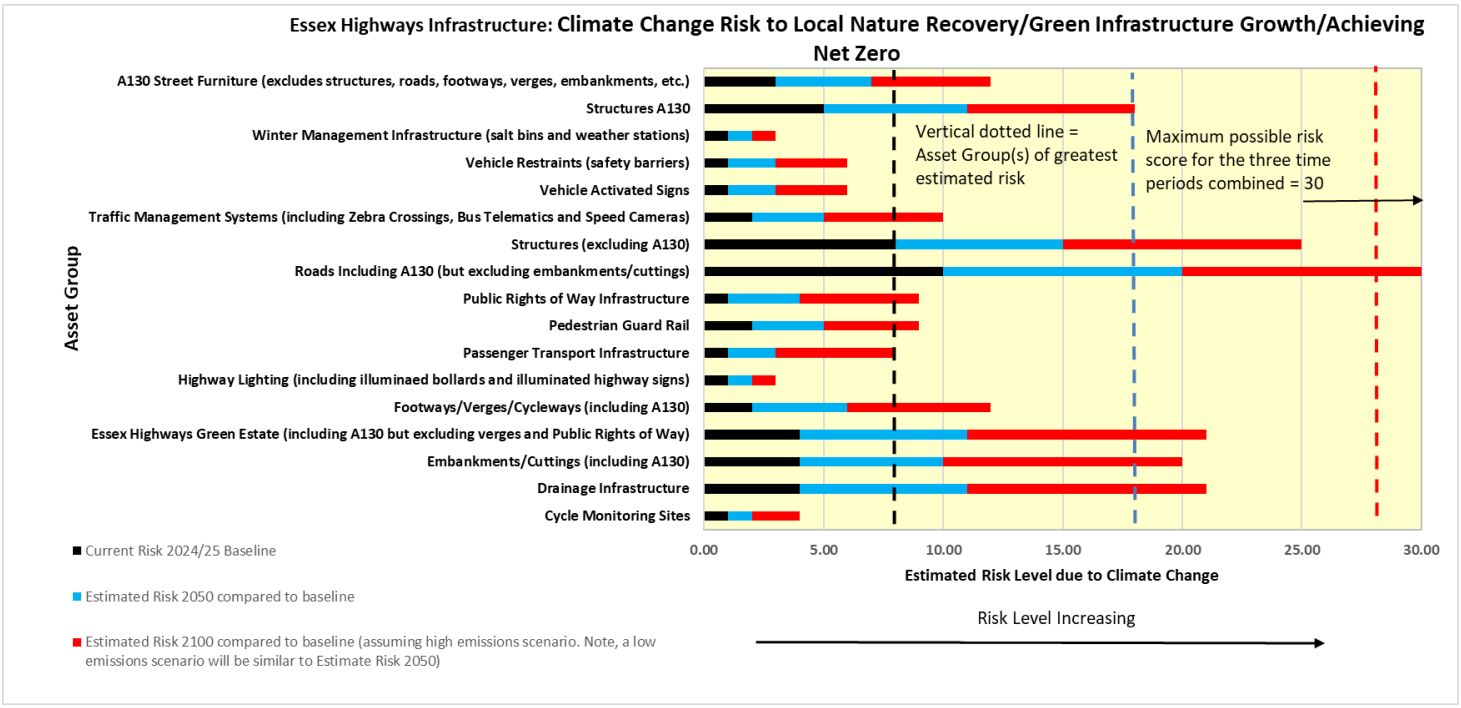
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Risk of Reputation for Council	Estimated risk of adverse public or political reaction arising from climate change risk due to the Asset Group in question	• Increased road, footway and cycleway, and property flooding increases deterioration of all assets such as roads and footways and cycleways and structures and will have negative impact on customer satisfaction. • Negative impact from reduced accessibility, serviceability and sustainability of the network will result in poor publicity for the Council. • Condition decline of footways and cycleways may have negative impact on active travel which could result in poor reputation for the Council, increasing traffic congestion and having negative impact on air quality. • Issues with Structures will result in risk of accessibility, serviceability, and sustainability which will have highest impact for vulnerable people and people in remote communities. • Climate change likely to affect containment performance of Vehicle Restraints. Failure of assets could have negative impact on Council Reputation.

Table 3/7: Climate Change Risk score for each Asset Group for each key Council Risk



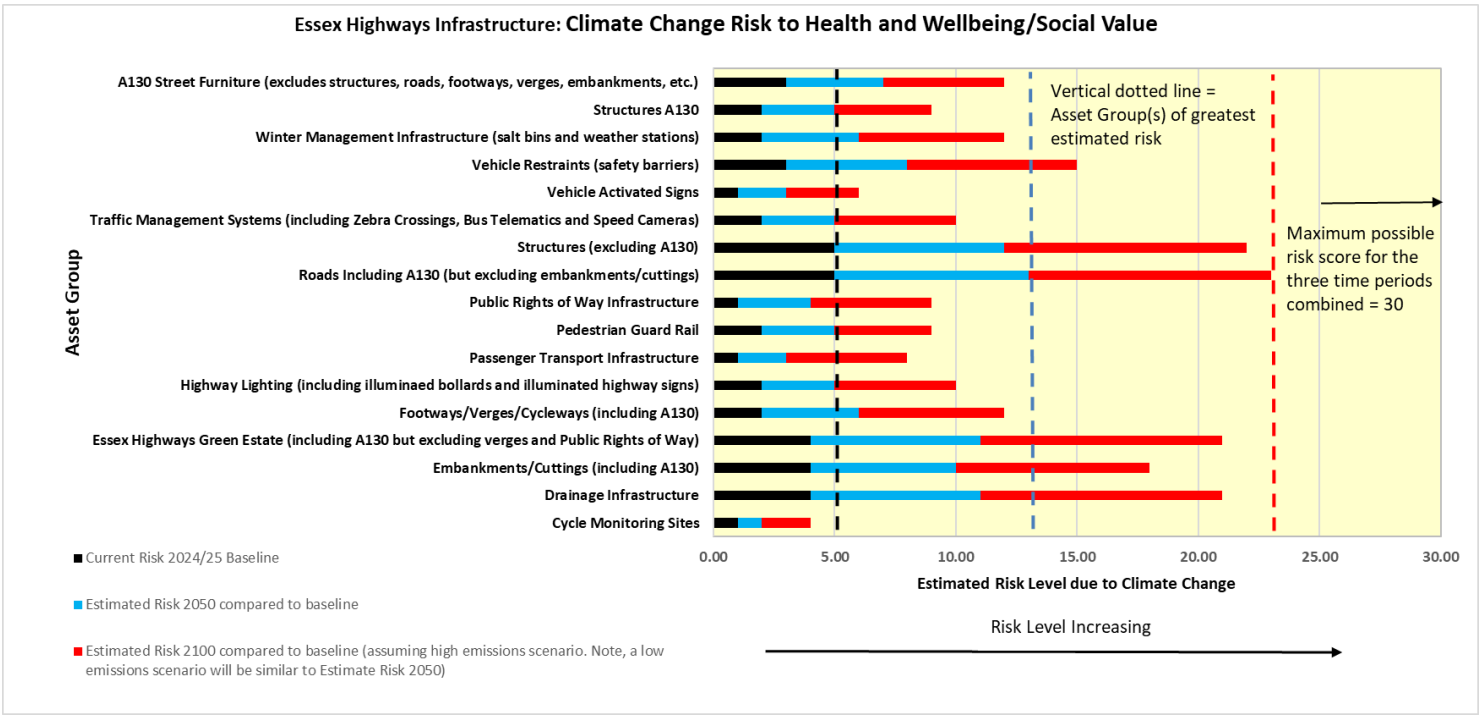
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Risk to Business Investment/Growth	The highway network is the key transport network for the county, for movement of goods, people and services, and its failure would have catastrophic cascading impacts for business investment and growth. Climate change has the potential to dampen economic growth by causing damage and disruption to the transport network.	• Failure to make assets more resilient to climate change will have a negative impact on future investment to the county due to reduced safety, accessibility, serviceability and sustainability of highway network and corresponding increased traffic disruption and poor journey time reliability. • Any reduction in safety, accessibility, serviceability and sustainability of the network will reduce access to services, education opportunities and employment opportunities which will have negative impact on investment. This will include any reduction in sustainable transport and active travel. • The cascading impact of these interdependent risks could be catastrophic for the County in respect of investment and growth.

Table 3/8: Climate Change Risk score for each Asset Group for each key Council Risk



Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Environmental Risk: Local Nature Recovery/Green Infrastructure Growth/Achieving Net Zero	Estimated risk of damage to the environment due to an incident occurring, having negative impact on nature recovery which would impact negatively on Council ambitions for Net Zero. Note, further deterioration of the environment could result from impact of climate related risks on the highways network. If we fail to recognise the value of the environment in managing climate risk, an opportunity to build resilience will be compromised.	• Incapacity of drainage assets to cope with increased rainfall or more frequent extreme events will result in increased road and property flooding. This will be exacerbated by poor condition of drainage assets. Increased flooding largely damages green estate and has negative impact on local nature recovery and biodiversity gain, which will have negative impact for achieving net zero. • Roads, footways, and cycleways create connection issues for nature and biodiversity - cut across habitats and isolate them, causing decline in Local Nature Recovery and Biodiversity. Climate Adaptation needs to include improved connectivity. • Highway Assets promote use of transport which is a high emitter of carbon emissions and therefore has negative impact on achieving net zero. • Failure to make Green Infrastructure climate resilient, such as planting appropriate tree species and retaining water, will have negative impact on the environment and achieving net zero.

Table 3/9: Climate Change Risk score for each Asset Group for each key Council Risk



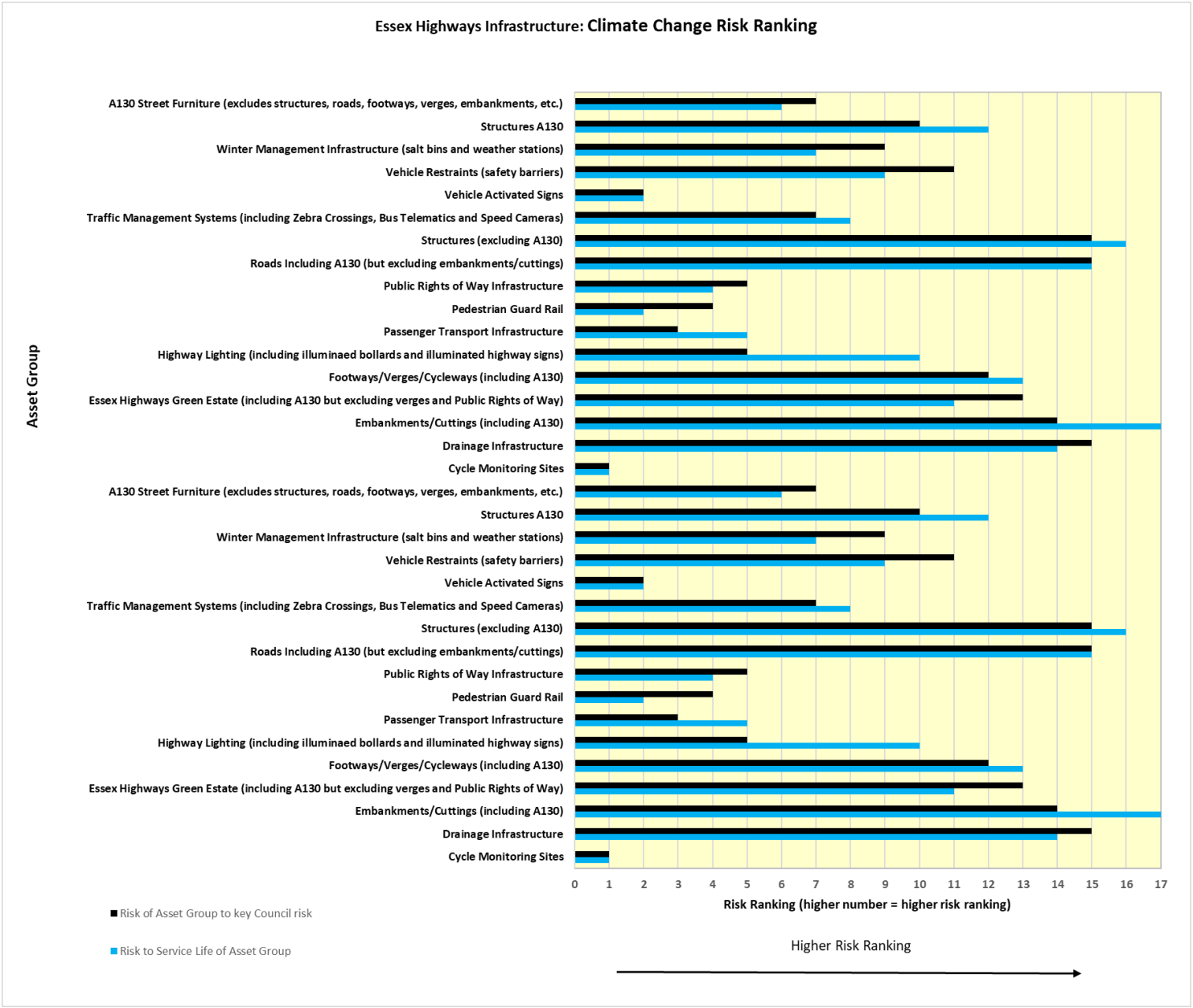
Risk Item	Risk Description	Highways Assets Key Climate Change risks, prior to mitigation. (Note: risks will increase over time)
Well Being/Social Value	Estimated risk impact on people's wellbeing through negative impact on accessibility, serviceability, and sustainability of highways network. Failure of highways network would have impact for access to care services, social services, education, sport, leisure, recreation, and travel.	• Increased flooding will have negative impact on the safety, accessibility, serviceability, and sustainability of the network which will have negative impact on access to services including access to care services and education, active travel, sport, leisure opportunities and open green spaces. This will have a negative impact on people's feeling of wellbeing. • Geotechnical failures of embankments/cuttings will have impact for accessibility to network with cascading risks for accessibility to Council services and negative impact for traffic flows around county. • Issues with structures will result in risk to accessibility, serviceability, and sustainability, which will have highest impact for vulnerable people as well as those in remote communities.

2.10.3 Recommendations for Asset Group Climate Change Mitigation Measures.

Our way of life is highly dependent upon the highways network. Keeping the highways network safe, accessible, serviceable, and sustainable is therefore the highest priority. Any failure to the highways network will have cascading risk impacts for the multitude of services which are dependent upon it. Failure of the highway network would therefore result in catastrophic disruption to our way of life.

The highways network is not just one Essex Highways Asset Group but the holistic relationship between all Essex Highways Asset Groups, although some Asset Groups represent a greater climate change risk impact to network safety, accessibility, serviceability, and sustainability than others.

The chart below shows Asset Group by risk ranking relating to Climate Change Risk to Service life of Asset Group. The same chart also shows the risk ranking by Asset Group risk to key Council risks (prior to climate risk mitigation). Note, the higher the number, the higher the risk ranking.



The climate change risk evaluation process has highlighted the following Asset Groups for which risk to Asset Group service life, as well as Asset Group risk to key Council risks, are the highest priority – refer to Table 4 below, which includes an indication of the risk characteristics and the recommendations for remedial measures.

Table 4: Recommended Climate Change Risk Mitigation Measures for Priority Asset Groups

Asset Group Priority for Climate Change Risk Mitigation	Risk Characteristics	Recommended Climate Change Risk Mitigation Measures
Drainage Infrastructure	Under Investment in physical and environmental maintenance in recent years has resulted in assets in poor condition. Also grip drainage no longer maintained. These matters have resulted in poor asset performance at a time when	Undertake condition assessment of drainage infrastructure and determine programme to restore asset condition. Rehabilitate grip drainage maintenance. Encourage design team to over design for drainage, in anticipation of increased precipitation in future years.

	increased precipitation can be expected. Poor performance of drainage assets has cascading impact for other assets that are dependent upon efficient drainage to realise nominal service life potential. Poor performance of drainage assets results in more widespread surface water remaining for longer periods on assets such as roads, footways, cycleways, structures, and green estate, resulting in accelerated asset condition decline as well as significant risk to safety, accessibility, serviceability, and sustainability of highways network. Impact will also damage the natural environment which will jeopardise local nature recovery and promotion of biodiversity as well as achievement of net zero ambitions.	Work with external organisations and local communities to identify sites for implementing sustainable urban drainage systems and natural flood management techniques. It is also recommended that the current Essex Highways approach to environmental maintenance of drainage assets is reviewed with reference to the need for climate adaptation. Review the current Surface Water Alleviation Scheme (SWAS) process and implement improvements. Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2026/27.
Embankments/ Cuttings	Extent and condition of assets is unknown and is not formally monitored. There have been several high-cost asset failures in recent years. Asset failure is likely to increase due to ground movement from increased precipitation and drought, which will impact significantly on highway network safety, accessibility, serviceability, and sustainability.	Undertake an asset survey to identify location and extent of all embankments and cuttings, undertake condition survey to establish condition of assets. Prioritise assets where there are condition concerns and implement monitoring regime. Identify programme over time for those assets that require maintenance or additional geotechnical works to sustain stability. Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2026/27 In the first instance, funding to be requested for asset survey and condition assessment.
Roads	Roads is the biggest capital asset of the Council. Keeping it in an appropriate condition, within budget constraints and high levels of traffic, remains an ongoing challenge for ECC. Condition of roads is likely to decline from current poor performance of drainage assets. Note an additional £12m Council funding is being allocated in 2024/25, largely to address localised issues. Possibility that concrete roads will experience structural failure at high temperatures. National Highways is replacing concrete roads by 2045. Possibility that bituminous surfaces or sealants will soften under anticipated high surface temperatures.	Within existing roads capital maintenance funding envelope, review current treatments with a view to making high priority routes more climate resilient. Undertake appropriate lifecycle planning to identify the best combination of treatments over time that results in best value or least carbon emissions (may need to be a trade-off between the two). Work with drainage engineers to dovetail in with plans to restore drainage condition and rehabilitate grip drainage as well as implement sustainable urban drainage solutions and natural flood management techniques, to reduce surface water accumulations. Employ technical working group to investigate vulnerability of concrete roads and also to investigate the resilience of current bituminous surfaces and sealants in high temperatures. Note that Eurovia road resurfacing contractor is currently undertaking research into the latter. Employ Technical Working Group to review operating procedures and treatment materials for flexible asphalt to ensure pothole repairs are climate resilient.

Structures	Structures are prone to water damage from scour and other hydraulic stresses (especially masonry arch bridges) and are also prone to ground movement from increased precipitation followed by drought. Expansion joints and bearings may have been designed for temperature ranges which will be exceeded under climate change. Increased strength of winds and increase in storms may result in increase in bridge closures. Around 30% of structures already in poor or very poor condition. Asset failure/closure will have significant impact for safety, accessibility, serviceability, and sustainability of highways network which will have greatest impact for vulnerable people and people in remote communities.	Identify structures most at risk from scour and implement/review current monitoring regime to ensure appropriate. Develop a shrink-swell layer ground related hazard map to identify structures most at risk from ground movement and investigate possibility of improving resilience. Identify structures where expansion joints and bearings may not have been designed for anticipated extreme temperatures and carry out risk assessment to identify what actions may be required. Note that around 30% of structures are already in poor or very poor condition, and therefore risk may be greater for assets where there are already condition concerns. Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2026/27.
Footways/Cycle ways	There are already condition concerns for footway assets. Asset register for Cycleway assets not yet completed, no condition survey undertaken and therefore condition of cycleway assets is unknown. These assets promote active travel which will contribute to the achievement of net zero targets. However, drainage issues currently result in higher incidence of surface water flooding and longer duration of flooding, which will cause condition decline and will have negative impact on active travel, especially during winter months. Negative impact on active travel will result in increased traffic congestion and higher carbon emissions. It will also have negative impact on accessibility to services.	Increase capital funding for footways to address current condition concerns and review treatment programme to make priority hierarchies more climate resilient. Increase revenue funding for footways to address current localised condition concerns. Complete cycleways asset register and undertake condition assessment. Verify required condition with ECC Highways Commissioning/Cabinet Member and determine corresponding capital maintenance investment requirements over time. As with roads, undertake appropriate lifecycle planning to identify the best combination of treatments over time that results in best value or least carbon emissions (may need to be a trade-off between the two). Work with drainage engineers to dovetail in with plans to restore drainage condition and rehabilitate grip drainage as well as implement sustainable urban drainage solutions and natural flood management techniques, to reduce surface water accumulations. Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning for funding from 2025/26.
Essex Highways Green Estate	Roads, footways, and cycleways, create fragmentation of habitat and cause biodiversity decline. They also create high risk scenarios for animals attempting to cross them to move from one habitat to another. Planting of trees close to high-speed roads, which may occur under ECC Tree Plan, will create road safety risks.	Work with reference to Local Nature Recovery Strategy to improve connectivity of habitat. Install animal tunnels, gully grate ladders, recessed kerbs, otter shelves and the like to improve safe animal migration. Include in all new schemes where appropriate and retro fit at existing key locations where appropriate. Explore verge maintenance to encourage connectivity and wildflower growth. Manage water resources better to retain water to release back into environment and explore natural flood management techniques to prevent flooding. Key

	Planting of trees which are not climate resilient will jeopardise achievement of net zero targets.	reference document: ECC Water Strategy - changing land use for water. Explore potential for rain gardens, green bridges, and green walls/roofs to promote biodiversity and contribute to green infrastructure growth targets. Work with ECC to ensure trees that are planted are of climate resilient species and that none is planted close to high-speed roads. Work with external organisations and local communities to identify sites for implementing sustainable urban drainage systems and natural flood management techniques. Draft business case for required investment and explore external funding opportunities/present to ECC Highways Commissioning. Funding year to be determined by Essex Highways Climate Adaptation Work Group.

While other Asset Groups may not be regarded as high priority for climate change risk mitigation, they none the less are included in climate adaptation activities, not least because they require to be monitored regularly – for more information refer to Table 5: Recommended Climate Change Risk Mitigation Measures for Other Asset Groups.

Table 5: Recommended Climate Change Risk Mitigation Measures for Other Asset Groups

Other Asset Group Climate Change Risk Mitigation	**Risk Characteristics**	**Recommended Climate Change Risk Mitigation Measures**
Highway Lighting (including illuminated bollards and illuminated highway signs)	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms which may result in power outages, increased ground movement resulting in heave may create condition integrity problems. Anticipated higher strength winds may pose considerable risk to lighting columns and high mast lighting.	Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.
Traffic Management Systems (including Zebra Crossings, Bus Telematics and Speed Cameras)	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms which may result in power outages, increased ground movement resulting in heave may create condition integrity problems. Anticipated higher strength winds may pose considerable risk to traffic signals, signal gantries, zebra crossing poles and beacons, as well as to speed cameras.	Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.

Vehicle Restraints (safety barriers)	There are already condition concerns for many of these assets. Relatively high exposure to increased precipitation which will accelerate condition decline such as corrosion of posts. High summer temperatures likely to compromise containment performance. Increased wind strength may pose risk to assets. Increased ground movement resulting in heave may create condition integrity problems.	Complete asset register and record asset condition in electronic format. Identify condition and determine asset replacement programme over time. Monitor sensitivity to climate change, i.e. determine if increased precipitation and higher wind strengths are impacting on asset service lives, and review/update strategy for detailed inspections. Liaise with suppliers to identify temperature range included in effective operation, to investigate potential impact of higher temperatures on containment performance. This likely to be an issue for older assets. Review re-tensioning programme to ensure tensioned assets are maintained appropriately for higher temperatures. Liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirement for investment, year of funding to be determined through investigation by Essex Highways Climate Adaptation Work Group.
Winter Management Infrastructure (salt bins and weather stations)	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms which may result in power outages for weather stations. Ground heave may pose considerable risk to weather stations; anticipated higher winds will pose risk for salt bins.	Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.
Public Rights of Way Infrastructure	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms, and to ground movement such as heave. Climate change likely to accelerate condition decline for all assets but especially assets sensitive to climate change such as structures. Increased likelihood of surface water accumulations resulting in flooding. If public rights of way become impassable this may lead to reduced active travel and increased traffic congestion and higher carbon emissions.	Complete Public Rights of Way Improvement Plan to include support for Local Nature Recovery, Biodiversity Gain, and better management of water. Effective public rights of way network required to promote active travel and to support net zero ambitions. Also required to provide access to green spaces that support health and wellbeing. Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.
Passenger Transport Infrastructure	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms, and to ground	Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have

	movement such as heave which may create condition integrity issues. Anticipated higher strength winds may pose considerable risk to wooden and metal bus shelters.	relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.
Other Asset Groups: Cycle Monitoring Sites, Pedestrian Guard Rail, Vehicle Activated Signs, Non-Illuminated Traffic Signs, and other Street Furniture	Relatively high exposure to increased precipitation, high summer temperatures, increased wind strength, increased frequency of storms which may result in power outages for powered assets, increased ground movement resulting in heave may create condition integrity problems. Anticipated higher wind strengths may pose issue for bollards, traffic signs, vehicle activated signs and other street furniture.	Monitor sensitivity to climate change, i.e. likely impact on asset service lives and review/update asset replacement programme. For those assets that have relatively short service lives, liaise with suppliers to obtain more climate resilient asset replacements. Draft business case to explore external funding opportunities/present to petition ECC Highways Commissioning for any increased requirements for investment, funding year to be determined through investigation by Essex Highways Climate Adaptation Work Group.

Glossary

Carbon Emissions; carbon dioxide equivalent (CO2 e). CO2e is the unit for comparing the radiative forcing of greenhouse gases (GHGs) to carbon dioxide. The carbon dioxide equivalent is calculated using the mass of a given GHG multiplied by its global warming potential.

Carbon Emissions Reduction is the quantified decrease in greenhouse gas emissions specifically related to or arising from an activity between two points in time or relative to a baseline.

Carbon Sequestration the process of capturing and storing atmospheric carbon dioxide. It is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of reducing global climate change.

Carbon Insetting is generally recognised as the term given to carbon reduction through the implementation of nature-based solutions for those that have the capacity to do so this within their own estate.

Carbon Management. This is the assessment, reduction, and removal of greenhouse gas emissions during the planning, optioneering, design, delivery, operation, use, end of life (and beyond) of new, or the management of existing, assets, networks and/or systems.

Carbon Offsetting is the discrete reduction in greenhouse gas emissions not arising from the defined subject, made available in the form of a carbon credit meeting a defined set of requirements (as per PAS 2060:2014) and used to counteract emissions from the defined subject. The term 'offsetting' is generally given to the activity of organisations that do not have capacity to implement any kind of nature-based solution with their own estate, so instead fund nature-based solutions to be undertaken elsewhere, such as the purchase of carbon credits.

Carbon Reduction (or Carbon Emissions Reduction) is the process of minimizing greenhouse gas emissions in the development of new, or the refurbishment of existing, assets or networks.

Circular Economy. A circular economy favours activities that preserve value in the form of energy, labour, and materials. This means designing for durability, reuse, remanufacturing, and recycling to keep products, components, and materials circulating in the economy.

Climate Adaptation. This is the adjustment to actual or expected climate change and its effects.

Climate Change. Is the change in weather patterns over time.

Climate Resilience. This is the ability of an asset or service to mitigate the impact of the effects of climate change.

Decarbonisation is a process by which organisations, sectors or other entities aim to achieve zero fossil carbon emissions, typically referring to a reduction of the carbon emissions associated with key sectors, such as electricity, industry and transport.

Embodied Carbon. This refers to the emissions of greenhouse gases arising from: the sourcing and extraction of raw materials needed to build the project; the energy needed to process those raw materials in construction components (i.e. the manufacturing stage); the transporting of those building materials; and the construction activities themselves from construction plant, through to worker accommodation and transport. Embodied carbon is often referred to as supply chain carbon, or construction carbon, and is sometimes considered separately from operational emissions that refer to the emissions of greenhouse gases arising as a result of the operation of a development.

End of Life is the stage which begins when the asset has reached the end of its design life and is ready for refurbishment, retrofit, disposal, dismantling, etc., and ends when the asset is recycled, reused, recovered, or returned to nature.

Financier (or investor) is an individual or organisation that holds financial equity or debt categorised as financial assets.

Green Estate. Highways green estate relates to verges, hedgerows, trees, public rights of way, and premises.

Greenhouse Gas (GHG) Assessment is the process of calculating the total amount of GHG emissions and removals due to the delivery, use, operation, maintenance, demolition and/or reuse of assets and/or networks'

Greenhouse Gases (GHGs) are gases in the earth's atmosphere that trap heat. The gaseous constituents of the atmosphere, natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere and clouds.

Greenhouse gases. Notably these are carbon dioxide, methane, nitrous oxide, hydro-fluorocarbons, perfluorocarbons, nitrogen trifluoride, sulphur hexafluoride. Greenhouse gas emissions (CO2e) are produced by many different sectors within the county: agriculture, mining and quarrying, manufacturing, electricity, water supply, construction, transport etc.

Infrastructure is the basic physical and organisational structures, facilities, equipment and services needed for the operation of an organisation, or the services and facilities necessary for an organisation to function.

Life Cycle is the consecutive and interlinked stages of a product, equipment or service, from raw material acquisition or generation from natural resources to design, production, transportation/delivery, use, end-of-life treatment and final disposal.

Nature-based Solutions are actions to protect, sustainably manage and restore natural or modified ecosystems, simultaneously providing human well-being and biodiversity benefits

Network is a combination of interconnected assets (buildings and infrastructure) that provide services (e.g. water, power, transport) to society as part of a wider system.

Net-Zero refers to the target of reducing the greenhouse gas emissions that cause global warming to zero by balancing the amount released into the atmosphere from sources with the amount removed and stored by carbon sinks. This is also described as 'carbon neutrality'.

SuDS stands for Sustainable Urban Drainage System. Sustainable drainage systems aim to reduce the amount of runoff from a site. Key to this is to slow the flow of water, to allow it to infiltrate into the ground.

Supply Chain in the context of this Strategy is the term given to a list of approved suppliers, all of whom may be included within an overarching contractual agreement for supply of materials, goods and services.

Heat Stress or Urban Heat Island Effect. An urban heat island occurs when a city experiences much warmer temperatures than nearby rural areas. The difference in temperature between urban and less-developed rural areas has to do with how well the surfaces in each environment absorb and hold heat.