ARUP

Milton Keynes City Council

Carbon & Climate Study

Baseline Report

1.0 | March 2024

© https://www.theparkstrust.com/our-work/landscape-management/milton-keynes-inspirational-landscapes/

Job number 295175-00

Ove Arup & Partners Limited
8 Fitzroy Street
London
W1T 4BJ
United Kingdom
arup.com

ARUP

Document Verification

Project title	Carbon & Climate Study
Document title	Baseline report
Job number	295175-00
Document ref	
File reference	

Revision	**Date**	**Filename**	2023-08-18_MKCC_CarbonClimate_BaselineReport_1.0-MazFix		
2.0	22 Sept 2023	**Description**	Interim baseline report		
			Prepared by	**Checked by**	**Approved by**
		Name	Christina Lumsden, Leo Bourikas, Emma Marsland, Georgia Puleikis, Ben Gurney, Elliot Rowen, Jacqueline Stables	Katie Kerr, Marilena Karyampa, Sarah Legge, Jon Rooney	Laura Frost
		Signature			
3.0	January 2024	**Filename**	Stage 2 report – Updated to address MKCC comments		
		Description	Updated to address MKCC comments. Sustainable Places Framework moved from Stage 3 report and added. Some additional best practice policy review added from Stage 3 report.		
			Prepared by	**Checked by**	**Approved by**
		Name	As above.		
		Signature			
3.1	23 Feb 2024	**Filename**	Baseline report		
		Description	Updated to include Urban Heat Island modelling, add image at Figure 19 and for final review.		
			Prepared by	**Checked by**	**Approved by**
		Name	As above.	Click or tap here to enter text.	
		Signature			

Issue Document Verification with Document ☑

Contents

1.	Introduction	6
1.1	Overview	6
1.2	Note on terminology	6
2.	Carbon Baseline	6
2.1	Relevant legislation	6
2.2	Baseline methodology	6
2.3	Baseline analysis	8
2.4	Conclusion and Recommendations	13
3.	Sequestration Baseline	14
3.1	Purpose of sequestration baseline	14
3.2	Baseline methodology	14
3.3	Baseline analysis	14
3.4	Conclusion and Recommendations	17
4.	Air Quality Baseline	18
4.1	Relevant legislation	18
4.2	Baseline methodology	20
4.3	Baseline analysis	20
4.4	Conclusion and Recommendations	32
5.	Climate Risk Baseline	34
5.1	Relevant legislation	34
5.2	Baseline methodology	34
5.3	Baseline analysis	39
6.	Landscape Assessment Update	55
6.1	Introduction	55
6.3	Evidence base review	56
6.4	Approach	58
7.	Best Practice Policy Review	63
7.1	Relevant legislation and policy	63
7.2	Best Practice Guidance	65
7.3	Technical Building Assessments	68
7.4	Best Practice Policy Review	68
7.5	Conclusions and Recommendations	87
8.	Net Zero Building Typologies	89
8.1	Drivers for high energy performance buildings	89
8.2	Methodology	91
8.3	Stranding risk and energy use intensity benchmark	92
9.	Framework for well designed and sustainable places	93
9.1	Sustainable design exemplars in practice	93
9.2	Sustainable design indicators	95

Tables

Table 1: Mapping of sectoral pathways to Milton Keynes sectoral emissions 8
Table 2: Percentage changes in GHG emissions per year 10
Table 3: Air Quality Standards 19
Table 4: Part A processes in Milton Keynes 24
Table 5: Automatic monitoring locations for NO_2 28
Table 6: Non-automatic monitoring locations for NO_2 29
Table 7: Monitoring location for PM_{10} 31
Table 8: Monitoring Locations for $PM_{2.5}$ 32
Table 9: Climate hazards and receptors that form the scope of the climate risk assessment. 35
Table 10: Summary of data used to inform climate risk assessment. 36
Table 11: Likelihood/exposure definitions applied in climate risk assessment. Source: adapted from MKCC Risk Scoring Guidance. Text in italics is adapted to enable interpretation for climate risk context. 37
Table 12: Consequence definitions applied in climate risk assessment. Source: MKCC 38
Table 13: Climate risk matrix applied in climate risk assessment. Source: MKCC 38
Table 14: Fluvial (river) flooding climate risk assessment. 41
Table 15: Surface and sewer water flooding climate risk assessment. 44
Table 16: Groundwater flooding climate risk assessment. 45
Table 17: Reservoir flooding climate risk assessment. 47
Table 18: Water scarcity/drought climate risk assessment. 49
Table 19: Extreme heat climate risk assessment. 52
Table 20: Extreme wind climate risk assessment. 53
Table 21: Existing wind turbine and solar PV developments in Milton Keynes 56
Table 22: Scoping of LCTs 59
Table 23: Summary of LCT sensitivity by development typology 62
Table 24: Summary of Technical Buildings Assessments 68
Table 25: Policies promoting complete neighbourhoods 70
Table 26: Policies promoting people-centred mobility 72
Table 27: Policies promoting connected places 74
Table 28: Policies promoting places for people 74
Table 29: Policies promoting clean construction 75
Table 30: Policies promoting green buildings and energy 78
Table 31: Policies promoting green and nature-based solutions 82
Table 32: Policies promoting sustainable lifestyles (see also Table 11, 12 and 13) 84
Table 33: Policies promoting a green economy 85
Table 34: Policies promoting resilient and distinctive places (see also Table 16) 85
Table 35: CRREM energy use and GHG emissions intensity targets for UK sectors. 92

Figures

Figure 1: Extract of clean technology adoption from CCC report 'The Sixth Carbon Budget: The UK's Path to Net Zero'[4] 8
Figure 2: Milton Keynes' area-wide GHG emissions breakdown by sector in 2021 9

Figure 3: Milton Keynes area-wide GHG emissions from Buildings in 2021 9
Figure 4: Milton Keynes area-wide GHG emissions from Transport in 2021 10
Figure 5: Milton Keynes area-wide GHG emissions 2015 to 2021. 11
Figure 6: Milton Keynes area-wide emissions pathways to 2050 under three scenarios 12
Figure 7. Estimated annual emissions from major developments granted permission in the period 2019 – 2023. 13
Figure 8: Land uses from OSMM within Milton Keynes (in hectares) 15
Figure 9: Milton Keynes Carbon Sequestration land use map. Land uses with the highest carbon sequestration potential are presented in the darkest green colour, with a gradient to the land uses with the lowest sequestration potential presented in an orange colour. Agricultural land is presented in grey and urban land has been omitted. 16
Figure 10: Air Quality Management Areas 21
Figure 11: Part A processes in Milton Keynes 23
Figure 12: Automatic monitoring locations 26
Figure 13: Non-automatic NO_2 monitoring locations 27
Figure 14: Four-step process to assess climate risks in Milton Keynes. 34
Figure 15: Fluvial flood risk map with climate change. Source: SFRA, Appendix D 40
Figure 16: Change in Milton Keynes' winter precipitation through the 21st century, compared with a 1981-2010 baseline. Source: UK-CRI. 40
Figure 17: Risk of flooding from surface water map. Source: SFRA, Appendix E. 42
Figure 18: Risk of flooding from surface water with climate change map. Source: SFRA, Appendix F. 43
Figure 19: Flooded underpass in Central Milton Keynes. Source: shared directly from Milton Keynes City Council. 44
Figure 20: Groundwater flooding map. Source: SFRA, Appendix G. 46
Figure 21: Reservoir inundation map. Source: SFRA, Appendix H. 47
Figure 22: Proportion of time MK is projected to be in SPEI drought. Source: UK-CRI. 49
Figure 23: Count of annual Met Office heatwave events that Milton Keynes is projected to experience. 50
Figure 24: Urban heat island map – peak daytime urban heat island intensity hour from England's hottest day on record (19th July 2022). Data produced using UHeat, an Arup urban heat island model. 51
Figure 25: Urban heat island map – peak nighttime urban heat island intensity hour from England's hottest day on record (19th July 2022). Data produced using UHeat, an Arup urban heat island model. 51
Figure 26: 2016 LSA methodology flow chart 57
Figure 27: Landscape sensitivity assessment process 58

Appendices

Appendices 100
A.1 Landscape classification changes 2016 to 2022 LCA 101
A.2 Review of Legislative Requirements 103
A.3 Best Practice Guidance: Technical Building Assessments 106
A.4 Urban Heat Island modelling (PowerPoint) 113

1. Introduction

1.1 Overview

This document forms the Baseline report of the Milton Keynes Climate and Carbon Study. It comprises a holistic picture of the MKCC administrative area's current emissions, sequestration potential, air quality and exposure to climate risk. It also provides reference standards and frameworks for new planning policies, including through a best practice review and a framework for well designed and sustainable places.

1.2 Note on terminology

On the terminology used in this Baseline report, two key terms are defined as follows:

- Where the term 'New City Plan' is included, this should now be read as 'MK City Plan 2050'; and
- Where the terms 'Milton Keynes', 'Borough', 'MKCC' or variations thereof are included, these should be read as 'MKCC administrative area'.

2. Carbon Baseline

2.1 Relevant legislation

The Climate Change Act 2008 is the basis for the UK's approach to tackling and responding to climate change. It requires that emissions of carbon dioxide and other greenhouse gases are reduced and that climate change risks are adapted to. The Climate Change Act commits the UK government by law to reducing greenhouse gas emissions by at least 100% of 1990 levels (net zero) by 2050.

The Act also established the Committee on Climate Change (CCC) to ensure that emissions targets are evidence-based and independently assessed.

The Climate Change Act requires the government to set legally-binding 'carbon budgets' to act as stepping stones towards the 2050 target. A carbon budget is a cap on the amount of greenhouse gases emitted in the UK over a five-year period. Budgets must be set at least 12 years in advance to allow policy makers, businesses and individuals enough time to prepare. The CCC advises on the appropriate level of each carbon budget. Once a carbon budget has been set, the Climate Change Act places an obligation on the Government to prepare policies to ensure the budget is met.

2.2 Baseline methodology

For the purposes of this study, area-wide baseline emissions for Milton Keynes were reported to a baseline year of 2021 and reported in tCO_2 equivalent (tCO_2e). Greenhouse gas emissions (GHG) for local authorities are published by the Department for Energy Security and Net Zero (DESNZ), and are reported for the years 2005 to 2021[1]. GHG emissions reported relate to energy consumption (electricity and fuel) within the local authority, emissions from waste generated, agricultural activities and land-use, land-use change and forestry (LULUCF) related emissions. Emissions excluded are aviation, shipping and military transport for which, according to DESNZ, "there is no obvious basis for allocation to local areas"[1].

[1] Zero, D. for E.S. and N. (2023). UK greenhouse gas emissions: local authority and regional. www.data.gov.uk. Available at: https://www.data.gov.uk/dataset/723c243d-2f1a-4d27-8b61-cdb93e5b10ff/uk-greenhouse-gas-emissions-local-authority-and-regional; and Technical report on emissions reporting: UK local and regional greenhouse gas emissions estimates for 2005-2021. (2023). Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1168163/uk-local-and-regional-ghg-emissions-2005-to-2021-technical-report.pdf [Accessed September 2023]

Milton Keynes' area-wide baseline emissions were projected to 2050 under three scenarios. The first scenario reflects a baseline scenario, that is expected emissions under current committed central government policies. Two additional emissions projections were developed to reflect the decarbonisation projections to mitigate climate change and stabilise global temperature growth. The full description and data sources are as follows:

- **Baseline scenario** reflects forecast emissions for the UK resulting from committed central government policies implemented, adopted, or planned as of August 2019. This scenario does not include policies announced in the Ten Point Plan, Energy White Paper, Transport Decarbonisation Plan, Industrial Decarbonisation Strategy or proposed within the Net Zero Strategy. This scenario was included in the UK government 'Net Zero Strategy: Build Back Better' published in 2021[2].
- **Tyndall Centre Carbon Budgets** is a decarbonisation pathway for local authorities to contribute a fair share to limiting global warming. The pathways and data were developed by the University of Manchester Tyndall Centre for Climate Change Research[3]. Their carbon budgets translate the "well below 2°C and pursuing 1.5°C" global temperature target and equity principles from the United Nations' Paris Agreement, to sub-national areas within the UK. Carbon budgets for each local authority in the UK are represented in emissions pathways from 2020 to 2100 for carbon emissions from energy consumption only. As such, they do not cover all emissions reported by DESNZ in their regional emissions inventories.
- **Committee on Climate Change (CCC) Balanced Pathway scenario** is a decarbonisation pathway recommended by the CCC to ensure the UK meets its legislated requirements to reduce emissions to net zero by 2050. The Committee on Climate Change produced a recommendation for how the UK should set its 6th carbon budget, recommending a target of 78% reduction by 2035 relative to 1990, and a 63% reduction from 2019[4]. This was based on an assessment of feasible uptake of low carbon technologies and behaviour change per sector, incorporated in the CCC Balanced Pathway Scenario. Figure 1 below shows anticipated key changes in technologies to deliver on this scenario.

Table 2.3
Phase-out dates of high-carbon activities under the Balanced Pathway

Technology/behaviour	Phase-out date (new sales)	Backstop date (operation)
New fossil-fuelled cars and vans	2032 (including plug-in hybrids)	2050
Gas boilers	2033 (in residential homes) 2030-33 (in commercial properties)	2050
Oil boilers	2028 (in residential homes) 2025-26 (in commercial properties)	2050
Gas power generation (unabated)	2030 (no new build of unabated gas plants from this date)	2035
HGVs	2040 (<1% of sales by 2040)	Beyond 2050
Biodegradable waste sent to landfill	N/A	2025 ban on all municipal & non-municipal biodegradable waste going to landfill
Unabated energy-from-waste plants	From today, new plants and extensions should be built with CCS or CCS ready	2050

[2] UK Government (2022). Net Zero Strategy: Build Back Greener. Available at: https://www.gov.uk/government/publications/net-zero-strategy. [Accessed September 2023]

[3] Kuriakose, J et al. (2023). Local and Regional Implications of the United Nations Paris Agreement on Climate Change. Available at: https://carbonbudget.manchester.ac.uk/reports/E06000042/ [Accessed September 2023]

[4] Climate Change Committee (2020). The Sixth Carbon Budget: The UK's Path to Net Zero. Available at: https://www.theccc.org.uk/wp-content/uploads/2020/12/The-Sixth-Carbon-Budget-The-UKs-path-to-Net-Zero.pdf. [Accessed September 2023]

Figure 1: Extract of clean technology adoption from CCC report 'The Sixth Carbon Budget: The UK's Path to Net Zero'[4]

To project emissions from the UK-wide pathways (the Baseline scenario and CCC Balanced Pathway scenario), sectoral reductions against 2021 were applied to the relevant sectoral emissions of Milton Keynes.

Table 1: Mapping of sectoral pathways to Milton Keynes sectoral emissions

Scenario	Scenario Sectoral Pathways	Mapping to Milton Keynes' Sectoral Emissions
Baseline Scenario	Buildings	Domestic Gas; Domestic 'Other'; Commercial Gas; Commercial 'Other'; Public Sector Gas, Public Sector 'Other;
	Industry	Industry Gas, Large Industrial Installations, Industry 'Other'
	Domestic Transport	Transport (Road transport, Railways)
	Power	Domestic Electricity; Commercial Electricity; Public Sector Electricity; Industry Electricity and Agriculture Electricity
	Waste	Landfill and Waste management 'Other'
	Agriculture	Agriculture Gas, Agriculture Other, Agriculture Livestock and Agriculture Soils
CCC Balanced Pathway Scenario	Residential Buildings	Domestic Gas; Domestic 'Other'
	Non-Residential Buildings	Commercial Gas; Commercial 'Other'; Public Sector Gas, Public Sector 'Other;
	Manufacturing and Construction	Industry Gas, Large Industrial Installations, Industry 'Other'
	Surface Transport	Transport (Road transport, Railways)
	Electricity Supply	Domestic Electricity; Commercial Electricity; Public Sector Electricity; Industry Electricity and Agriculture Electricity
	Waste	Landfill and Waste management 'Other'
	Agriculture	Agriculture Gas, Agriculture Other, Agriculture Livestock and Agriculture Soils

2.3 Baseline analysis

Milton Keynes' area-wide GHG emissions in 2021 totalled 1,184 $ktCO_2e$ including net emissions from LULUCF (emissions generated minus emissions sequestered). The most significant proportion of emissions is from domestic buildings (fuels and electricity) and transport (on-road and rail), representing 31% and 28% respectively of total emissions. Industrial sources and commercial buildings - including the public sector - account for 17% and 14% of total emissions respectively. Waste-related emissions and those associated with agriculture are the smallest, representing just 7% and 4% respectively. LULUCF emissions are net positive (positive in reduction), but make a small contribution of just - 2 $ktCO_2e$ (0.2%). This breakdown is shown in Figure 2.

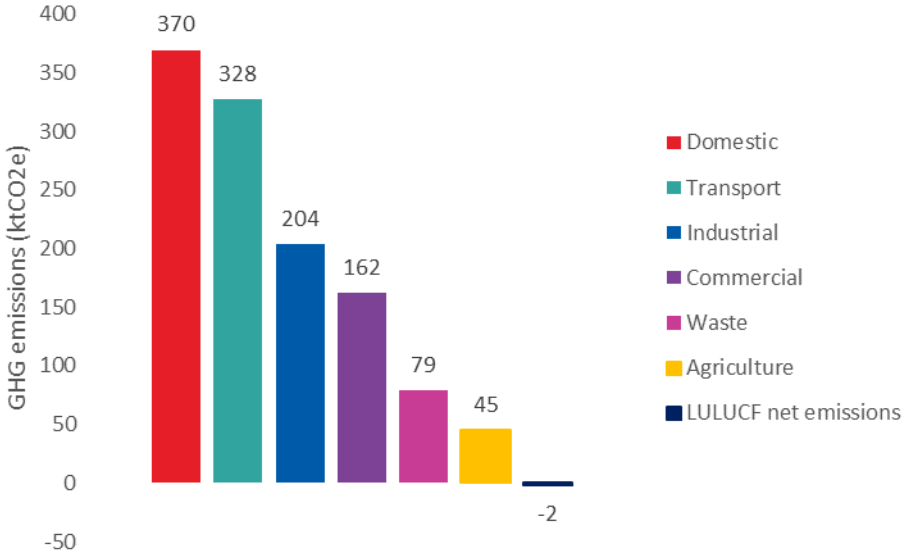


Figure 2: Milton Keynes' area-wide GHG emissions breakdown by sector in 2021

2.3.1 Building emissions

Building-related emissions are composed of domestic and commercial emissions. Taken together, these represent 45% of total emissions. Figure 3 shows the breakdown by end user and fuel group: electricity or fuel. Fuel emissions refer to combustion of fossil fuels, predominantly natural gas for heating and hot water.

In Milton Keynes, as in most local authorities, emissions from dwellings dominate and within these the combustion of fuels represents 53% of total Buildings sector emissions. Commercial and Domestic fuels together represent 67% of Buildings sector GHG emissions.

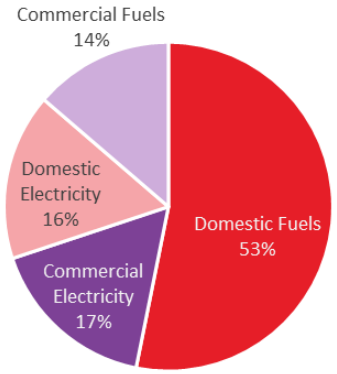


Figure 3: Milton Keynes area-wide GHG emissions from Buildings in 2021

2.3.2 Transport emissions

Transport emissions are also reported at a greater disaggregation, as shown in Figure 4. Road transport-related emissions dominate, representing 98% of total transport GHG emissions. Road transport emissions from A-roads and minor roads are evenly split, according to the reporting in 2021.

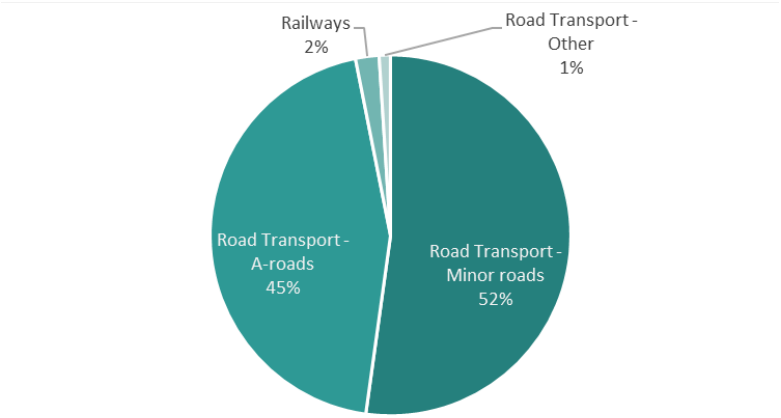


Figure 4: Milton Keynes area-wide GHG emissions from Transport in 2021

2.3.3 Emissions over time

Milton Keynes' GHG emissions have fluctuated since 2016, as shown in Table 2 and Figure 5.

Table 2 shows the percentage change in emissions per sector and over time. Domestic and Commercial emissions (Buildings sector) were decreasing until 2021 and showed a rise in 2021. Transport and Industrial emissions have varied more, fluctuating up and down depending on the year.

It is notable that there is a 19% decrease in transport emissions in 2020, the year of the Covid-19 pandemic, and that emissions rose again in 2021 albeit not returning to the emission level in 2019. This could indicate a permanence in certain behaviour changes which affect transport emissions, such as working from home.

The trend within the emissions in waste and agriculture is affected by new data availability from 2018 onwards, which therefore increased the emissions in these sectors. Within the waste sector, landfill-related emissions were included from 2018 onwards; and within agriculture, direct emissions from livestock and soils were included from 2018 onwards.

Overall, total GHG emissions have decreased since 2015 by 14%, and showed a decline since 2020 of 5%.

Table 2: Percentage changes in GHG emissions per year

Annual % changes	2015	2016	2017	2018	2019	2020	2021
Domestic	-	-3%	-6%	-2%	-3%	0%	4%
Commercial	-	-16%	-15%	-20%	-14%	-16%	10%
Industrial	-	-10%	9%	20%	-7%	-7%	8%
Transport	-	3%	-3%	-4%	0%	-19%	4%
Waste	-	-3%	5%	678%	-33%	26%	-5%
Agriculture	-	-11%	12%	530%	-5%	3%	-1%
LULUCF net emissions	-	-39%	26%	0%	10%	-2%	-4%
Total		-5%	-5%	7%	-7%	-8%	5%

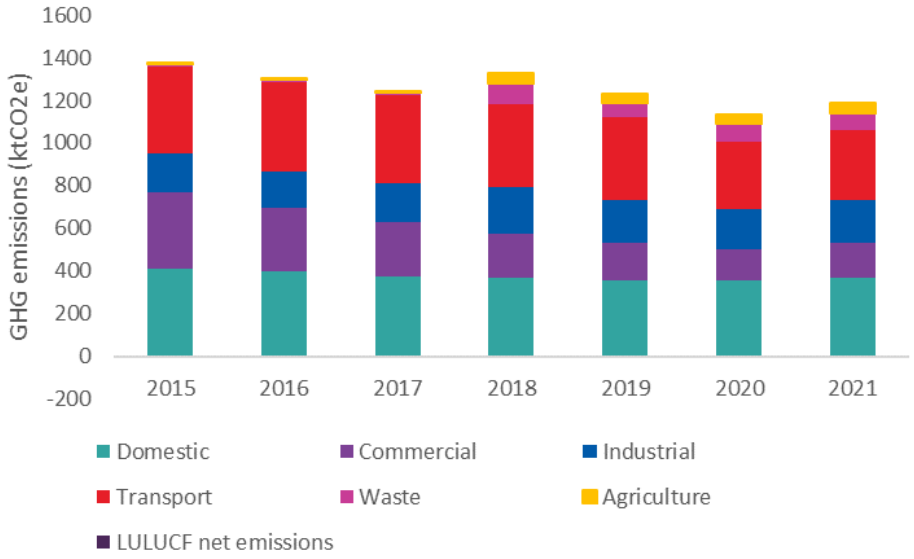


Figure 5: Milton Keynes area-wide GHG emissions 2015 to 2021.

2.3.4 Emissions projections

Figure 6 shows the projected emissions to 2050 under the scenarios described in Section 1.2. Sectoral emissions are shown according to the UK government reported Baseline scenario. According to the Baseline scenario, GHG emissions in Milton Keynes are projected to reduce by 17% in 2030 and 34% in 2050 compared with emissions in 2021. Most sectors show a decline in emissions; however it is notable that domestic emissions are forecast to increase to 2050 despite incorporating grid-decarbonisation projections, highlighting how challenging this sector is to decarbonise.

Under the CCC Balanced Pathway Scenario, total emissions in Milton Keynes would reduce by 42% in 2030 and 95% in 2050. This is a net zero pathway as recommended by the CCC.

The Tyndall Centre Carbon Budget was developed to showcase the carbon emissions pathway for energy-related emissions only (fuel and electricity) and as such can be assumed to apply to 1,065 $ktCO_2e$ or 90% of total GHG emissions based on the data from 2021[5]. This scenario is a top-down recommendation for how Local Authorities can make a fair share contribution to the Paris Agreement and recommends approximately a 74% and 98% reduction in energy-related emissions in 2030 and 2050 respectively, against 2021 emissions.

[5] Excluded direct emissions from Agriculture, Waste and LULUCF as these include a large share of non-energy related emissions.

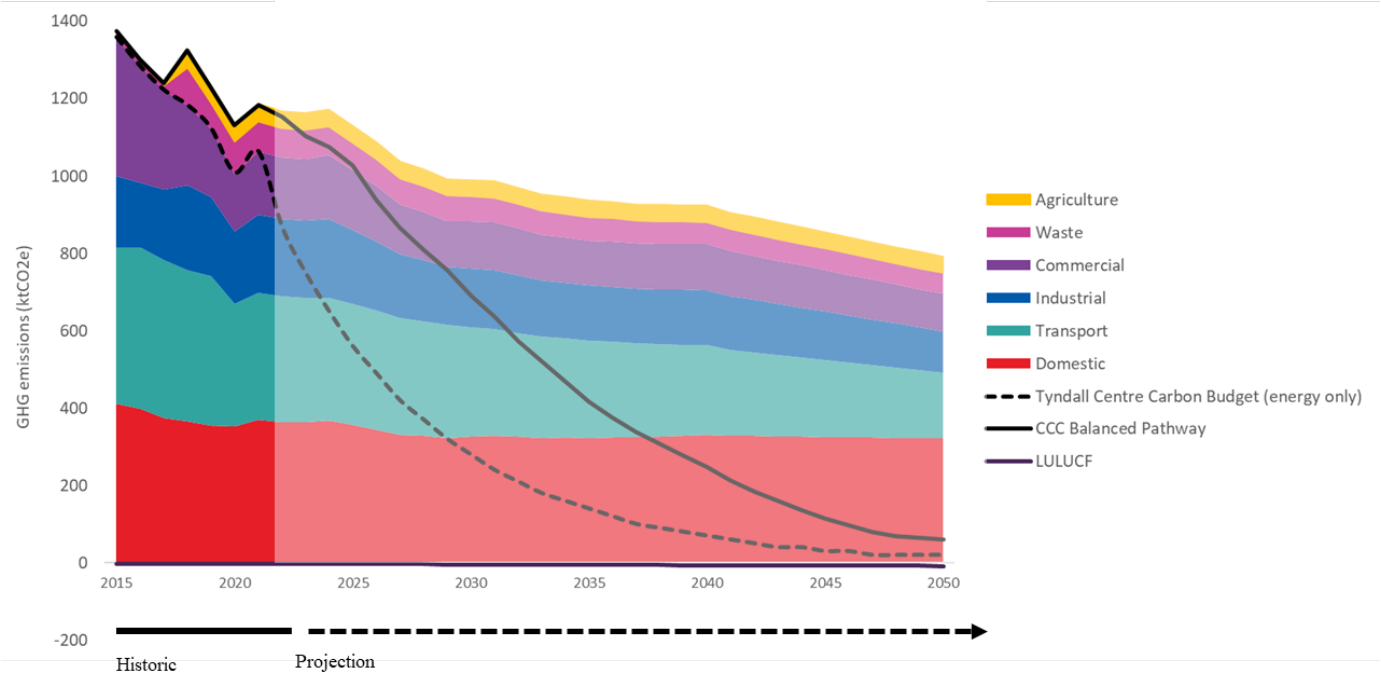


Figure 6: Milton Keynes area-wide emissions pathways to 2050 under three scenarios

2.3.5 Currently permitted development baseline update

This analysis considered the carbon impact from major developments that have been granted permission in the period 2019 to 2023. In total, permissions were granted for 17,456 dwellings and 81ha of employment land. For the carbon modelling it was assumed that small development (≤1,500 dwellings) is completed in 1 year, medium (1,500 < dwellings ≤4,000) development may be completed in 5 years and large development (>4,000 dwellings) it can take up to 10 years to complete. The modelling has considered updates in Building Regulations during this period. It was assumed that all new dwellings from 2026 onwards have an Air Source Heat Pump system installed instead of gas boilers. Transport emissions calculations assumed that development mainly took place within and at the borders of Milton Keynes, and nearby suburbs assuming an urban conurbation growth model.

The results show that new development has a significant contribution to the MK emissions baseline, as shown in Figure 7. The previously permitted development creates a historical backlog of emissions that will be added to the emissions of the existing building stock. This will likely increase emissions from buildings and transport to 2030 before grid decarbonisation, electrification of transport and heating, and other transport interventions start reducing emissions associated with existing growth.

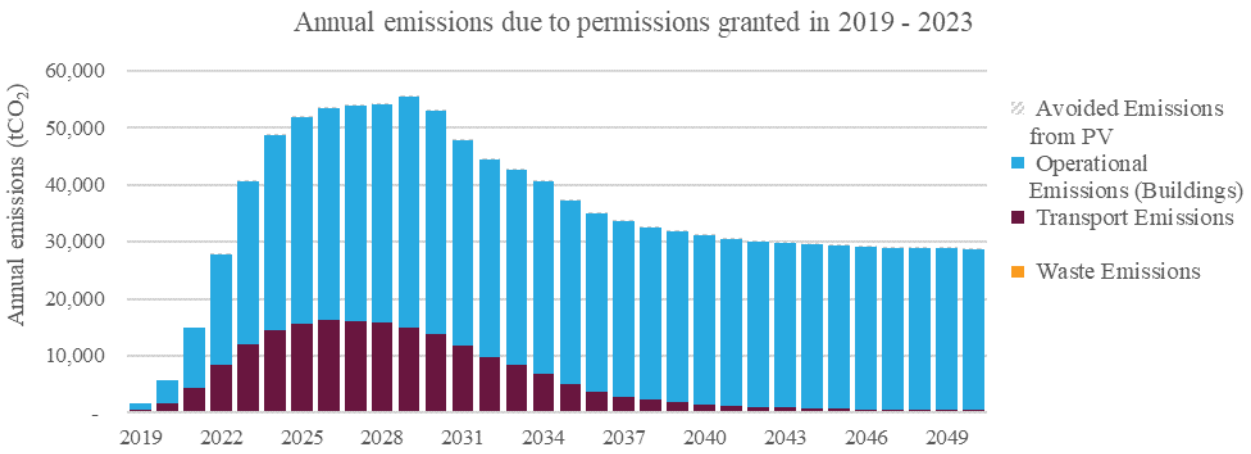


Figure 7: Estimated annual emissions from major developments granted permission in the period 2019 – 2023

2.4 Conclusion and Recommendations

The findings from the carbon analysis highlight sectors where Milton Keynes could leverage its powers and convening role to accelerate climate action:

- Buildings: Domestic and commercial buildings together represent 45% of Milton Keynes' total emissions in 2021. Milton Keynes City Council could consider the role they can take to improve energy efficiency and fuel switching. Key strategies promoted within the CCC 6th Carbon Budget Report[4] include retrofitting buildings and transitioning heating systems to low carbon fuels, with heat pumps promoted as the more cost effective and feasible option in most cases.
- Transport: Transport emissions account for 28% of total area-wide emission in Milton Keynes, of which 98% are from on-road transport. MKCC can impact these emissions by encouraging the greater uptake of public and active transport amongst its communities, as well as influence private network providers such as the bus operators. Within the MK Bus Improvement Plan[6], there is an ambition to support bus operators to transition all vehicles to electric by 2030. Additionally, innovative models for public transport provision such as MKConnect[7] could be expanded to serve a greater share of the population within urban areas. A modal shift to public and active transport will need to be supported with infrastructure and planning policies to facilitate the transition towards more sustainable and healthy travel choices.
- Waste and agriculture represent a smaller share of emissions (7% and 4% respectively), however these also play a critical role to address emissions and achieve net zero. Addressing emissions from landfill sites and increasing rates of recycling should be priorities for MKCC. With respect to agriculture, planning policies cannot affect agricultural policy directly, but can influence the amount of greenfield development that comes forward in the new plan, and therefore the supply of best quality and most versatile agricultural land.

[6] Milton Keynes Bus Service Improvement Plan Excellent, green and inclusive public transport. (2021). Available at: https://www.milton-keynes.gov.uk/sites/default/files/2021-12/Bus%20Service%20Improvement%20Plan.pdf [Accessed September 2023].

[7] Milton Keynes. (ND). MK Connect. Available at: https://getaroundmk.org.uk/on-board/mk-connect [Accessed September 2023]

3. Sequestration Baseline

3.1 Purpose of sequestration baseline

The DESNZ values for LULUCF were presented as part of the Carbon Baseline (Section 1), however these values cannot be broken down spatially across the MKCC administrative area. Therefore, a baseline map of carbon sequestration potential for Milton Keynes was prepared to spatially demonstrate the carbon sequestration potential of current land uses within the MKCC administrative area. Carbon sequestration calculations were also prepared as part of the process.

The analysis undertaken in the Carbon Baseline drew upon local authority emissions data published by the DESNZ. The scope and methodology behind the DESNZ LULUCF values is presented in a published methodology report[8]. The methodology used to prepare the high resolution carbon sequestration mapping and analysis is described below.

3.2 Baseline methodology

The Ordnance Survey MasterMap (OSMM) layer in GIS was used to establish the current breakdown of land uses within the Milton Keynes local authority boundary. Carbon sequestration values ($tCO_2e\ ha^{-1}\ yr^{-1}$) (otherwise known as carbon flux values) were selected from the literature and matched to the OSMM land use categories. Carbon sequestration values were sourced from Natural England[9], the Woodland Carbon Code[10] and the Environment Agency[11]. The areas of the land use polygons from OSMM were multiplied with the relevant carbon sequestration values to represent annual carbon sequestration potential across the city associated with current land uses. Urban land was given a sequestration value of zero.

3.3 Baseline analysis

As shown in Figure 8, Milton Keynes is dominated by agricultural land (57%), followed by urban land (34%) (including structures and transport infrastructure, e.g. roads, railways), trees with other vegetation (for examples trees and shrub) (5%) and trees (1%). Most urban settlements are located in the south of the MKCC administrative area and are intersected by green infrastructure.

The Baseline Carbon Sequestration map is presented in Figure 9, with the darkest green reflecting highest carbon sequestration potential. Urban land uses including civil infrastructure have been omitted. It should be noted that although agricultural land has a positive carbon sequestration value (therefore is on average most likely to be emitting carbon rather than sequestering), the actual carbon sequestration value will vary site to site and will be highly dependent on agricultural practices carried out, as regulated by DEFRA. For example, if sustainable agricultural practices have been implemented then the land is more likely to be sequestering carbon than emitting. For this reason, agricultural land is presented in a grey colour.

The total annual carbon sequestration potential for Milton Keynes has been estimated as -44,991 tCO_2e from this analysis.

---

[8] Department for Energy Security and Net Zero (2021) Mapping Carbon Emissions & Removals for the Land Use, Land-Use Change & Forestry Sector. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/996062/lulucf-local-authority-mapping-report-2019.pdf [Accessed September 2023]

[9] Natural England (2021) Research Report NERR094: Carbon storage and sequestration by habitat: a review of the evidence (second edition). Available at: https://publications.naturalengland.org.uk/publication/5419124441481216 [Accessed September 2023]

[10] Woodland Carbon Code (2021) Carbon Calculation spreadsheet Available at: https://www.woodlandcarboncode.org.uk/standard-and-guidance/3-carbon-sequestration/3-3-project-carbon-sequestration [Accessed September 2023]

[11] Environment Agency (2021) Achieving net zero: A review of the evidence behind potential carbon offsetting approaches. Available at: https://www.gov.uk/flood-and-coastal-erosion-risk-management-research-reports/achieving-net-zero-carbon-emissions-a-review-of-the-evidence-behind-carbon-offsetting [Accessed September 2023]

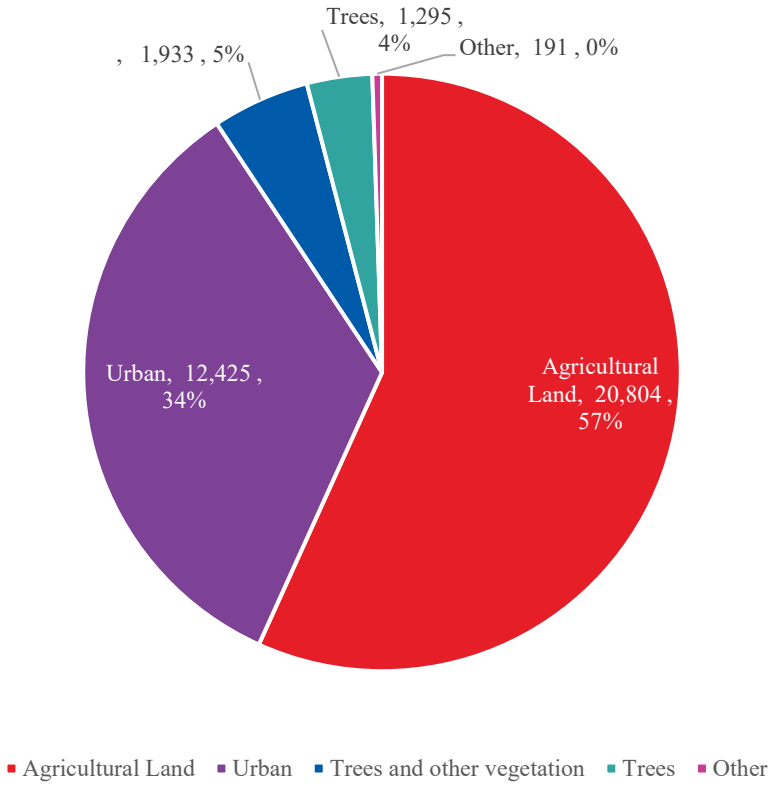


Figure 8: Land uses from OSMM within Milton Keynes (in hectares)

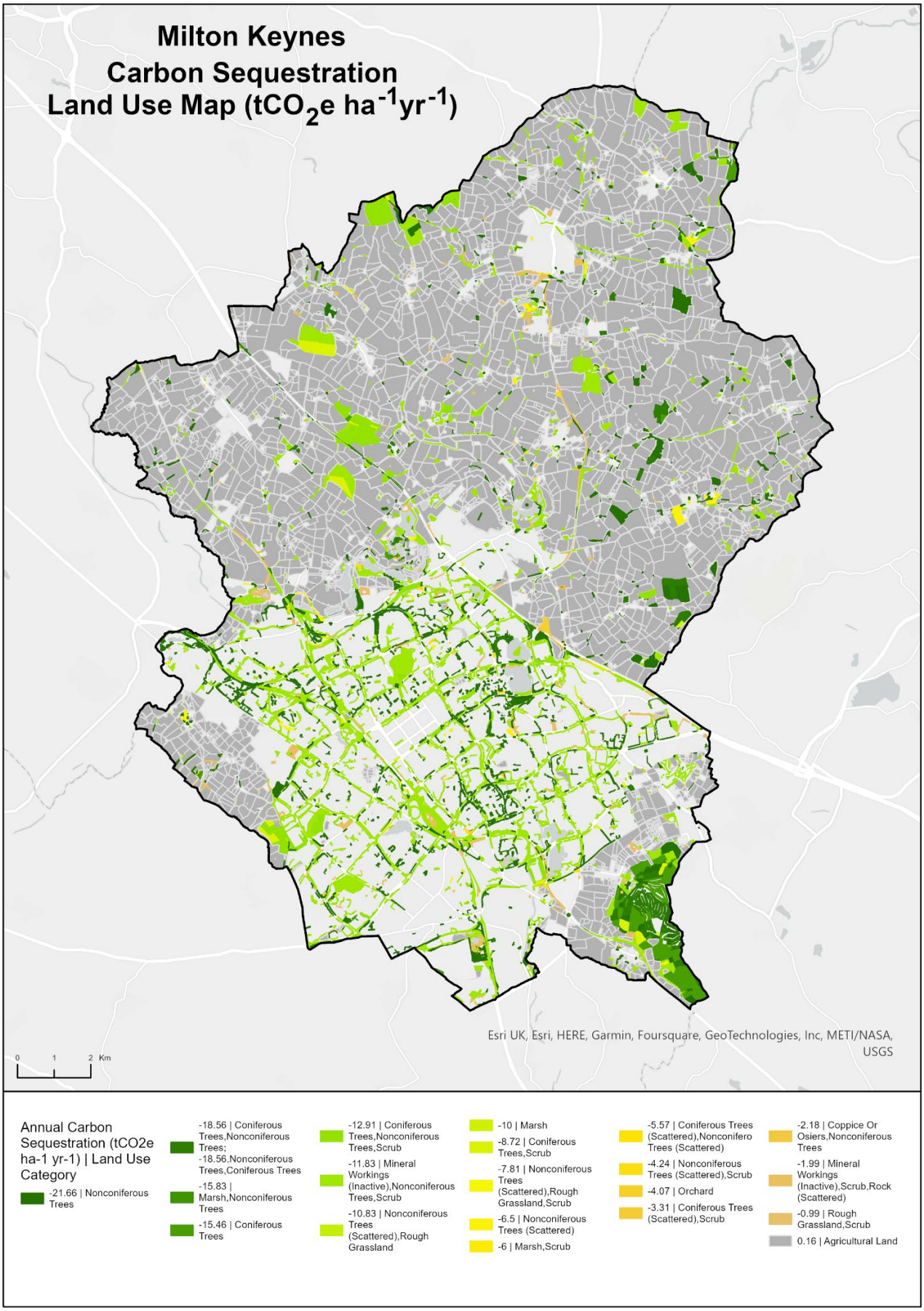


Figure 9: Milton Keynes Carbon Sequestration land use map. Land uses with the highest carbon sequestration potential are presented in the darkest green colour, with a gradient to the land uses with the lowest sequestration potential presented in an orange colour. Agricultural land is presented in grey and urban land has been omitted.

3.4 Conclusion and Recommendations

The carbon sequestration land use map provides direction as to the land uses across Milton Keynes that have the greatest potential to sequester carbon from the atmosphere. This baseline therefore highlights area of the city where land should be considered for protection from development due to its inherent sequestration potential, which will contribute to reducing the city's net emissions.

The map also indicates areas where carbon sequestration is not currently significant. In these areas, interventions to enhance sequestration may be considered through the implementation of nature-based solutions. Larger-scale nature-based solutions may be possible on greenfield land, such as tree planting, while smaller-scale solutions can be incorporated into sites that are selected for development. As development locations are identified over time, it will be possible to identify the solutions that are most appropriate in a given location, enabling greater direction for planning policy.

Figure 9 shows that urban and semi-urban green space have an important function as net carbon absorbers from the atmosphere along with widely acknowledged benefits for air quality, mental and physical health of MK residents and animals. Planning policy should consider how new developments (and redevelopments) can positively affect the green infrastructure through the creation of high-quality space and corridors that connect blue, green space and natural features. This is an important element in design and management of ecosystem services that can enhance carbon sequestration, biodiversity and maximise social co-benefits.

Development site selection should acknowledge the value of natural environments and aim to minimise and mitigate any residual impact. Brownfields, formerly developed areas, and areas with low sequestration potential should be considered as first options for development. Planning policy should require evidence that carbon sequestration has been considered at site level and where appropriate, adequate measures have been integrated into design and construction phases to enhance the post-development sequestration potential. Sequestration should be included as a planning permission guidance in a holistic approach looking into biodiversity, sustainable drainage, surface water run-off, rainwater collection, evaporative cooling potential and shading (urban heat island intensity, overheating), air quality, human and local animal health.

Agricultural and other non-developed land has also been considered for renewable energy systems, with a focus on solar PV panels. Recent examples have showcased how this type of development can be combined with sustainable land use practices in a "dual use" of land[12] for renewable energy and ecosystem services, agriculture, or livestock related activities. Planning policy should require developers to explore such options and adopt in their designs and operation features that can increase sequestration, enhance biodiversity, and deliver quality improvements to maximise benefits for nature and local communities.

[12] For example, see Enel & Arup report "Towards Sustainable Solar Energy". Available at: https://www.arup.com/perspectives/publications/research/section/toward-sustainable-solar-energy [Accessed September 2023]

4. Air Quality Baseline

4.1 Relevant legislation

Environment Act 2021

The Environment Act 2021[13] amends the Environment Act 1995[14] and the Clean Air Act 1993[15] to give local authorities more power to reduce local pollution, particularly that from domestic burning. It also amends the Environmental Protection Act 1990[16] to reduce smoke from residential chimneys by extending the system of statutory nuisance to private dwellings.

The following sections of the Environment Act 1995[17] have been transposed into the Environment Act 2021.

- The Secretary of State must develop, implement and maintain an Air Quality Strategy. This includes the statutory duty, also under Part IV of the Environment Act 1995, for local authorities to undergo a process of local air quality management and declare an Air Quality Management Area (AQMA) where pollutant concentrations exceed the national air quality objectives. Where an AQMA is declared, the local authority needs to produce an Air Quality Action Plan (AQAP) which outlines the strategy for improving air quality in these areas.
- The Act will implement key parts of the Government's Clean Air Strategy and include targets for tackling air pollution in the UK.

The Environment Act 2021 includes the following considerations for air quality[18]:

- for the Secretary of state for Defra to set long-term legally binding targets on air quality, of at least 15 years' duration;
- for the Secretary of State to publish a report reviewing the Air Quality Strategy every five years;
- for the Office for Environmental Protection to be established[19] to substitute the watchdog function previously exercised by the European Commission;
- for local authorities' powers to be extended under the current Local Air Quality Management framework, including responsibilities to improve local air quality and to reduce public exposure to excessive levels of air pollution;
- for "air quality partners" to have a duty to share responsibility for dealing with local air pollution among public bodies; and
- to introduce a new power for the Government to compel vehicle manufacturers to recall vehicles and non-road mobile machinery if they are found not to comply with the environmental standards that they are legally required to meet.

[13] Environment Act 2021. Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted. Accessed [Accessed March 2023].

[14] Environment Act 1995, Chapter 25, Part IV Air Quality.

[15] Clean Air Act 1993. Available at: https://www.legislation.gov.uk/ukpga/1993/11/contents. [Accessed March 2023]

[16] Environmental Protection Act 1990. Available at: https://www.legislation.gov.uk/ukpga/1990/43/contents. [Accessed March 2023]

[17] Environment Agency (2016) Air emission risk assessment for your environmental permit. Available at: https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit#environmental-standards-for-air-emissions [Accessed March 2023]

[18] Environment Act 2021. Part 4 Air Quality and Environmental Recall.

[19] Environment Act 2021. Chapter 2. The Office for Environmental Protection.

Air Quality Standards

Air quality limit values[20] and objectives are quality standards for clean air. Some pollutants have standards expressed as annual average concentrations due to the chronic way in which they affect health or the natural environment, i.e. effects occur after a prolonged period of exposure to elevated concentrations. Other pollutants have standards expressed as 24-hour, 1-hour or 15-minute average concentrations due to the acute way in which they affect health or the natural environment, i.e. after a relatively short period of exposure. Some pollutants have standards expressed in terms of both long and short-term concentrations.

In this assessment, the term 'air quality standard' has been used to refer to both the UK objectives and European limit values. Table 3 sets out the air quality standards for nitrogen dioxide (NO_2) and particulate matter (PM_{10} and $PM_{2.5}$). Other pollutants have been screened out of this air quality assessment since they are not likely to cause exceedances of their respective standards.

In this assessment, a 10µg/m^3 standard has been used for $PM_{2.5}$, as under the Environment Act 2021[1] the UK Government set new legally-binding long-term targets to reduce concentrations of $PM_{2.5}$[21]. This target includes a reduction to an annual mean concentration of 10µg/m^3 by 2040. This target will help drive reductions in $PM_{2.5}$ across the country, whilst ensuring nationwide action to improve local air quality.

Table 3: Air Quality Standards

Pollutant	Averaging Period	Air Quality Standard
Nitrogen dioxide (NO_2)	Annual mean	40µg/m^3
	1-hour mean	200µg/m^3 not to be exceeded more than 18 times a year (99.79th percentile)
Particulate matter (PM_{10})	Annual mean	40µg/m^3
	24-hour mean	50µg/m^3 not to be exceeded more than 35 times a year (90.41st percentile)
Fine particulate matter ($PM_{2.5}$)	Annual mean*	20µg/m^3
		10µg/m^3 *(to be achieved by 2040)*
		12µg/m^3 *(interim target to be achieved by 2028)*
* The Environmental Targets (Fine Particular Matter) (England) Regulations 2023 state that "the annual mean level of $PM_{2.5}$ in ambient air must be equal to or less than 10µg/m^3 ("the target level")" by 31st December 2040. However, Defra guidance is to continue to assess impacts against existing air quality standards (20 µg/m^3), until the upcoming 2023 Air Quality Strategy is released with further details. The Environmental Improvement Plan (2023) also sets an interim target of 12µg/m^3, to be achieved by 31 January 2028.		

[20] UK Air Quality Limits, 2023. Available at: https://uk-air.defra.gov.uk/air-pollution/uk-eu-limits [Accessed August 2023]

[21] Defra Air Quality strategy: framework for local authority delivery, 2023. Available at: https://www.gov.uk/government/publications/the-air-quality-strategy-for-england/air-quality-strategy-framework-for-local-authority-delivery [Accessed August 2023]

4.2 Baseline methodology

Existing or baseline ambient air quality refers to the concentration of relevant substances that are already present in the environment. These are present from various sources, such as industrial processes, commercial and domestic activities, road traffic and natural sources.

The baseline analysis has considered background air pollutant concentrations from sources including:

- local authority review and assessment reports and local air quality monitoring data[22], extracting local monitoring locations of MKCC;
- the UK Air Information Resource website from the Department for Environment, Food and Rural Affairs (Defra)[23], extracting background concentrations of locations across MKCC;
- the Environment Agency Industrial Processes database[24], extracting local industrial processes from across MKCC; and
- the UK National Atmospheric Emissions Inventory[25] (NAEI), extracting relevant information on pollutant concentrations from across MKCC.

4.3 Baseline analysis

4.3.1 Local air quality

The Environment Act 2021[26] requires local authorities to report to Defra on local air quality and local air quality management within their local authority area. This also requires an assessment of compliance with the relevant air quality standards.

Information on air quality in the UK can be obtained from a variety of sources including local authorities, national network monitoring sites and other published sources. Main sources of pollution across Milton Keynes are expected to be from road traffic and industrial processes.

4.3.2 Local authority review and assessment

Where standards are predicted not to be met, local authorities must declare the area as an AQMA. They are also required to produce an AQAP which includes measures to improve air quality in the AQMA.

There is one AQMA I in the local authority area, the Olney AQMA, which was declared in 2008 for exceedances in the annual mean NO_2 standard, shown in Figure 10, however it is proposed to be revoked as air pollution has been within the objective for several years. The AQMA encompasses all properties fronting Bridge Street and High Street South, and part of Market Place. The AQMA was considered for revocation in 2021[27], but no further information around this has been found, and the AQMA still remains on the Defra AQMA website[28]. MKCC have included an AQAP within a document surrounding this AQMA[29].

---

[22] Milton Keynes City Council (2022) Milton Keynes City Council Annual Status Report Available at: https://www.milton-keynes.gov.uk/sites/default/files/2022-10/ASR_MKC_2022_v2.0.pdf [Accessed July 2023]

[23] Defra. (2023) UK Air. Available at: https://uk-air.defra.gov.uk/ [Accessed July 2023]

[24] Environment Agency Industrial Processes. (2023). Available at: https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed August 2023]

[25] NAEI. (2023). Available at: https://naei.beis.gov.uk/ [Accessed August 2023]

[26] Environment Act (2012) Available at: https://www.legislation.gov.uk/ukpga/2021/30/contents/enacted [Accessed July 2023]

[27] Olney (2021) AQMA Revocation Report. Available at: https://www.milton-keynes.gov.uk/sites/default/files/2023-01/Revocation%20report%208Oct21.pdf [Accessed July 2023]

[28] Defra (2023) AQMA. Available at: https://uk-air.defra.gov.uk/aqma/details?aqma_ref=581 [Accessed July 2023]

[29] Olney Action Plan (2012) Available at: https://www.milton-keynes.gov.uk/sites/default/files/2022-08/MK%20Council%20Olney%20Action%20Plan%20Nov12.pdf [Accessed July 2023]

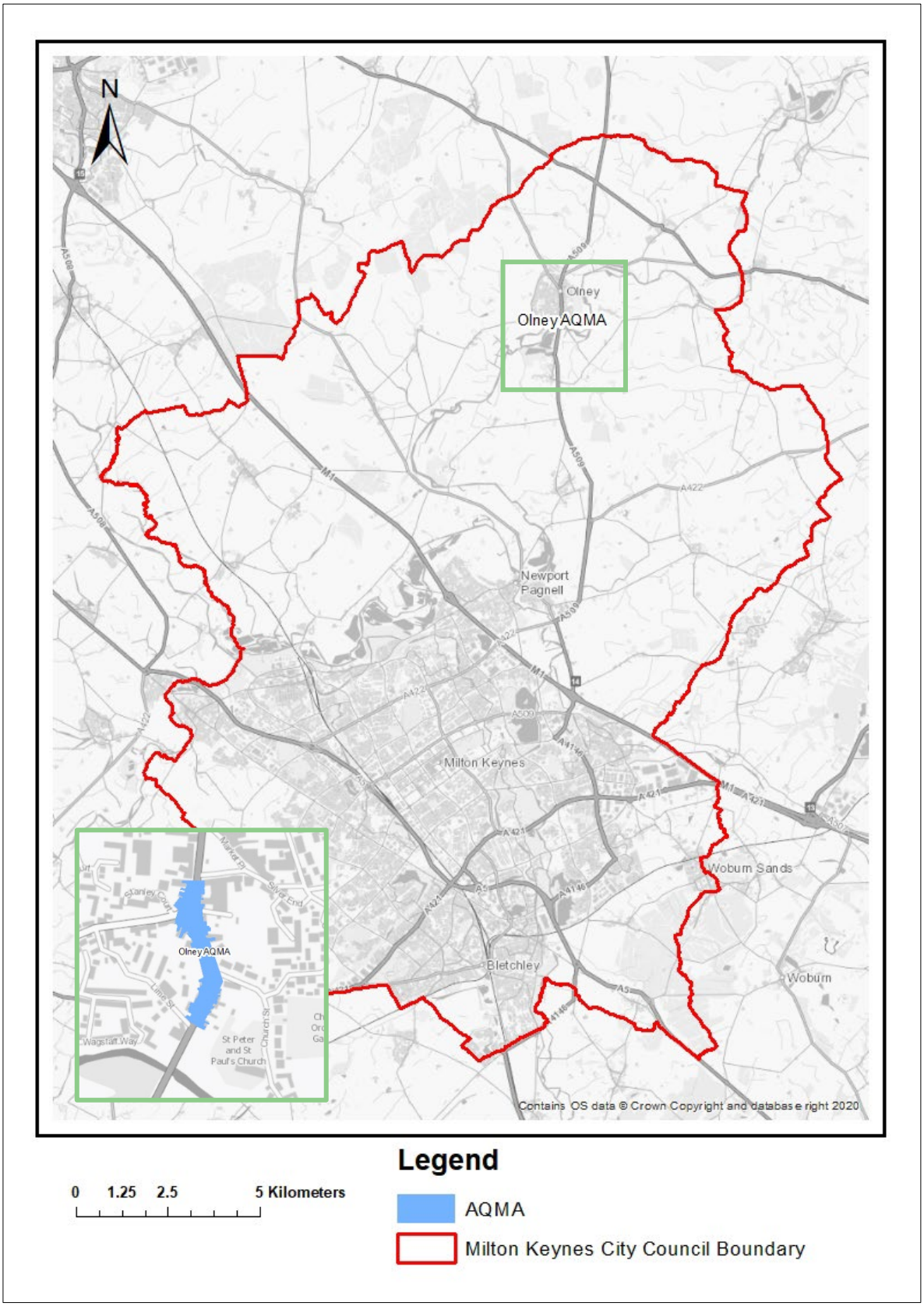


Figure 10: Air Quality Management Areas

4.3.3 Industrial processes

Industrial air pollution sources are regulated through a system of operating permits or authorisations, requiring stringent emission limits to be met and ensuring that any releases to the environment are minimised or rendered harmless. Regulated (or prescribed) industrial processes are classified as Part A, and are regulated through the Pollution Prevention and Control (PPC) system[30,31]. The larger more polluting processes are regulated by the Environment Agency, and the smaller less polluting ones by local authorities. Local authorities regulate only for emissions to air, whereas the Environment Agency regulates emissions to air, water and land.

The Public Register online, provided by the Environment Agency, licenses industry, businesses, and individuals to carry out activities that may pollute the environment[32]. The register shows there are 13 Part A processes in Milton Keynes, shown in Figure 11. Details of these are also included in Table 4.

The contribution of all industrial processes is included within the Defra background pollutant estimates (detailed in section 4.3.5).

[30] Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control)

[31] The Environmental Permitting (England and Wales) (Amendment) Regulations 2013, SI 2013/390

[32] Environment Agency Industrial Processes (2023). Available at: https://environment.data.gov.uk/public-register/view/search-industrial-installations [Accessed August 2023].

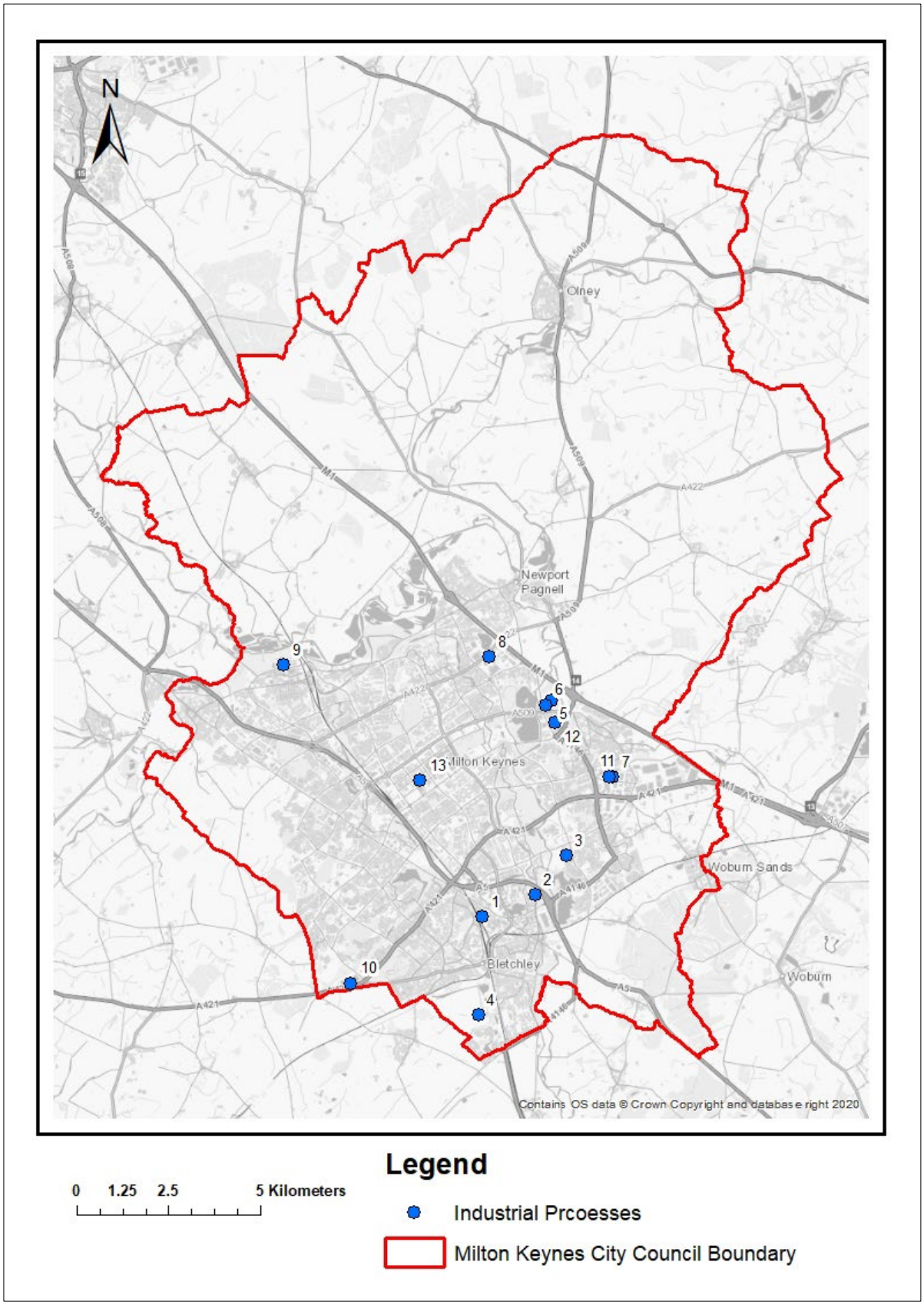


Figure 11: Part A processes in Milton Keynes

Table 4: Part A processes in Milton Keynes

Site ID	Operator	OS grid reference		Activity Type
		X	Y	
1	UK POWER RESERVE LIMITED	486710	234770	Combustion Plant
2	POWER UP GENERATION LIMITED	488150	235380	Combustion Plant
3	MSD ANIMAL HEALTH UK LIMITED	489000	236460	Pharmaceuticals
4	FCC WASTE SERVICES (UK) LIMITED	486600	232090	Waste Landfill
5	ANGLIAN WATER SERVICES LIMITED	488590	240700	Directly Associated Activity
6	ALPHEUS ENVIRONMENTAL LIMITED	488440	240570	Hazardous Waste
7	2M MANUFACTURING LIMITED	490280	238590	Organic Chemicals
8	WAFER TECHNOLOGY LIMITED	486900	241890	Inorganic Chemicals
9	THALIA WASTE MANAGEMENT LIMITED	481290	241650	Incinerator
10	CRANSWICK CONVENIENCE FOODS LIMITED	483120	232960	Animal Food Treatment
11	THE INDIUM CORPORATION OF AMERICA	490190	238610	Inorganic Chemicals
12	REFRESCO DRINKS UK LIMITED	488700	240100	Animal Food Treatment
13	THAMESWEY CENTRAL MILTON KEYNES LIMITED	485020	238500	Combustion Plant

4.3.4 Local authority monitoring

There is both automatic and non-automatic (diffusion tube) monitoring of NO_2 taking place in Milton Keynes. There are three automatic monitoring locations operated by MKCC, shown in Figure 12, listed in Table 5, and 40 non-automatic monitoring locations, shown in Figure 13 and listed in Table 6.

No exceedances of the NO_2 air quality standard were recorded at any of the monitoring locations from 2018 to 2022. Annual mean NO_2 concentrations were well below the air quality standard at all monitoring sites with the highest concentrations having been recorded at site C1, C2, C3 (36.4µg/m^3) in 2019.

There is one monitoring location for PM_{10} in Milton Keynes, shown in Figure 12 and listed in Table 7. No exceedances of the annual PM_{10} standard were recorded at this monitoring location from 2018 to 2022. The highest concentration was recorded in 2019 (6.1 µg/m^3).

There is one monitoring location for $PM_{2.5}$ in MKCC, shown in Figure 12 and listed in Table 8. This monitoring site exceeded the $PM_{2.5}$ standard of 10µg/m^3 in 2019, with the recorded concentration being 11.2µg/m^3. This is the highest recorded concentration at this location, with results available from 2019 to 2022.

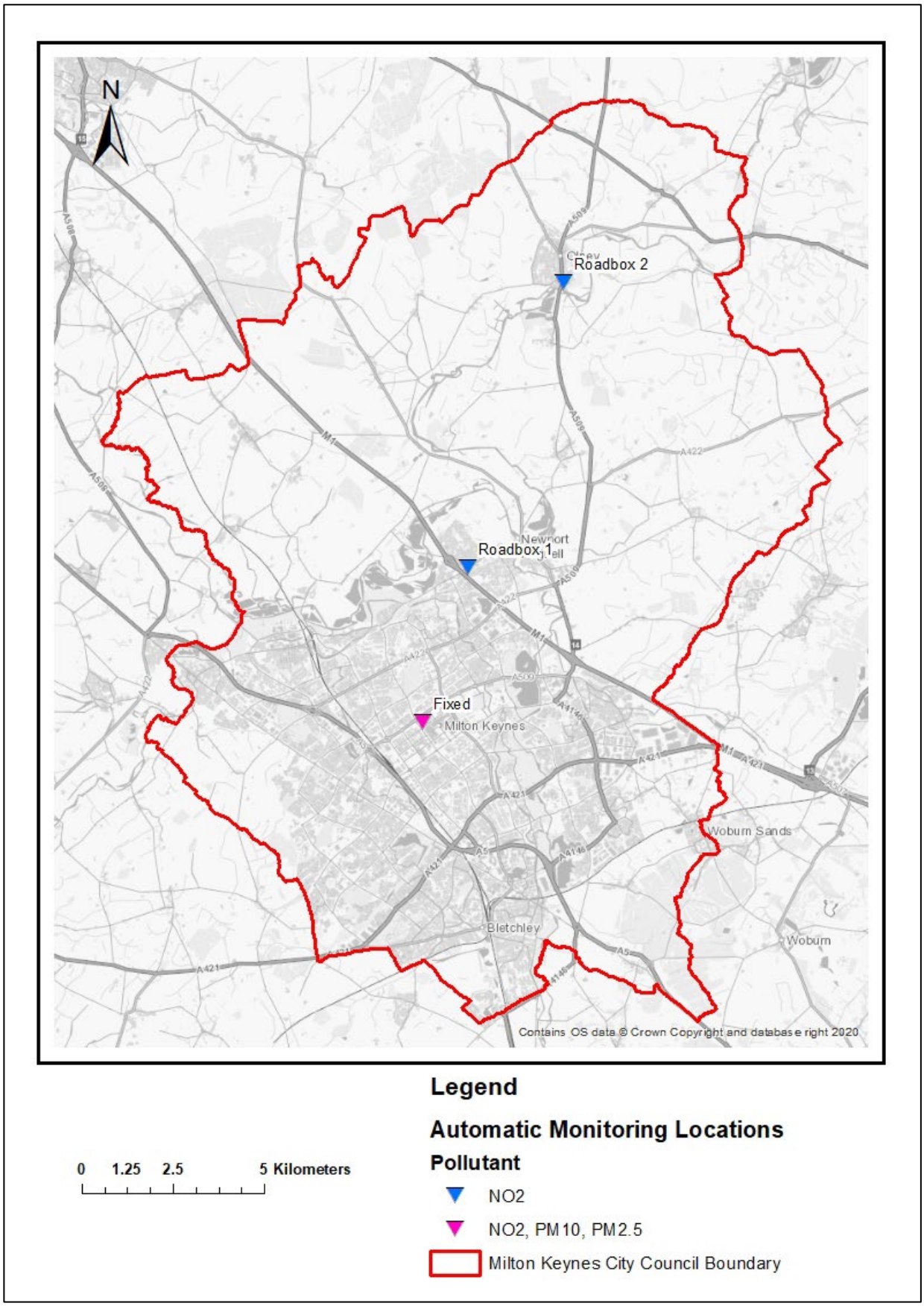


Figure 12: Automatic monitoring locations

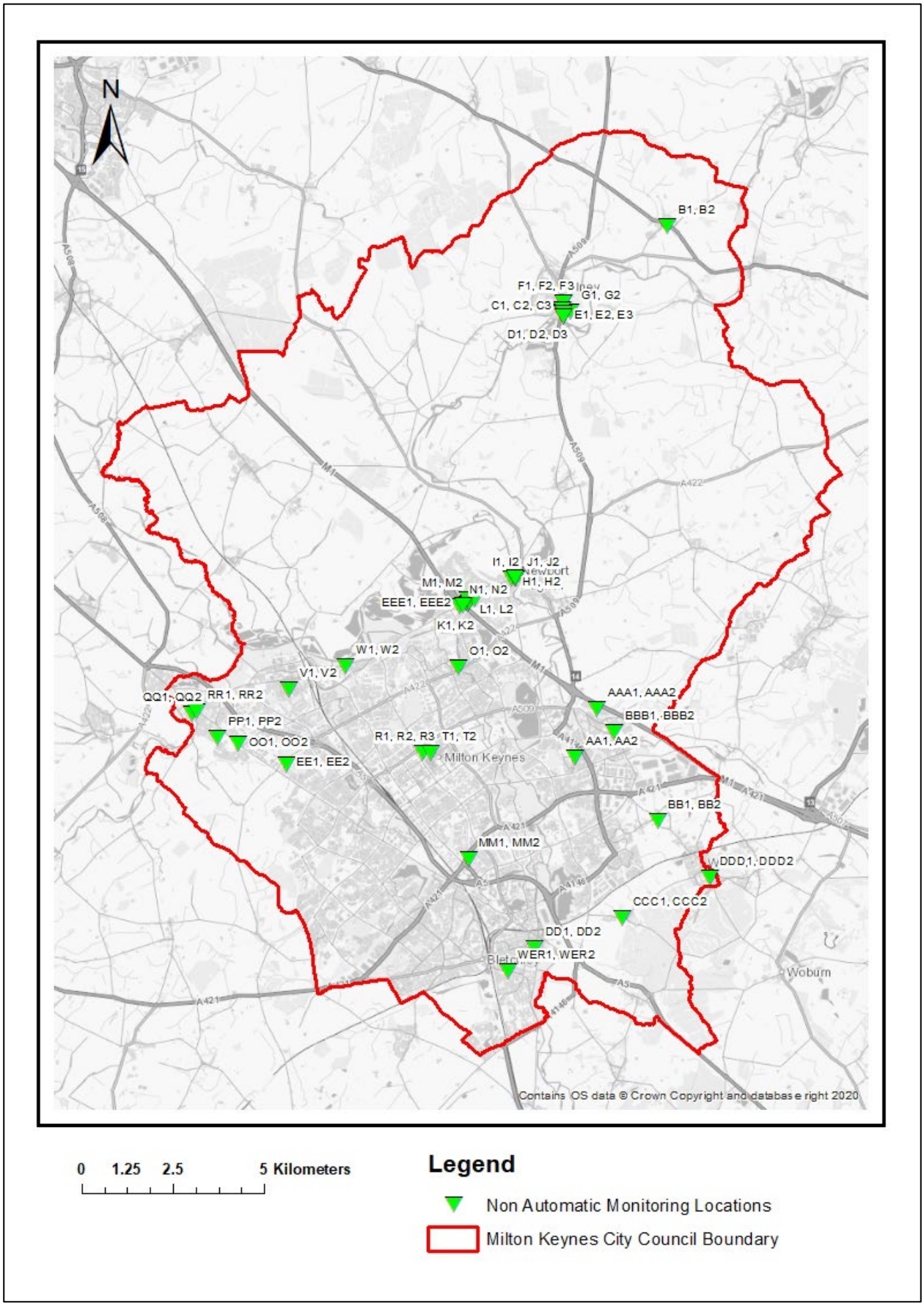


Figure 13: Non-automatic NO_2 monitoring locations

Table 5: Automatic monitoring locations for NO_2

Site ID	OS grid reference		Site type	NO_2 annual mean concentration (µg/m³)				
	X	Y		2018	2019	2020	2021	2022*
Fixed	485070	239131	Urban Centre	16.2	23.5	16.4	16.6	12.4
Roadbox 1	486290	243344	Roadside	25.6	27.1	24.2	29.7	24.9
Roadbox 2	488922	251157	Roadside	19.9	23.9	17.8	18.5	15.9
*At the time of writing, the 2023 ASR had not been made publicly available, but draft information was provided by MKCC for this study.								

Table 6: Non-automatic monitoring locations for NO_2

Site ID	OS grid reference		Site type	NO_2 annual mean concentration (µg/m^3)				
	X	Y		2018	2019	2020	2021	2022*
B1, B2	491769	253542	Roadside	17.4	18.8	14.8	14.5	12.8
C1, C2, C3	488914	251173	Roadside	33.9	36.4	28.5	31.6	26.5
D1, D2, D3	488904	251177	Roadside	30.2	30.9	24.7	33.3	29.1
E1, E2, E3	488926	251455	Roadside	21.3	19.8	17.4	18.3	14.9
F1, F2, F3	488905	251456	Roadside	23.1	25.1	19.6	20.7	17.8
G1, G2	489108	251213	Suburban	10.8	11.1	8.8	9.4	7.9
H1, H2**	487514	243901	Roadside	23.8	21.8	20.2	21.5	n/a
I1, I2	487588	243912	Kerbside	26.7	24.6	23.6	23.6	20.2
J1, J2**	487620	243922	Kerbside	30	25.8	22.2	24.9	n/a
K1, K2	486296	243208	Suburban	22.2	20.5	19.3	18.5	16.8
L1, L2	486345	243230	Suburban	20.7	20.7	17.8	17.6	16.0
M1, M2	486495	243345	Suburban	16.9	14.7	13.9	13.5	11.7
N1, N2	486069	243148	Suburban	21.5	14.8	16.5	18.3	14.8
O1, O2	486039	241484	Urban Background	15.2	16.3	13.4	14.7	12.0
R1, R2, R3	485070	239131	Urban Centre	18.4	17.1	13.6	14.6	13.1
S1, S2, S3	486290	243344	Roadside	27.4	21.4	22.2	23.8	20.4
T1, T2	485298	239126	Kerbside	21.6	18.3	17.7	21.3	18.3
V1, V2	481412	240860	Suburban	15.0	15.0	11.8	12.8	11.1
W1, W2	482965	241515	Roadside	17.7	17.9	16.5	18.0	15.4
AA1, AA2	489237	239016	Suburban	14.4	13.7	12.7	12.9	11.4
BB1, BB2	491498	237284	Roadside	18.4	16.5	13.8	15.0	12.1
DD1, DD2	488118	233814	Roadside	22.8	19.8	20.1	22.5	18.4
EE1, EE2	481331	238825	Suburban	12.2	10.6	8.6	9.9	8.4
FF1, FF2, FF3	488898	251186	Roadside	30.6	34.0	27.5	27.7	25.3
HH1, HH2, HH3	488891	251248	Roadside	26.6	27.9	23.1	25.3	20.7
JJ1, JJ2, JJ3	488922	251157	Roadside	23.5	18.4	19.9	21.5	16.9
KK1, KK2, KK3	488917	251068	Roadside	32.9	34.7	28.7	31.3	26.8
LL1, LL2, LL3	488909	251077	Roadside	28.1	29.6	25.1	26.6	21.8
MM1, MM2	486332	236228	Urban Background	22.6	19.0	20.3	21.7	20.0

Site ID	OS grid reference		Site type	NO_2 annual mean concentration (µg/m^3)				
	X	Y		2018	2019	2020	2021	2022*
OO1, OO2**	480015	239400	Roadside	19.9	12.1	11.7	13.1	n/a
PP1, PP2	479459	239536	Suburban	10.6	10.3	7.8	8.5	6.7
QQ1, QQ2	478740	240217	Suburban	17.7	14.9	13.3	13.7	11.5
RR1, RR2	478882	240265	Suburban	21.2	19.2	16.9	17.4	14.4
TT1, TT2	487589	243923	Roadside	26.8	25.3	22.9	25.7	18.9
WER1, WER2	487395	233174	Roadside	20.0	17.9	18.8	19.5	15.6
AAA1, AAA2	489835	240351	Suburban	19.4	17.8	15.9	16.2	13.5
BBB1, BBB2	490299	239695	Roadside	19.7	19.1	17.6	19.1	16.9
CCC1, CCC2	490529	234611	Roadside	14.5	13.4	12.7	12.6	10.4
DDD1, DDD2	492923	235716	Roadside	14.9	15.1	12.0	12.0	10.3
EEE1, EEE2	486164	243168	Suburban	n/a	14.8	17.5	17.8	15.1

*At the time of writing, the 2023 ASR had not been made publicly available, but draft information was provided by MKCC for this study.

** Sites not included in 2023 ASR update, but included on the published 2022 ASR.

Table 7: Monitoring location for PM_{10}

Site ID	OS grid reference		Site type	PM_{10} annual mean concentration ($\mu g/m^3$)				
	X	Y		2018	2019	2020	2021	2022*
Fixed	485070	239131	Urban Centre	14.7	16.1	11.7	11.6	12.4
*At the time of writing, the 2023 ASR had not been made publicly available, but draft information was provided by MKCC for this study.								

Table 8: Monitoring Locations for $PM_{2.5}$

Site ID	OS grid reference		Site type	$PM_{2.5}$ annual mean concentration (µg/m³)				
	X	Y		2018	2019	2020	2021	2022*
Fixed	485070	239131	Urban Centre	n/a	**11.2**	7.56	7.88	8.18

*At the time of writing, the 2023 ASR had not been made publicly available, but draft information was provided by MKCC for this study

Bold indicates the concentration exceeds the air quality standard.

4.3.5 Defra projected background concentrations

Background concentrations refer to the existing levels of pollution in the atmosphere, produced by a variety of stationary and non-stationary sources, such as roads and industrial processes. The Defra website[23] includes estimated background pollutant concentrations for oxides of nitrogen (NOx), NO_2, PM_{10} and $PM_{2.5}$ for each 1km by 1km OS Grid square in the UK. Background concentrations from across all OS Grid squares of MKCC have been considered.

The Defra background concentrations of NO_2 are estimated to be below the standard of 40µg/m³ in 2019, 2023 and 2030. The projections for 2030 are calculated using the BEIS Updated Energy and Emission Projection guide[33], which feeds into the Defra Background Mapping website[34]. The BEIS guidance takes into account annual evidence, policy development and methodology improvements, electricity and energy supply and demand, as well as emission projections. The highest concentration within MKCC is 21.3µg/m³ (in 2019), and the lowest concentration is 5.7µg/m³ (in 2030). As shown in Table 6, the highest concentration of NO_2 from an MKCC background monitoring location is 22.6µg/m³ in 2019 (at location MM1, MM2), a value 1.3µg/m³ higher than the highest Defra background concentration (in 2019). The lowest concentration of NO2 from an MKCC background monitoring location is 12.0µg/m³ in 2022 (at location O1, O2), a value 6.3µg/m³ higher than the lowest Defra background concentration (in 2030).

The background concentrations of NOx (relevant to ecological receptors) are estimated to be generally below the 30µg/m³ critical level across Milton Keynes. The highest concentrations are 30.3µg/m³ (in 2019) and the lowest 7.2µg/m³ (in 2030).

The background concentrations of PM_{10} are estimated to be below the standard of 40µg/m³ in 2019, 2023 and 2030. The highest concentration within Milton Keynes is 19.8µg/m³ (in 2019) and the lowest 12.2µg/m³ (in 2030).

The background concentrations of $PM_{2.5}$ are estimated to exceed the relevant standard (10µg/m³) in 2019, 2023 and 2030. The highest concentration is 12.2µg/m³ (in 2019) and the lowest 7.8µg/m³ (in 2030). The MKCC $PM_{2.5}$ monitoring location in 2019 also recorded an exceedance of the standard, with a concentration of 11.2µg/m³.

4.4 Conclusion and Recommendations

Across Milton Keynes, the collected Defra background concentrations for NO_2 from 2019, 2023, and 2030 show no exceedances in the air quality standard, or any estimates for exceedances in the future years. PM_{10} concentration also show no estimated exceedances for 2019, 2023, or 2030. Following the updated $PM_{2.5}$ standards, there is estimated to be an exceedance of this pollutant in 2019. However, the background

[33] BEIS (2018) Updated Energy and Emissions Projection. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/794590/updated-energy-and-emissions-projections-2018.pdf [Accessed September 2023]

[34] Defra (2018) Background Mapping data for local authorities UK AIR, Available at: https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2018 [Accessed September 2023]

concentration of $PM_{2.5}$ does fall below the relevant standard by 2030, showing estimated improvements of $PM_{2.5}$ concentrations across Milton Keynes in future years.

The local monitoring results sourced from the most recent MKCC ASR[22] show that across the 40 non-automatic monitoring locations, no exceedances of the air quality standard were recorded for NO_2 from 2018 through to 2022. Across the three non-automatic monitoring locations outlined in the MKCC ASR[22], measuring NO_2, PM_{10}, and $PM_{2.5}$, one exceedance was found for $PM_{2.5}$ at the Fixed monitoring location. The exceedance occurred in 2019, similar to the Defra background exceedance. Again, due to estimated future trends as well as results from the MKCC ASR monitoring locations, the $PM_{2.5}$ monitoring location fell below the air quality standard in following years, 2019 to 2022, showing improvements in the local air quality.

Overall, following the update in $PM_{2.5}$ air quality standards[20], it is important to note the stringent air quality standard, as shown in Table 3, in future local plans such as The New City Plan, and Progress Reports, and to ensure this standard is not exceeded in future years, and NO_2 and PM_{10} remain below their air quality standards. The Local Air Quality Management process, monitored and managed through future Annual Status Reports and monitoring data, can help ensure that air quality in the area remains below the air quality standards, to protect health.

5. Climate Risk Baseline

5.1 Relevant legislation

Climate risk and adaptation has been incorporated into UK policy and legislation, alongside ambitions to reduce greenhouse gas emissions to reduce future climate change. The **Climate Change Act (2008)** committed the UK government to set legally binding targets to reach net zero by 2050, implemented several requirements for climate adaptation and set up the Committee on Climate Change. Through the Act, the UK Government is required to conduct a Climate Change Risk Assessment every five years to identify climate risks, followed by a National Adaptation Programme to address those risks. The third and latest Climate Change Risk Assessment (CCRA3) was published by the UK Government in 2022. This identified 61 climate risks and opportunities to the country associated with climate change, organised under five categories:

1. Natural Environment & Assets
2. Infrastructure
3. Health, Communities & the Built Environment
4. Business & Industry
5. International Dimensions

The Department for the Environment, Food and Rural Affairs (Defra) releases the **National Adaptation Programme** (NAP) every five years. The NAP, published in 2023, sets out the actions the UK government and others will take to adapt to climate change between 2023 and 2028. This third NAP recognises the vital role that local government plays in climate adaptation. Local authorities are said to be responsible for ensuring that local service delivery is resilient to the impacts of the changing climate. The NAP also states that local authorities have an important role in raising awareness and involving local communities by sharing information to explain local climate changes, how they can be managed and what households and businesses can do to help.

The Act has further put in place an Adaptation Reporting Power which can ask authorities to outline how they are preparing and adapting to the current and predicted climate risks. These organisations include the Environment Agency, Natural England, Network Rail and Anglian Water, who report on what they are doing to adapt to climate change. These reports can help to inform national and local climate risk assessments.

5.2 Baseline methodology

The Climate Risk Assessment Methodology for this study compromised of a four-step process, as shown in Figure 14. More detail on these four steps is provided in the subsequent sections.

Figure 14: Four-step process to assess climate risks in Milton Keynes.

5.2.1 Step 1: Screening climate risks

The 61 climate risks and opportunities presented in the UK's Third Climate Change Risk Assessment (CCRA3)[35], were screened to identify those of relevance to Milton Keynes City Council, in particular in relation to the city's spatial development and policy options. The most relevant climate hazards from the C40 City Climate Hazard Taxonomy[36] were also identified. These two sources of climate risks and hazards were

[35] UK Government (2022) UK Climate Risk Assessment 2022. Available here: https://www.gov.uk/government/publications/uk-climate-change-risk-assessment-2022 [Accessed September 2023]

[36] C40 Cities (2015) C40 City Climate Hazard Taxonomy. Available here: https://www.arup.com/perspectives/publications/research/section/city-climate-hazard-taxonomy [Accessed September 2023]

mapped against one another, to identify the key climate hazards and receptors for the city, as presented in Table 9. Each climate hazard and receptor were paired and assessed individually – one example of a hazard-receptor pairing is the extreme heat risk to infrastructure.

Table 9: Climate hazards and receptors that form the scope of the climate risk assessment.

Climate hazards	Receptors
Flooding (fluvial) Flooding (surface water and sewer) Flooding (groundwater) Flooding (reservoir) Extreme heat Water scarcity/drought Wind	Health, Communities & the Built Environment Business & Industry Infrastructure Natural Environment & Assets

5.2.2 Step 2: Gather relevant data

Secondary data sources and climate projection data were gathered to inform the climate risk assessment (Table 10). Wherever possible, maps were used to understand how risks vary across the city and to identify city neighbourhoods, suburbs or villages that are particularly at risk. This was only possible for the flood risks, using the maps produced for the Council's Strategic Flood Risk Assessment.

Where possible, our assessment includes consideration of future climate hazards. This makes use of the latest UK Climate Projections 2018 (UKCP18)[37]. To manage the uncertainty with future global emissions, these projections use four Representative Concentration Pathways (RCPs), representing a range of emissions scenarios: RCP2.6, 4.5, 6.0 and 8.5. We have adopted the RCP 8.5 scenario – often considered a 'worst case' scenario. This aligns with a projected median ~3-4°C increase in average annual temperatures in Milton Keynes by the 2080s compared with 1981-2010, although this could be as high as ~5-6°C at the extreme 90th percentile[38]. This scenario was chosen as it has been commonly used across key data and literature such as the Strategic Flood Risk Assessment - based on the Environment Agency's guidance for applying climate change allowances in flood risk modelling[39] and recent Anglian Water work on water resources[40] and drainage[41]. The timeframe for assessing future climate risk varies from the 2050s to the 2080s, depending on data availability, so risk scores are reviewed and standardised to account for this variation.

We have not assessed risks from groundwater flooding, reservoir flooding or wind using future climate data, as these projections are not available (groundwater and reservoir flooding), or there is lower confidence in the future projections (wind). Groundwater flooding is driven by persistent rainfall that recharges aquifers until they are full; or may be as a result of high river levels. There is a suggestion that the groundwater recharge season, which typically happens between September and April, may shorten, with a greater amount

[37] UK Climate Projections, UKCP. (2018) Met Office. Available at: https://www.metoffice.gov.uk/research/approach/collaboration/ukcp/index [Accessed September 2023]

[38] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

[39] Environment Agency (2022) Flood risk assessments – climate change allowances. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances [Accessed September 2023]

[40] Anglian Water (2023) Revised Draft Water Resources Management Plan 2024. Available at: https://www.anglianwater.co.uk/siteassets/household/about-us/wrmp/revised_draft_wrmp24_main_report.pdf. [Accessed September 2023]

[41] Anglian Water (2023) Drainage and Wastewater Management Plan 2023. Available at: https://www.anglianwater.co.uk/siteassets/household/about-us/dwmp/dwmp---technical-report-1.pdf. [Accessed September 2023]

of recharge in a shorter amount of time which could increase the risk of flooding[42]. However, this climate change impact to groundwater is not currently well-understood or studied. High groundwater levels can also be a risk magnifier of surface water and fluvial flooding, as seen in Newport Pagnell in 2020. Therefore, the increasing frequency and intensity of heavy rainfall events that drive surface water flood events, or high river levels that cause fluvial flooding, may translate to more flood events where groundwater is a contributing factor. For reservoir flooding, it is anticipated that the increase in peak river flows and rainfall associated with climate change may translate into greater reservoir flood risk, however the risk is greatly controlled by appropriate management of reservoirs and avoidance of their failure. Global climate models indicate a UK-wide increase in near surface wind speeds in winter months from 2050 onwards, however this increase is modest compared with inter-annual variability[43].

Table 10: Summary of data used to inform climate risk assessment.

Climate hazard	Secondary sources and data sources	Assessment of future risk as well as present-day?	Maps?
Flooding (fluvial)	MKCC Strategic Flood Risk Assessment (2023, draft)[44] MKCC Section 19 Flood Investigations[45] Local news reports of past events	Y	Y
Flooding (surface water and sewer)	MKCC Strategic Flood Risk Assessment (2023, draft) MKCC Section 19 Flood Investigations Anglian Water's Drainage and Wastewater Management Plan 2023 Local news reports of past events	Y	Y
Flooding (groundwater)	MKCC Strategic Flood Risk Assessment (2023, draft) MKCC Section 19 Flood Investigations	N	Y
Flooding (reservoir)	MKCC Strategic Flood Risk Assessment (2023, draft)	N	Y
Extreme heat	NHS Bedfordshire, Luton and Milton Keynes (2023) Health impact assessment: estimating the health impacts	Y	N

[42] Mansour & Hughes, (2018), British Geological Survey, Summary of results for national scale recharge modelling under conditions of predicted climate change. Available at: https://nora.nerc.ac.uk/id/eprint/521605/1/OR17026.pdf [Accessed January 2024]

[43] Fung F *et al.* (2021) UKCP18 Factsheet: Wind. Met Office Hadley Centre, Exeter. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-wind_march21.pdf. [Accessed January 2024]

[44] Milton Keynes City Council (2023) Level 1 Strategic Flood Risk Assessment, Draft. JBA Consulting. Milton Keynes City Council. Shared directly with project team by MKCC.

[45] Milton Keynes City Council (2020) Flood investigations. Available at: https://www.milton-keynes.gov.uk/flood-and-water-management/flood-investigations. [Accessed September 2023]

Climate hazard	Secondary sources and data sources	Assessment of future risk as well as present-day?	Maps?
	of the BLMK ICS Green Plan (2022-25)[46] UK-CRI: Climate Risk Indicators Local news reports of past events		
Water scarcity/drought	MKCC Water Cycle Study (2017)[47] Anglian Water's Revised Draft Water Resources Management Plan 2024	Y	N
Wind	Local news reports of past events	N	N

5.2.3 Step 3: Assessing climate risks

To assess the risks, all hazard-receptor pairings were assigned likelihood and consequence ratings. Risk ratings were calculated using the risk equation: risk = impact x consequence. The ratings and matrix align with those in Milton Keynes' Corporate Risk Register[48].

- **Likelihood:** This rating is based on the probability of the climate hazard occurring, considering through time as well as across the city, making use of the map data where available. This is rated from 'practically impossible' to 'common or occurs frequently', as outlined in Table 11. Where future climate hazard data was available, likelihood ratings have been assigned using climate projection data. The final likelihood score used for the risk assessment was the highest score identified across present-day and future time periods. Where future data was unavailable, the likelihood score was based on present-day data.
- **Consequence:** This rating considers the economic, strategic, operational, stakeholder and reputational impacts that would arise if a hazard event occurred. In this study we have defined impact as the consequence of a risk or opportunity, which is rated from 1 to 5, as outlined in Table 12.

The ratings were combined to provide an overall risk rating, using the matrix shown in Table 13.

Table 11: Likelihood/exposure definitions applied in climate risk assessment. Source: adapted from MKCC Risk Scoring Guidance[49]. Text in italics is adapted to enable interpretation for climate risk context.

Level of Likelihood	Definition of Likelihood
Practically impossible (1)	Not likely, 0-20% likelihood of occurring. *Difficult to see how this could occur.* *Is a highly unlikely climate scenario, even at the extremes of climate projections.*
Not likely to occur (2)	Low likelihood, 20-40% likelihood of occurring. *Do not expect occurrence but it is possible.*
Could occur or I've heard of it before (3)	Likely, 40-60% likelihood of occurring. *May occur occasionally.* *Has happened in the past; reasonable possibility it will happen as part of climate change scenarios.*

[46] NHS Bedfordshire, Luton and Milton Keynes (2023) Health impact assessment: estimating the health impacts of the BLMK ICS Green Plan (2022-25). Available at: https://bedfordshirelutonandmiltonkeynes.icb.nhs.uk/our-publications/sustainability/health-impact-assessment-blmk-green-plan/?layout=default. [Accessed September 2023]

[47] Milton Keynes Council (2017) Water Cycle Study. Available at: https://www.milton-keynes.gov.uk/sites/default/files/2022-01/Milton%20Keynes%20Water%20Cycle%20Study%202017%20MKFLO002.pdf. [Accessed September 2023]

[48] Milton Keynes City Council (n.d.) Risk Scoring Guidance framework. Provided directly by Milton Keynes City Council for use on this project.

[49] Milton Keynes City Council (n.d.) Risk Scoring Guidance framework. Provided directly by Milton Keynes City Council for use on this project.

Level of Likelihood	Definition of Likelihood
It is known to occur or "it has before" (4)	Highly likely, 60-80% likelihood of occurring. *Will occur persistently but is not an everyday occurrence.* *Circumstances occasionally encountered within likely climate change scenarios*
Common or occurs frequently (5)	Near certain, 80-100% likelihood of occurring. *High probability of situation occurring* *Regular occurrence, circumstances frequently encountered, daily/weekly/monthly/seasonally*

Table 12: Consequence definitions applied in climate risk assessment. Source: MKCC[50]

Level of Consequence	Definition of Consequence
1	No financial Impact upon the Council. No or little Impact upon the Council's strategy or operational activities.
2	Limited financial Impact upon the Council. Limited Impact upon the Council's strategy or operational activities. Stakeholders largely unaffected.
3	Moderate financial Impact upon the Council. Likely to be manageable. Indirect Impact upon the Council's strategy or operational activities. Noteworthy stakeholder concern.
4	High financial Impact upon the Council. Beyond normal planning expenditure. Impact on the Council's strategy or operational activities. Stakeholder concern. Reputational damage to the Council.
5	Very high financial Impact upon the Council. Likely to present significant budgetary challenges. Significant impact on the Council's strategy or operational activities. Significant stakeholder concern. Significant reputational damage to the Council.

Table 13: Climate risk matrix applied in climate risk assessment. Source: MKCC [51]

Likelihood		Consequence				
		1	2	3	4	5
1	Practically impossible (1)	1	2	3	4	5
2	Not likely to occur (2)	2	4	6	8	10
3	Could occur or I've heard of it before (3)	3	6	9	12	15
4	It is known to occur or "it has before" (4)	4	8	12	15	20
5	Common or occurs frequently (5)	5	10	15	20	25

[50] Milton Keynes City Council (n.d.) Risk Scoring Guidance framework. Provided directly by Milton Keynes City Council for use on this project.

[51] Milton Keynes City Council (n.d.) Risk Scoring Guidance framework. Provided directly by Milton Keynes City Council for use on this project.

5.2.4 Step 4: Incorporation of city stakeholder feedback

We have undertaken stakeholder engagement via an online Microsoft Teams workshop to review the findings of our desk-based climate risk assessment and to garner insights about the impacts of climate hazards and proposed adaptation interventions. This was held with Council, wider government and business stakeholders, including from the following organisations:

- Anglian Water
- NHS
- The Parks Trust
- Woodland Trust
- Buckinghamshire and Milton Keynes Natural Environment Partnership
- BP Pulse
- Peabody
- BPHA

Feedback provided during the workshop has informed a revised version of the climate risk assessment, and supported the narrative provided in this report.

5.3 Baseline analysis

The following sections provide the results of the baseline climate risk assessment, considering climate impacts both at present-day and, where possible, under a warming climate through the latter stages of the 21st century.

The headline findings from this baseline assessment are:

- Key future climate risks are **extreme heat**, and **fluvial** and **surface water flooding.** Reservoir risk is lower due to the ability to manage reservoir levels, and groundwater risk is more localised than fluvial and surface water flood risk.
- Impacts of **drought and water scarcity** are greatest for the agricultural sector and the natural environment, although future development will increase the challenge of supplying households.
- There have been recent examples of **extreme wind** causing infrastructure disruption; this risk is expected to persist but is not anticipated to increase with climate change.

5.3.1 Fluvial (river) flooding

Fluvial flooding has been historically prevalent in Milton Keynes, with events in 1947, 1968, 1973, 1980, 1988 and 2020. The primary fluvial flood risk in Milton Keynes is along the River Great Ouse and its tributaries, including the River Ouzel and River Tove. Areas where there are properties at risk from Main River flooding include Newport Pagnell, New Bradwell, Bletchley and Water Eaton and Stony Stratford. Key areas at risk of flooding from ordinary watercourses include Bletchley, Lavendon, Stoke Goldington, Tathall End and Walton Park. The Grand Union Canal (GUC) also flows through Milton Keynes administrative area. This has the potential to interact with other watercourses and create a flow path during flood events or in a breach scenario. There have been two recorded incidents of breach and two of overtopping on the Grand Union Canal.

The risk is shown to increase in future, with flood extents shown to cover a greater proportion of the city (Figure 15), driven by increasing river flows as a result of increased winter precipitation, as shown in Figure 16. The areas in the MKCC administrative area most sensitive to fluvial impacts of climate change are:

- Along the River Great Ouse in the north, affecting Cold Brayfield, Filgrave, Lathbury and Little Linford.

- Along the River Ouzel flowing in a southerly direction, affecting Broughton, Woolstone, Simpson and Fenny Stratford.
- On the confluence between Chicheley Brook to the River Ouse located at Newport Pagnell.

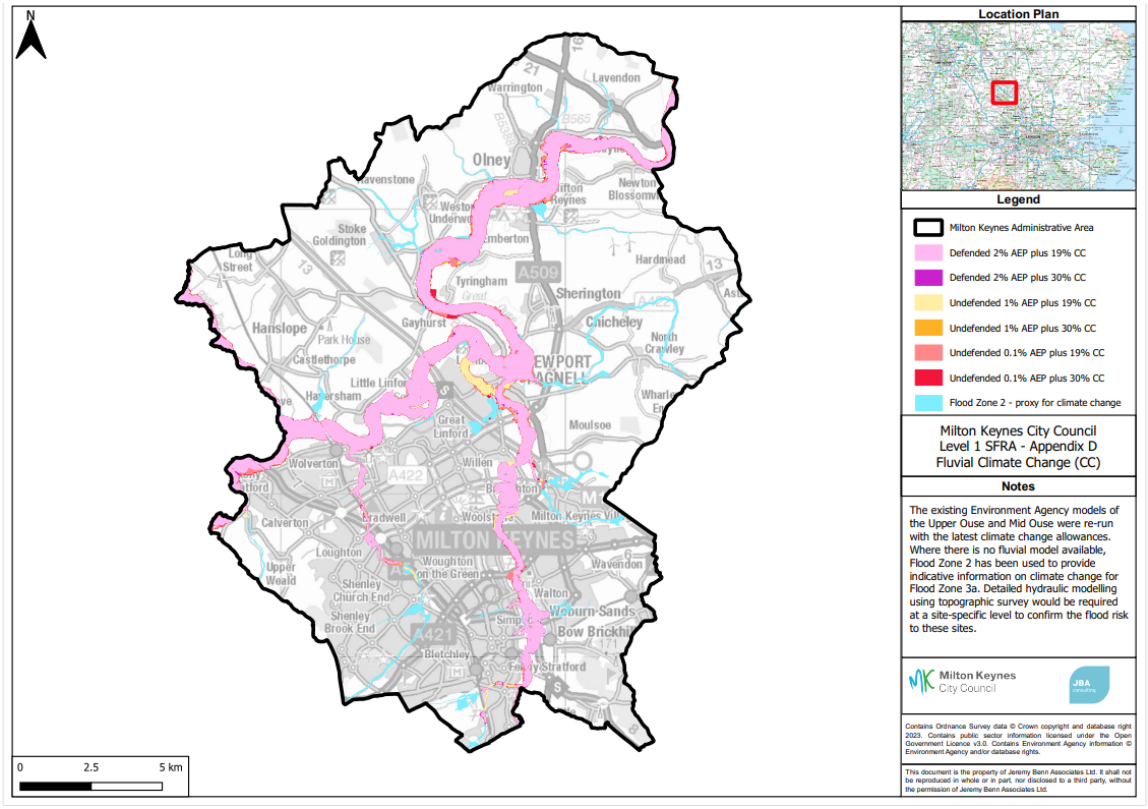


Figure 15: Fluvial flood risk map with climate change. Source: SFRA, Appendix D[52]

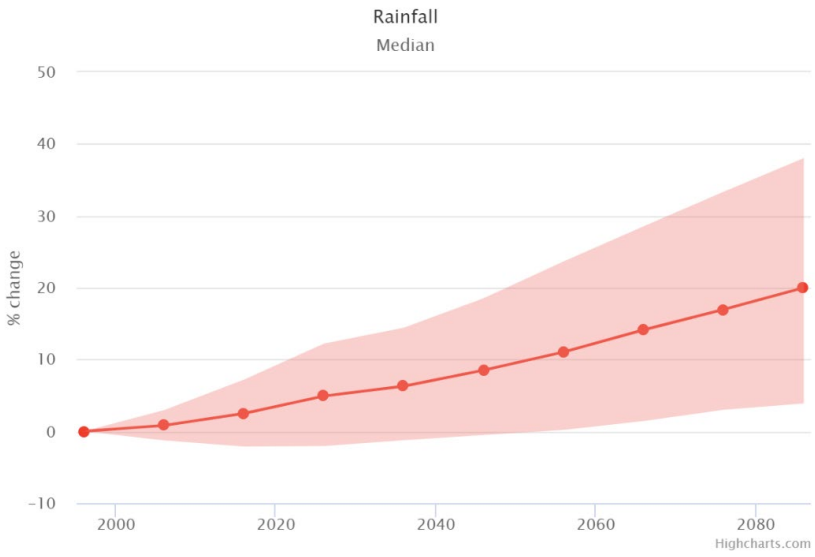


Figure 16: Change in Milton Keynes' winter precipitation through the 21st century, compared with a 1981-2010 baseline. Source: UK-CRI[53].

[52] Milton Keynes City Council (2023) Level 1 Strategic Flood Risk Assessment, Final. JBA Consulting. Milton Keynes City Council.

[53] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/. [Accessed September 2023]

Fluvial floods have the potential to cause catastrophic impacts to the area, resulting in all four receptors being at a very high future risk from fluvial flooding, as shown in Table 14.

The health, communities and built environment receptor is expected to be impacted in terms of physical impacts to people, properties and community buildings, with potential for mental health impacts to local residents. Historic fluvial flooding events in Milton Keynes have been shown to affect different kinds of properties, as seen by the December 2020 floods affecting Newport Pagnell, Ravenstone and Sherington[54].

Infrastructure is also affected during fluvial flood events, affecting the physical condition of assets and causing impacts to service delivery. This is expected to occur in areas where physical infrastructure assets and flood extents shown in Figure 15 intersect, and the risk is most acute in areas with critical infrastructure like data centres, major train stations and key roads. However, as fluvial flooding is a well-established and legislated risk, infrastructure assets are also expected to be designed and built with some resilience.

Local businesses and industry are also expected to be affected by flood events due to physical impacts to commercial buildings, and disruption to business operations. The agricultural sector, here considered as part of the natural environment receptor, may also be affected. Furthermore, the natural environment will be impacted in terms of farmland and green spaces – albeit less extreme impact (anticipate lower cost, quicker recovery). Finally, with more frequent drying and wetting of clay soils, this could lead to subsidence and negative effects on trees, buildings and infrastructure.

Table 14: Fluvial (river) flooding climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Likelihood and exposure: future	Likelihood and exposure: higher central	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	5	It is known to occur or "it has before" (4)	Common or occurs frequently (5)	Common or occurs frequently (5)	**25**	**VH**
Infrastructure	5	Not likely to occur (2)	Could occur or I've heard of it before (3)	Could occur or I've heard of it before (3)	**15**	**VH**
Business & Industry	5	It is known to occur or "it has before" (4)	Common or occurs frequently (5)	Common or occurs frequently (5)	**25**	**VH**
Natural Environment & Assets	3	It is known to occur or "it has before" (4)	Common or occurs frequently (5)	Common or occurs frequently (5)	**15**	**VH**

5.3.2 Surface water flooding

Surface water flood risk is present across the city and has resulted in Milton Keynes being designated a Flood Risk Area. The SFRA details several historical events driven by surface water flooding in the years 1980, 1992, 1998, 2004, 2007, May 2018, December 2020 and June 2021.

The Risk of Flooding from Surface Water map in Figure 17 shows a number of prominent overland flow routes; these predominantly follow topographical flow paths of existing watercourses or dry valleys with

[54] Milton Keynes City Council (2020) Flood investigations. Available at: https://www.milton-keynes.gov.uk/flood-and-water-management/flood-investigations. [Accessed September 2023]

some isolated ponding located in low lying areas. Surface water flood risk is widespread across the city centre and beyond. The likelihood of this risk occurring is expected to increase with climate change, as shown in Figure 18; many areas currently expected to flood once every 100 years are in future expected to flood during a 1 in 30-year event.

There are 2,342 Anglian Water sewer historic flooding data points dispersed across Milton Keynes administrative area. These are mostly from foul sewer, but there are also combined sewer and surface sewer records. Within the administrative area the majority of points are located within the southern half of the boundary in the town centre, with smaller clusters in the north in Castlethorpe, Hanslope, Ravenstone, Olney and Sherington.

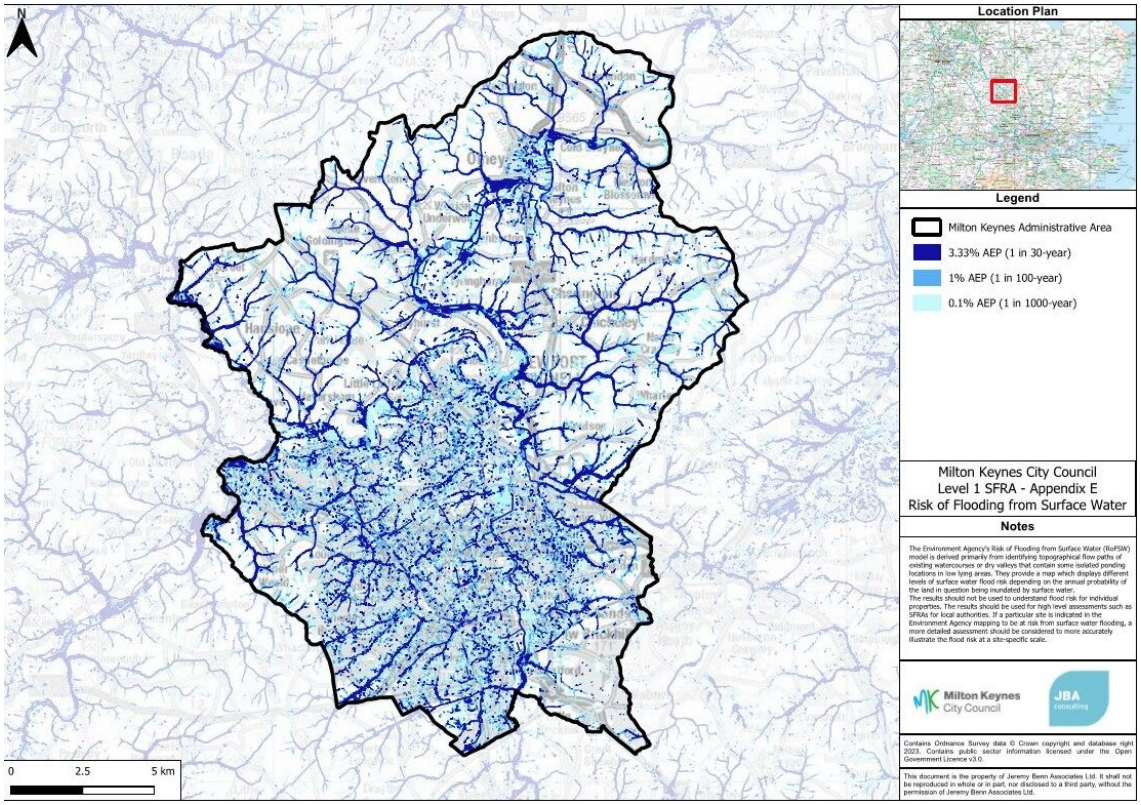


Figure 17: Risk of flooding from surface water map. Source: SFRA, Appendix E[55].

[55] Milton Keynes City Council (2023) Level 1 Strategic Flood Risk Assessment, Final. JBA Consulting. Milton Keynes City Council.

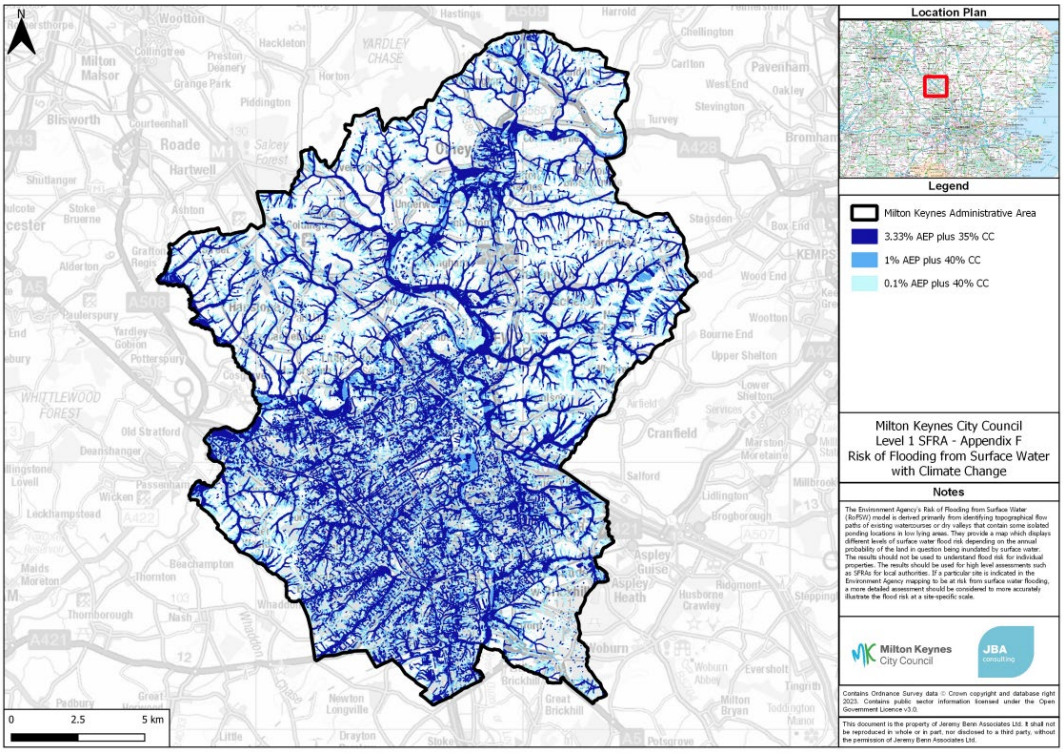


Figure 18: Risk of flooding from surface water with climate change map. Source: SFRA, Appendix F[56].

Milton Keynes is at a very high risk of surface water flooding across all four receptors, as shown in Table 15.

For the 'health, communities and the built environment' and 'business and industry' receptors, surface water and sewer flooding have the potential to cause catastrophic impacts to the Milton Keynes area, with extensive damage to properties and built environment in affected areas. There are several historical events driven by surface water flooding, with impacts across areas of MK affecting many properties, for example, the Independent Flood Review of the May 2018 incident estimates that flooding from surface water and ordinary watercourses affected 1000 residential and non-residential properties across Milton Keynes administrative area during this event.[57] From available data, it is estimated that 490 residential and 17 non-residential properties flooded internally. Critical affected included the Milton Keynes University NHS Foundation Trust and Centre and the MK shopping centre.[58]

In terms of infrastructure there are also physical impacts to assets and to service delivery. However, it is anticipated that critical infrastructure assets are more likely to be protected against flooding than other types of receptors, hence the lower likelihood score. However, surface water flood risks to new technologies have been recently observed in the city. As Milton Keynes moves away from traditional combustion vehicles, there is an increasing reliance on on-street electric vehicle (EV) charging, however these facilities have been seen to be adversely affected by surface water flood events, as experienced on 12th September 2023. This can also affect local communities, as flooding of EV chargers could result in them being taken offline and potentially cause local residents to become stranded. Greater rainfall events could lead to detritus runoff or increased leaf fall, which could in turn create obstruction risks. This may pose a challenge to the Council or highways authorities required to keep roads and pavements clear. These flood events can also affect active travel routes in the city centre – one example shown in Figure 19 relates to a surface water flooding event from February 2024, causing pooling in a Central Milton Keynes underpass.

[56] Ibid.

[57] Ibid.

[58] Ibid.

For the natural environment and assets receptor, impacts could include land or watercourse contamination from surface runoff containing pollutants, however impacts can be expected to be shorter-term than for other receptors.

Table 15: Surface and sewer water flooding climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Likelihood and exposure: future (upper end)	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	5	Common or occurs frequently (5)	Common or occurs frequently (5)	**25**	**VH**
Infrastructure	5	It is known to occur or "it has before" (4)	It is known to occur or "it has before" (4)	**20**	**VH**
Business & Industry	5	Common or occurs frequently (5)	Common or occurs frequently (5)	**25**	**VH**
Natural Environment & Assets	3	Common or occurs frequently (5)	Common or occurs frequently (5)	**15**	**VH**

Figure 19: Flooded underpass in Central Milton Keynes. Source: shared directly from Milton Keynes City Council.

5.3.3 Groundwater flooding

Groundwater flood risk in Milton Keynes is localised, influenced by underlying geology. The groundwater flood risk map in Figure 20 shows the areas with the highest risk of groundwater emergence, which generally follow the flow paths of the major watercourses in Milton Keynes - particularly along the River Great Ouse and its tributaries such as the River Ouzel - and areas of low-lying topography. There are large areas across the city where the risk of groundwater flooding is negligible due to the nature of the local geological deposits. Historically, groundwater flooding has been reported in Newport Pagnell in 2020 and also in Olney in 1969 and 1976. Areas of new development, such as MK East, encroach on locations where groundwater flooding is an issue.

There is no modelling data available to assess climate change impacts on groundwater since the impact of climate change on groundwater flooding would depend on the flooding mechanism and geological

characteristics. Flood risk could increase when groundwater is already high or emerged, causing additional overland flow paths or areas of still ponding.

Most receptors are at a very high risk from groundwater flooding, as shown in Table 16. Groundwater has the potential to damage buildings, with water rising through floors rather than through doors, and properties with functioning basements are particularly vulnerable. There has been one recent case of groundwater flooding, in Newport Pagnell in December 2020, which exacerbated flooding driven by heavy rainfall and river flooding and 15 properties were affected.[59] The nature of groundwater flooding, usually occurring days or even weeks after heavy or prolonged rainfall, can make it harder to forecast and therefore leave people and properties less well prepared.

Like residential properties, built assets such as depots, control centres and treatment works could also be affected by groundwater flooding. Business and industrial assets, such as offices, depots and warehouses, could also be affected by groundwater flooding and the long-term nature of groundwater flooding means it could have a prolonged impact.

In terms of natural environment and assets, groundwater flooding is generally not considered a key risk to the natural environment, as it occurs in geologically discrete environments that are anticipated to be resilient to high water tables.

Table 16: Groundwater flooding climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	5	Could occur or I've heard of it before (3)	**15**	**VH**
Infrastructure	5	Could occur or I've heard of it before (3)	**15**	**VH**
Business & Industry	5	Could occur or I've heard of it before (3)	**15**	**VH**
Natural Environment & Assets	2	Could occur or I've heard of it before (3)	**6**	**M**

[59] Ibid

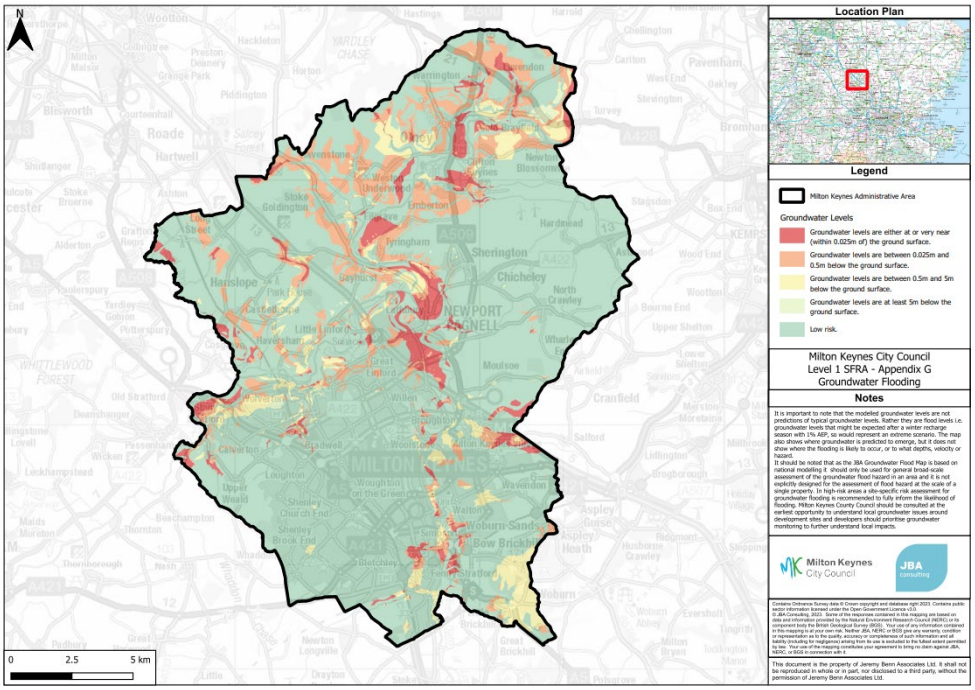


Figure 20: Groundwater flooding map. Source: SFRA, Appendix G[60].

5.3.4 Reservoir flooding

There is a potential risk of flooding from reservoirs both within the MKCC administrative area and those outside as shown in Figure 21. The level and standard of inspection and maintenance required under the Reservoirs Act means that the risk of flooding from reservoirs is relatively low. However, there is a residual risk of a reservoir breach, and this risk should be considered in any site-specific Flood Risk Assessments, where relevant. The likelihood for reservoir flooding is lower than other flood risks since reservoir levels can be managed, but the impact of an event would be catastrophic. To date, no past events of reservoir flooding have been reported.[61]

[60] Ibid.

[61] Ibid.

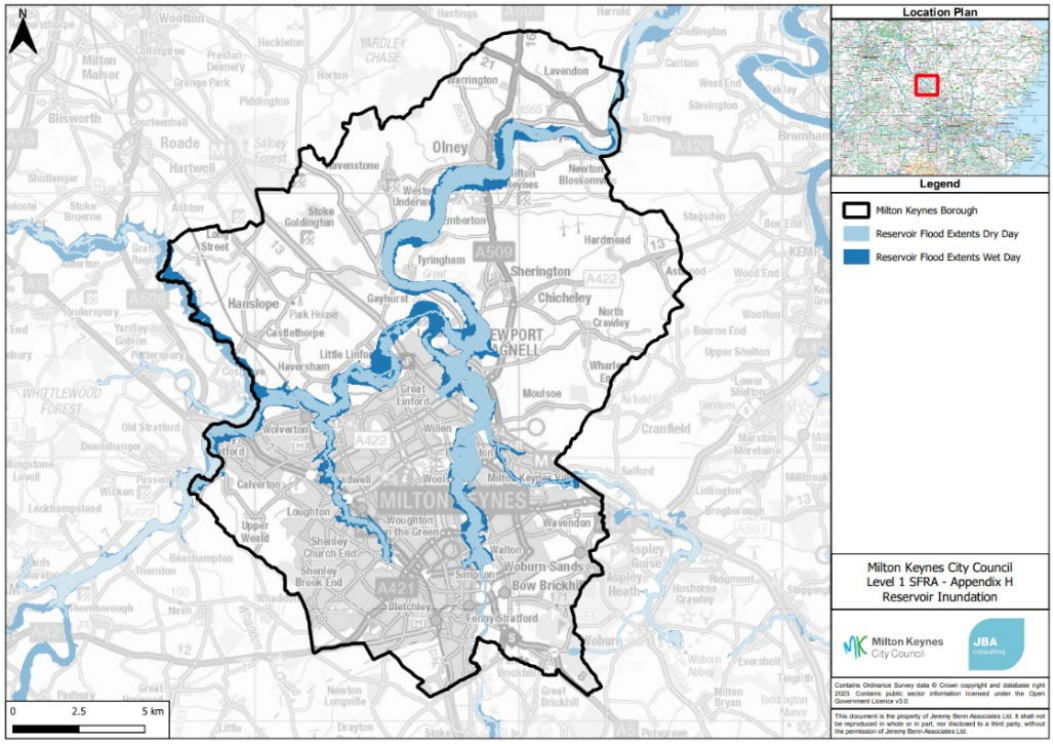


Figure 21: Reservoir inundation map. Source: SFRA, Appendix H[62].

For all four receptors, the reservoir flood risk ratings shown in Table 17, are lower than the ratings for fluvial and surface water flooding. It is anticipated that impacts would be similar to those felt from fluvial flooding, in terms of physical damage. The natural environment is likely to be impacted in terms of the erosion of farmland and greenspaces.

Table 17: Reservoir flooding climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	5	Not likely to occur (2)	**10**	**H**
Infrastructure	5	Not likely to occur (2)	**10**	**H**
Business & Industry	5	Not likely to occur (2)	**10**	**H**
Natural Environment & Assets	3	Could occur or I've heard of it before (3)	**6**	**M**

5.3.5 Water scarcity / drought

Water scarcity and drought is influenced by rainfall patterns and volumes over varying timescales. It is also important to recognise that the risk is greatly controlled by how available water is managed by key stakeholders in Milton Keynes, such as Anglian Water and local farmers. Climate projections indicate that

[62] Ibid

rainfall patterns are expected to become more extreme, with drier summers and wetter winters. This poses a water scarcity challenge, with the potential for available water resources in the city to decrease.

The water scarcity risk varies between all four receptors, as shown by Table 18. Drought events have the potential to directly impact the supply of clean water for household customers and if there is insufficient water available for abstraction, the water company (Anglian Water) would look to implement its Drought Plan and potentially introduce water restrictions. While water restrictions would affect the whole of Milton Keynes, the impact on daily life of temporary use bans or 'hosepipe bans' is anticipated to be low. Anglian Water's plan for managing its supply and demand of clean water (Water Resources Management Plan 2019), states it plans to become resilient to a 1 in 200-year drought by 2025, while the 2024 draft plan states this is to increase to a 1 in 500-year return period by 2039, indicating a very low likelihood of impacts to households.[63]

It should be noted that this assumes a significant level of investment into both demand-side and supply-side options across the Anglian Water region, including two new reservoirs and a water reuse scheme. The view of Anglian Water and other water companies is that, in order to manage the effects of climate change effectively, the single most cost-effective measure to help manage drought risk is to manage demand downwards. The reduction in demand will also help to reduce carbon emissions which aids in reducing impacts of climate change, and planning policy has a significant role to play in helping to achieve this.[64]

Impacts to infrastructure are anticipated to be minimal, as water supply to critical infrastructure is expected to be prioritised and protected during periods of dry weather. If impacts were to materialise, they could be significant, such as the inability to cool data centres, of which there are eight in Milton Keynes. It is anticipated that there will be a limited impact of water scarcity on business and industry in Milton Keynes since businesses are currently exempt from any water restrictions imposed by water companies. This exemption is based on current procedures, which could change in future if climate change places more significant stresses on water supply.

The natural environment and agricultural sector are the most vulnerable receptor to the impacts of drought. This risk is expected to increase with climate change, as shown by the proportion of time Milton Keynes is projected to be in drought according to the Standardised Precipitation Evaporation Index (SPEI) drought[65], as shown in Figure 22. While exempt from water company restrictions, farms often have their own private reservoirs[66] that may have low water levels during drought events. This would affect irrigation and may cause crop failure. There would also be reduced flows in rivers and streams such as tributaries to the Great Ouse, threatening aquatic biodiversity.

[63] Anglian Water (2023) Revised Draft Water Resources Management Plan 2024.

[64] Milton Keynes Council (2017) Water Cycle Study. Available at: https://www.milton-keynes.gov.uk/sites/default/files/2022-01/Milton%20Keynes%20Water%20Cycle%20Study%202017%20MKFLO002.pdf. [Accessed September 2023]

[65] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/. [Accessed September 2023] A location is in drought according to when the 6-month accumulated rainfall minus potential evaporation is calculated to be less than -1.5. This is a common drought metric used in the agricultural sector.

[66] The Bedford Group of Drainage Boards, https://www.idbs.org.uk/ [Accessed September 2023]

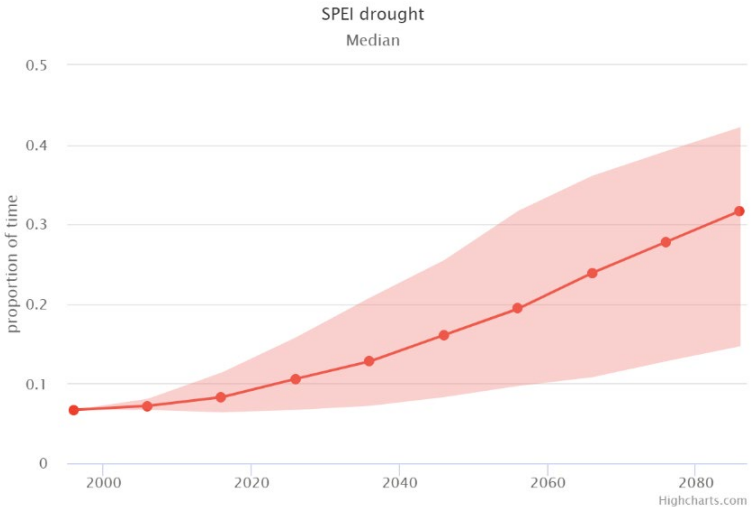


Figure 22: Proportion of time MK is projected to be in SPEI drought. Source: UK-CRI[67].

Table 18: Water scarcity/drought climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Likelihood and exposure: future	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	2	Could occur or I've heard of it before (3)	It is known to occur or "it has before" (4)	**8**	**M**
Infrastructure	5	Practically impossible (1)	Practically impossible (1)	**5**	**M**
Business & Industry	2	Practically impossible (1)	Practically impossible (1)	**2**	**L**
Natural Environment & Assets	3	It is known to occur or "it has before" (4)	Common or occurs frequently (5)	**15**	**VH**

5.3.6 Extreme heat

Milton Keynes, like the rest of the UK and around the world, is already experiencing the impacts of climate change, with average global temperatures over 1°C hotter than the pre-industrial era[68]. The warming trend is projected to continue throughout the 21st century, with Milton Keynes expected to have higher temperatures all year round. The hottest temperatures are anticipated to become more extreme, with hot days[69] and heatwaves[70] expected to become more frequent, as shown in Figure 23, leading to significant heat-related impacts.

[67] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

[68] Met Office (2022) Reading Climate Pack. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/spf/reading-city-pack_august-2022.pdf [Accessed September 2023]

[69] Dale, B. and Stylianou, N. (2022)."What will climate change look like near me?" BBC News. Available at: https://www.bbc.co.uk/news/resources/idt-d6338d9f-8789-4bc2-b6d7-3691c0e7d138#user-input-container [Accessed September 2023]

[70] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

Under UKCP18 RCP8.5 50th percentile, the likelihood of a heatwave increases throughout the 21st Century, with an average of 0.7 events in the baseline period (1981-2010). By the 2080s, results suggest this would increase to 4.7 events per year, or 6.1 events per year at the 90th percentile – as shown in Figure 23.[71] The likelihood of a Met Office Amber heat-health alert also increases throughout the 21st Century. While there were no events in the baseline period (1981-2010), projections suggest alerts would be raised 2.5 times per year, or 5.2 times per year at the 90th percentile by the 2080s.[72] Under the same scenario, the likelihood of a day above 35°C in Milton Keynes grows notably throughout the 21st century, but by the 2080s results suggest this threshold would be met on 2.9 days per year and exceeding 13 days per year at the extreme 90th percentile.[73]

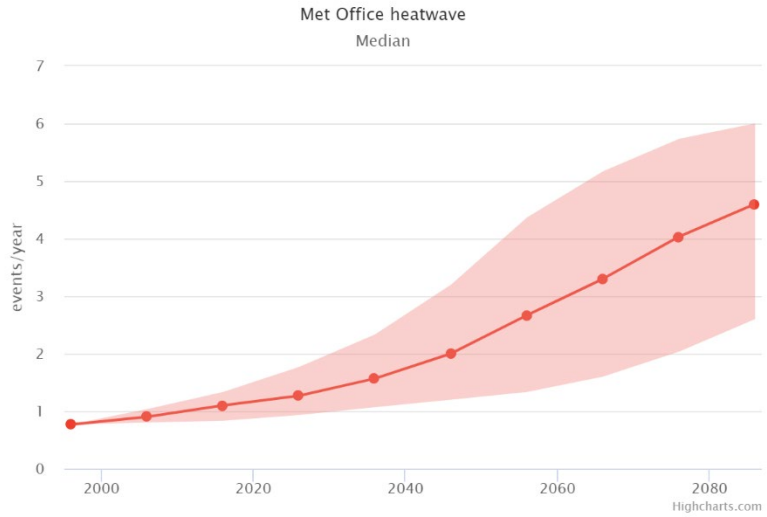


Figure 23: Count of annual Met Office heatwave events that Milton Keynes is projected to experience.

While city-wide temperatures are project to increase, it is also important to consider the variability in temperatures across the city, also known as the 'urban heat island' effect. This has been modelled by the Arup team, with peak urban heat island intensity during the day and night from England's hottest day on record, 19th July 2022, shown in Figure 24 and Figure 25 respectively. The daytime temperature shown in Figure 24 is taken from 11:00am, when the greatest urban heat island intensity was found. Additional maps showing a wider array of results, and the methodology for this analysis is explained in Appendix A.4.

Both maps show a clear distinction between the temperatures within the central urban boundary of Milton Keynes and the surrounding rural areas, except for the town of Olney, north of Milton Keynes. The most significant daytime hotspot during the day has been identified as Gemini Wolverton Works, where the average area temperature is 37°C. Temperature differences are starker between urban and rural areas at nighttime. Central Milton Keynes appears as a more prominent hotspot in the night, as well as Bletchley, Fenny Stratford, Broughton and the previously identified Wolverton area. This demonstrates the propensity for heat to be absorbed and retained within urbanised areas, and highlights the risk of night-time overheating during intense heatwave events.

Multiple cold spots are found outside the central urban area; driven by the rural land cover that has a higher albedo (ability to reflect, rather than absorb, sunlight) than the surfaces found more widely in urban areas, which therefore keeps surface temperatures lower. A cold spot within the urban area of Milton Keynes is at Ouzel Valley Park, where the daytime temperature when the UHI intensity is strongest is 33°C, or ~4°C lower than the hottest part of the urban area. This remains a cold spot within the urban area of Milton Keynes at night, suggesting that water bodies have prominent cooling effects at night.

[71] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

[72] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

[73] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

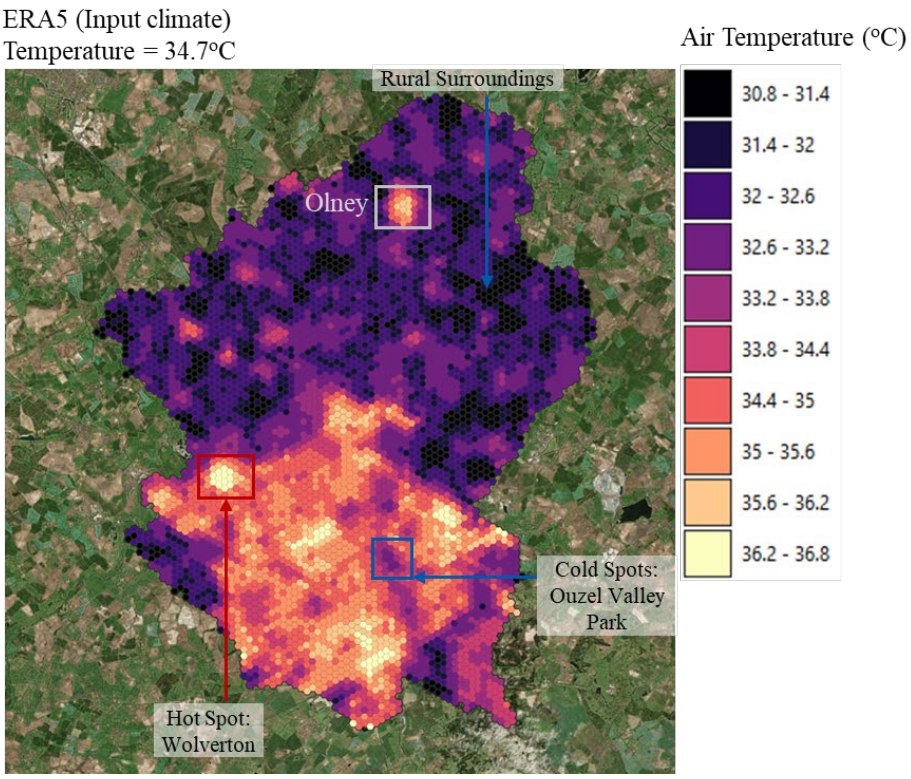


Figure 24: Urban heat island map – peak daytime urban heat island intensity hour from England's hottest day on record (19th July 2022). Data produced using UHeat, an Arup urban heat island model.

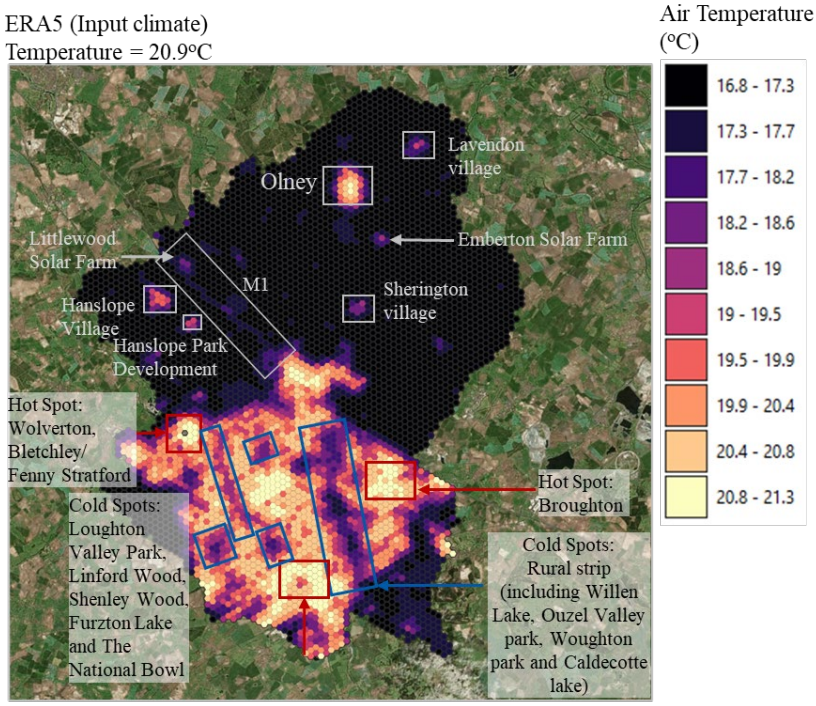


Figure 25: Urban heat island map – peak nighttime urban heat island intensity hour from England's hottest day on record (19th July 2022). Data produced using UHeat, an Arup urban heat island model.

Extreme heat can have a major impact on local communities in Milton Keynes, as seen in Table 19. Hospitals are particularly vulnerable given the high density of energy-intensive equipment that produce significant amounts of waste heat energy. The heatwave of summer 2022 caused fires to break out, including

one that gutted a nursery in Milton Keynes[74]. Additionally, with increased hot weather and hotter days, there is a noticeable influx of people into parks to keep cooler. The Parks Trust has noticed this trend leading to a rise in anti-social behaviour and littering.

Infrastructure assets or services disrupted due to extreme heat events can have a major impact. Examples include track buckling, disrupting train services and commuting. The likelihood of temperatures exceeding that linked with an increased risk of road melt (25ºC) is projected to increase from a baseline of 15.9 days per year between 1981-2010, to 71.6 days per year in the 2080s, under the RCP8.5 50th percentile[75]. It is anticipated that infrastructure assets will have some degree of built-in resilience due to their criticality, such as bridges and energy distribution networks. Critical infrastructure operators have a requirement under the Climate Change Act 2008 to report climate risks and adaptation measures as part of the UK Government's Adaptation Reporting Power, thus providing a requirement to explicitly consider climate impacts including extreme heat.

Although climate projections indicate extreme heat in future is likely to affect employee productivity at an increasing frequency, it is expected that the impacts to business and industry would be lower than to human health and local communities, as mechanical cooling is more likely to be available in commercial buildings than homes.

There is notable potential for crop failure during prolonged periods of extreme heat. Impacts to terrestrial species - if not resilient to higher temperatures - could drive changes in migration patterns or mortalities. Increased insect populations will bring greater risk of mosquito-borne diseases and viruses that are not currently detectable in the UK. Aquatic biodiversity may also struggle if rising temperatures affect oxygen levels, for example increasing toxic algal blooms.

Table 19: Extreme heat climate risk assessment

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Likelihood and exposure: future (central)	Likelihood and exposure: future (higher central)	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	Major (4)	Could occur or I've heard of it before (3)	Common or occurs frequently (5)	Common or occurs frequently (5)	**20**	**VH**
Infrastructure	Major (4)	Could occur or I've heard of it before (3)	It is known to occur or "it has before" (4)	It is known to occur or "it has before" (4)	**16**	**VH**
Business & Industry	3	Could occur or I've heard of it before (3)	It is known to occur or "it has before" (4)	It is known to occur or "it has before" (4)	**12**	**H**
Natural Environment & Assets	Major (4)	Could occur or I've heard of it before (3)	Common or occurs frequently (5)	Common or occurs frequently (5)	**20**	**VH**

[74] Kendon, M., (2022) "Unprecedented extreme heatwave, July 2022". Met Office National Climate Information Centre. Available at: https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learn-about/uk-past-events/interesting/2022/2022_03_july_heatwave_v1.pdf [Accessed September 2023]

[75] UK-CRI (ND) Climate Risk Indicators. Available at: https://uk-cri.org/ [Accessed September 2023]

5.3.7 Extreme wind

Extreme wind events often occur as part of storm events in Milton Keynes. There have been a number of events in recent years, including autumn 2021 and February 2022. In terms of climate change impacts, there is no observed trend in increasing high winds (maximum gust speeds) since records began in 1969 and the impact of climate change on future wind patterns is subject to significant uncertainty. Winter wind speeds are anticipated to increase between 2050 and 2100, accompanied by an increase in the frequency of winter storms. However, the overall projected increases in wind speeds are small compared to the inter-annual variability observed in recent years, and so the future risk is considered similar to present-day.

Local communities have been adversely affected by recent wind events. For example, in February 2022, four schools closed due to Storm Eunice as a result of the forecast high winds.[76] High winds can cause damage to properties, such as the dislodgement of roof tiles, although it is not anticipated to cause widespread damage during an event in the city. As such, impacts to local communities (health, communities, and the built environment), as well as to local businesses, are considered moderate.

High winds can damage transport and digital infrastructure. In October/November 2021, overhead electrical wires were damaged during extreme winds, which affected local rail transport and telecommunication cables and masts[77].

Finally, high winds have the potential to damage trees and can also affect agricultural land, as well as contribute to soil erosion if experienced concurrently with hot, dry weather.

Table 20: Extreme wind climate risk assessment.

Impact description	Consequence (1-5)	Likelihood and exposure: present-day	Future risk rating (L/M/H/VH)	
Health, Communities & the Built Environment	3	Could occur or I've heard of it before (3)	**9**	**M**
Infrastructure	Major (4)	Could occur or I've heard of it before (3)	**12**	**H**
Business & Industry	3	Could occur or I've heard of it before (3)	**9**	**M**
Natural Environment & Assets	2	Could occur or I've heard of it before (3)	**6**	**M**

5.4 Conclusions and Recommendations

This baseline climate risk assessment has provided an overview of the city's main climate hazards, and the key vulnerable receptors to these hazards, both now and into the future considering the impacts of ongoing climate change (where possible). As such, it provides direction about the key climate risks that should influence the planning and design of future development with respect to the New City Plan.

The following recommendations are made with respect to the application of this climate risk assessment, to inform the city's spatial development and policy options:

[76]Burnett, T. (2022). Milton Keynes schools closed due to strong winds. Buckinghamshire Live. Available at: https://www.buckinghamshirelive.com/news/buckinghamshire-news/storm-eunice-sees-milton-keynes-6679671 [Accessed September 2023]

[77] Murrer, S. (2021) High winds of up to 70mph cause havoc all over Milton Keynes. MK Citizen. Available at: https://www.miltonkeynes.co.uk/news/people/high-winds-of-up-to-70mph-cause-havoc-all-over-milton-keynes-3440248 [Accessed September 2023]

Further assessment

- The flood risk data used in this baseline assessment could be interrogated in more detail to identify more granular locations across the city which are particularly vulnerable to flooding. This is a proposed step as part of the Spatial Options Analysis, in the next stage of this project (see 'Analysis' report).
- Further consideration and focus on understanding community vulnerability across the city will follow in the Vulnerable Neighbourhoods component of the Land Use Analysis. This analysis will inform the Climate Risk component of the Spatial Options Analysis, as well as help to shape the policy recommendations.

Incorporating climate adaptation measures into policy

- A holistic approach to considering climate risks can help with identifying suitable climate resilience measures. For example, while increasingly intense rainfall events may encourage developers to consider the use of sustainable drainage to encourage greater infiltration, this may not be appropriate in areas that have a high likelihood of groundwater flooding. On the other hand, planning policy requirements for green space, tree planting or habitat creation around buildings may simultaneously help to mitigate localised overheating, manage stormwater, absorb carbon and promote biodiversity and amenity uses.
- Stakeholder feedback indicated there is enthusiasm for planning policy to include Passivhaus principles, given benefits to manage overheating, reduce risk of damp and heat retention. There was also support for new industrial units to provide additional on-site renewable energy generation which would reduce the need for greenfield renewable developments and help to retain some of the cooling effects of greenfield sites.
- There are several existing Supplementary Planning Documents (SPD) or Guidelines (SPG) that refer to climate resilience measures that could help reduce climate risks, such as the Milton Keynes Drainage Strategy SPG[78] and the Biodiversity SPD[79]. Moving towards mandating these guidelines for new development is seen as the key mechanism towards delivery, and ensuring new development provides self-resilience to climate impacts, as well as providing wider benefits to the existing population of Milton Keynes. These documents may also benefit from a review and update from a climate risk perspective, to maximise their potential to provide climate resilience benefits.
- While it is appreciated that the focus of this study is new development, there is a need to address issues to the current housing stock via retrofit. Much of this is pre-fabricated, built at the same time during the 1960s and therefore ageing. Retrofitting these houses would create significant benefits to the climate resilience of local residents, and has the potential to reduce carbon emissions.
- Additionally, Change of Use projects in the city are not required to address any resilience or flood requirements. It is recommended consideration is given to if/how policy could be updated to bring Change of Use development in line with the requirements associated with new development.

[78] Milton Keynes City Council (2004) Milton Keynes Drainage Strategy – Development and Flood Risk Supplementary Planning Guidance. Available at: https://www.milton-keynes.gov.uk/sites/default/files/2022-02/3.1.1%20AdoptedFloodingSPGpdf.pdf. [Accessed September 2023]

[79] Milton Keynes City Council (2021) Biodiversity Supplementary Planning Document (2021). Available at https://www.milton-keynes.gov.uk/planning-and-building/planning-policy/biodiversity-supplementary-planning-document-2021. [Accessed September 2023]

6. Landscape Assessment Update

6.1 Introduction

This section of the study sets out a high-level review of the sensitivity of the rural landscape areas within Milton Keynes with regards to wind turbine and solar photovoltaic (PV) development. It first provides an overview of the planning policy context, which is driving and shaping the demand for new renewable energy infrastructure. Landscape is a key concern for communities as it relates to their attachment to place and is often an area of challenge in the planning system for such proposals. A brief review of existing wind farm and solar farm development in Milton Keynes is provided to set the context for the review of landscape sensitivity. This work has been carried out in advance of a review of historical Areas of Attractive Landscape (AAL), which were designated in previous iterations of the Milton Keynes Local Plan.

6.2 Context

6.2.1 Planning policy overview

The government published Powering Up Britian, a document setting out its blueprint for delivering energy security and net zero in March 2023. This includes commitments to support the energy transition, including a fivefold increase in solar by 2035, noting that ground-mounted solar is one of the cheapest forms of electricity generation and is readily deployable at scale. There has been an effective moratorium on onshore windfarm development since the government introduced policy in 2015 requiring it to be identified in the development plan and with full community support. Paragraph 12.17 of Plan:MK notes that no sites are allocated for wind farm development.

Onshore wind farm development is currently dealt with under the Town and Country Planning Act (TCPA) 1990 regime or through Local Development Orders, Neighbourhood Development Orders or Community Right to Build Orders. The government had indicated an intention to relax the policy, however the updated National Planning Policy Framework (NPPF), published December 2023, does not include any change to the policy in this respect. The NPPF only refers to wind farm development within footnote 57 and 58, which relate to paragraph 163. This requires Local Planning Authorities to approve applications if its impacts are (or can be made) acceptable, including the re-powering and life-extension of existing renewable sites.

Solar farm development below 50MW is dealt with under the TCPA or orders referred to above for wind farm development. Most solar farms which are operational in the UK today were consented in this way and well below the 50MW threshold. Many were developed to take advantage of the feed-in tariffs which were available in the 2010s.

The economics of solar farm development have been changing in recent years and there has been a push to promote and develop large-scale solar farms, often including ancillary infrastructure including substations and battery storage. Schemes exceeding the 50MW threshold are considered Nationally Significant Infrastructure Projects (NSIP) and require a Development Consent Order (DCO). Most such proposals exceed 300MW, requiring substantial areas of land. The National Policy Statement for Energy (EN-1) makes specific reference to the landscape and visual considerations of energy infrastructure, applying a hierarchical approach to protection from nationally designated areas through to areas with no landscape designation. There are currently no applications for solar farm DCOs registered with the Planning Inspectorate.

Plan:MK includes Policy NE5 which addresses the conservation and enhancement of landscape character. Policy SC3, which relates to low carbon and renewable energy generation, also refers to landscape and visual impacts as a possible reason for refusal.

It is likely that there will continue to be pressure for the development of renewable energy infrastructure in the rural landscape surrounding Milton Keynes, which has the potential to change its character. Landscape, which involves the relationship between people, place and nature, is often a key concern for local communities. The perception of what is considered a large or small capacity wind or solar farm has moved on since 2016 and continues to change so it is also likely that increasing land take will be sought by

developers. Planning for renewable energy infrastructure in the right place is therefore key to successful and timely delivery.

6.2.2 Existing wind turbine and solar farm development in Milton Keynes

Table 21 includes information of existing solar PV and onshore wind farm developments which are currently in operation in Milton Keynes. The data has been collected from the Renewable Energy Planning Database[80].

Table 21: Existing wind turbine and solar PV developments in Milton Keynes

Development name	Energy type	Capacity	Planning application reference	2022 Landscape Character Types (LCT) name
Hyde Farm	Solar PV	5MW	15/01791/FUL	LCT 2 Undulating Valley Slopes
Salcey Solar Farm	Solar PV	5MW	13/02504/FUL	LCT 2 Undulating Valley Slopes
Littlewood Farm	Solar PV	14MW	14/01227/FUL	LCT 1 Wooded Wolds
Rectory Farm/ Emberton	Solar PV	9MW	14/00407/FUL	LCT 2 Undulating Valley Slopes
Milton Keynes Wind Farm	Wind	14MW	06/01349/FULEIS	LCT 2 Undulating Valley Slopes
The Kickles	Solar PV	5MW	14/01068/FUL	LCT 3 Undulating Clay Plateaux

Prior to 2008, Milton Keynes had no solar or wind farm development. The first wind farm to be fully operational within the area was Milton Keynes Wind Farm which was implemented in 2010. Solar farm developments in Milton Keynes emerged later in 2014, the first being Salcey Solar Farm, a 5MW capacity solar farm, on the north-west edge of the MKCC administrative area. Since 2014, a further five solar PV developments have been successfully implemented, whilst another two were refused. Three wind farm proposals have also been refused in the MKCC administrative area during the same period.

It is evident that strategic extensions on the city edges have led to pressure from development in the surrounding area and land adjacent the following LCT types being developed: LCT 3 River Floodplains, LCT 4 Undulating Clay Plateaux and LCT 5 Clay Vales. The locations of existing solar PV and wind farms appear to be focussed in the north on the more elevated land, distributed sporadically around small villages and surrounding landscape.

6.3 Evidence base review

6.3.1 Milton Keynes Landscape Character and Sensitivity Assessment, 2016

In June 2016, Gillespies, on behalf of Milton Keynes City Council (MKCC), undertook a review and update of the Milton Keynes landscape character assessment (2016 LCA)[81]. This was followed by a landscape sensitivity assessment (2016 LSA)[82] of onshore wind turbine and field-scale solar PV development.

The 2016 LSA assessed six LCTs identified in the 2016 LCA. It then provided siting guidance and identified where landscape character areas (LCAs) had greater or less capacity for development. The methodology was based on various Scottish Natural Heritage (now NatureScot) guidance for windfarms (listed in Appendix C

[80] Renewable Energy Planning Database, Department for Energy Security & Net Zero. https://data.barbour-abi.com/smart-map/repd/desnz/?type=repd [Accessed September 2023]

[81] Milton Keynes Landscape Character Assessment (2016) Gillespies, Milton Keynes Council

[82] Landscape Sensitivity to Wind Turbine and Solar PV Development (2016) Gillespies, Milton Keynes Council

of the 2016 LSA), and the general principles from the Guidelines for Landscape Visual Impact Assessment, third edition (GLVIA3[83]). This was widely accepted as an appropriate approach in the absence of England-specific guidance on landscape sensitivity assessment with respect to wind farm development.

An extract from the 2016 LSA summarising the methodology is provided in Figure 26.

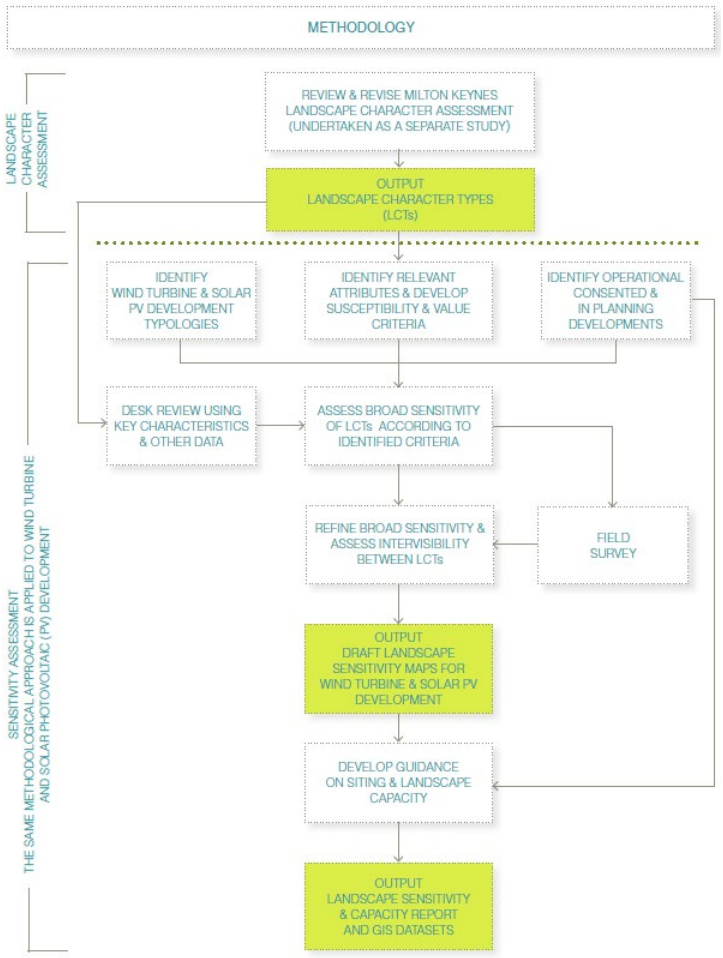


Figure 26: 2016 LSA methodology flow chart

6.3.2 An approach to landscape sensitivity assessment, 2019

In June 2019, Natural England published guidance[84] which set out a consistent approach to assessments of landscape sensitivity for judgements concerning spatial planning and land management. The guidance drew on the definition of sensitivity as provided in GLVIA3, which advocates for reaching separate judgements on the susceptibility of the landscape to specific types of development and the value attached to the landscape.

An extract from Natural England's guidance showing an overview of the process is provided in Figure 27.

[83] Landscape Institute and Institute of Environmental Management and Assessment (2013) Guidelines for Landscape Visual Impact Assessment Third Edition

[84] Tudor, C. (2019) An approach to landscape sensitivity assessment – to inform spatial planning and land management. Natural England.

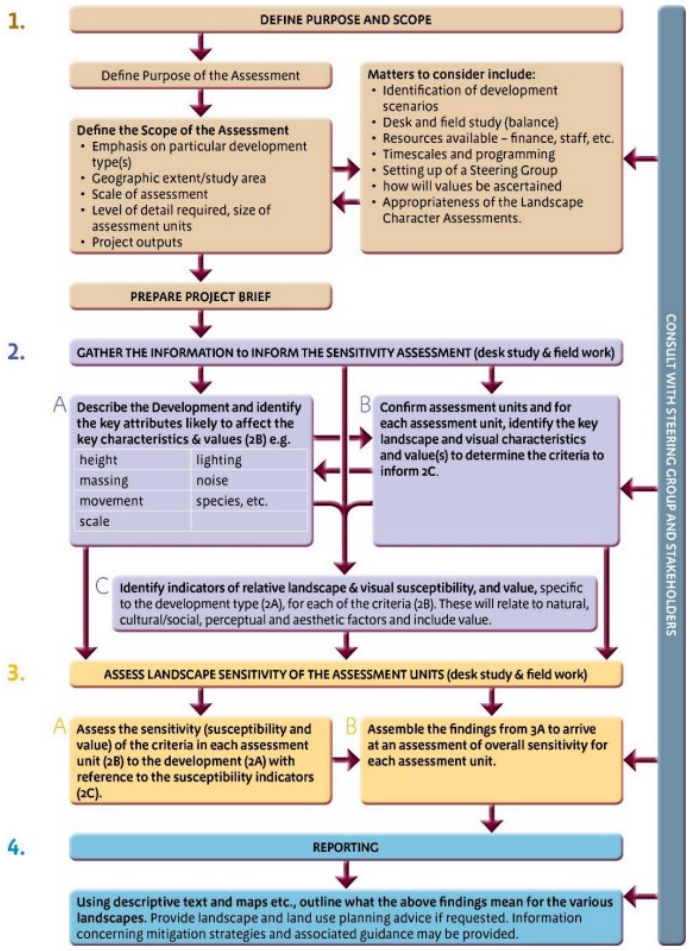


Figure 27: Landscape sensitivity assessment process

6.3.3 Milton Keynes Landscape Character Assessment, 2022

In May 2022, LUC was commissioned by MKCC to review the 2016 LCA and prepare an updated landscape character assessment (2022 LCA)[85] to inform the evidence base of the emerging New City Plan. This included an evaluative section for each LCT highlighting valued landscape qualities, forces for change, and an overall landscape strategy and management guidance. One of the outcomes of the 2022 LCA was that the boundaries and definitions of several of the LCTs defined in the 2016 LCA were amended, as described in Appendix A.1. The scope of the 2022 LCA did not include any further assessment of landscape sensitivity.

6.4 Approach

The New City Plan will refer to the updated evidence on landscape character and value published in the 2022 LCA, superseding the LCTs and LCAs assessed for sensitivity to wind and solar farm development in the 2016 LSA. Therefore, it is necessary to first assess to what extent the changes to the LCTs and LCAs in the 2022 LCA could affect the findings of the 2016 LSA.

The table extracted from the 2022 LCA in Appendix A.1 sets out the landscape classification changes from the 2016 LCA. These mostly comprise name changes and minor boundary refinements to better reflect the prevailing landscape character. Many of the LCTs remain largely consistent between the 2016 and 2022 LCAs. However, some revisions have involved the redrawing of LCT boundaries to exclude strategic site allocations from Plan:MK which could otherwise reduce the sensitivity of the landscape.

This review utilises the updated LCT boundaries defined within the 2022 LCA to provide a common and consistent baseline for future plans and policies. It considers the changes to the landscape baseline since

[85] Milton Keynes Landscape Character Assessment (2022) LUC, Milton Keynes Council

2016 and the influences these changes may have on landscape sensitivity. The 2016 LSA methodology is broadly in line with Natural England's 2019 landscape sensitivity assessment guidance as the approach in both of these documents was informed by the industry standard GLVIA3. The 2016 LSA approach has therefore been adopted for the sensitivity appraisal to allow for direct comparisons where possible.

This has followed a two-stage approach, as described below:

- **Baseline review**: A review of allocated sites within Plan:MK and development completed since 2016 within each LCT. If no changes are identified, then the LCT has been scoped out of further assessment and the findings of the 2016 LSA are assumed to remain valid. Where LCT boundary refinements have resulted in existing development being included or excluded within new LCTs, for example Pensoe wind farm, it is assumed that any slight increase in influence would not make a material difference to the overall sensitivity.
- **Sensitivity appraisal**: An appraisal of landscape sensitivity for the LCTs affected by policy changes and/or completed development. In accordance with the 2016 LSA methodology, consented and submitted planning applications or proposed allocations in the New City Plan are not considered at this stage as they are only relevant in the consideration of landscape capacity.

6.4.1 Baseline review

This section explores policy changes and the notable developments completed since the 2016 LSA to determine which LCTs are scoped in for further assessment.

Table 22: Scoping of LCTs

2022 LCT name	Key changes in 2022 LCA from 2016 LCA	Scoped in/out
LCT 1 Wooded Wolds	Boundary redefined to follow 90m contour. The 2022 LCA notes that built development has intensified at Hanslope Park but this remains within the existing extent as shown on 2016 OS 1:25k mapping so is unlikely to influence the landscape sensitivity of LCT 1.	Scoped out
LCT 2 Undulating Valley Slopes	Boundary redefined to follow valley slopes. Hyde solar farm has since been implemented but was considered within the 2016 LSA as part of the consented solar developments in the LCT.	Scoped out
LCT 3 River Floodplains	Boundary redefined to exclude the 'Milton Keynes East' strategic allocation as identified in Plan:MK. This has removed the former Ouzel North Urban River Valley area defined in the 2016 LCA from the LCT, which could influence its landscape sensitivity.	Scoped in
LCT 4 Undulating Clay Plateaux	Boundary redefined to follow 80-85m contour and extended north around Top Farm and Petsoe Manor wind farm. The 'Milton Keynes East' strategic allocation and the 'Western Expansion Area' as allocated in Plan:MK, are located close to, or adjacent to, the LCT. These have been gradually implemented adjacent to the LCT, which could	Scoped in

2022 LCT name	Key changes in 2022 LCA from 2016 LCA	Scoped in/out
	influence the landscape sensitivity of the LCT. The recently consented Air Park development at Cranfield Airport in Central Bedfordshire is also located close to the edge of the LCT which could further affect the LCT's landscape sensitivity.	
LCT 5 Clay Vales	Boundary redefined to exclude the 'Milton Keynes East', 'South East Milton Keynes' and 'Eaton Leys' strategic allocations as identified in Plan:MK. It has also been refined to exclude the recent development at Newport Pagnell and Woburn Sands.	Scoped in
LCT 6 Wooded Greensand Ridge	Boundary redefined to follow 100m contour line. No notable new developments have been identified within the LCT.	Scoped out

6.4.2 Sensitivity appraisal

This section provides a desk-based appraisal of the LCTs identified as scoped-in (see Table 22 above), where recent development may alter the previous landscape susceptibility and landscape sensitivity judgements.

6.4.2.1 LCT 3 River Floodplains

The 2016 LSA divided this LCT by rural areas (LCA 2a and 2b) and urban edge areas (LCA 2c, 2d, 2e).

The redefined LCT boundary has removed the 'Milton Keynes East' strategic allocation from the LCT. This consisted predominantly of the former LCA 2d Ouzel North Urban River Valley area, which was dominated by major roads including the M1, A422 and A509, as defined in the 2016 LCA.

With reference to the 2016 LSA susceptibility criteria, these specific changes are likely to influence the landcover, built environment, historic landscape character, and perceptual qualities of the LCT.

The 2016 LSA noted the '*widespread land cover change as a result of the restoration of mineral workings and development*' around the settlement edge as contributing to the medium susceptibility of the landcover to wind turbines and solar PV. The revised LCT now excludes the active sand and gravel mineral workings which partly reduces the influence of disturbed landscapes on the wider semi-natural habitats and increases its susceptibility. However, the 2020 LCA still notes '*historic and current mineral extraction… including the creation of extensive large lakes and ponds'* as a key characteristic of the revised LCT.

The 2016 LSA identified the M1 and A5 crossing the LCT as contributing to a medium susceptibility of the built environment to wind turbines and solar PV. The revised LCT interfaces to a lesser extent with the M1 and the A509, so is subject to partly reduced influences from major transport corridors, which increases its susceptibility. The M1 and A5 however still intersects the LCT and the 2020 LCA refers to major transport corridors as influencing the rural character of the LCT.

The revised LCT removes the Caldecote Mill from the LCT which formed part of the historic features noted in the 2016 LSA as contributing to the medium susceptibility of the historic landscape character to wind turbines and solar PV. This decreases the susceptibility of the revised LCT as it contains less evidence of historic patterns and features, although the 2020 LCA still identifies similar heritage assets and other evidence of time depth as a key characteristic of the LCT.

Overall, when considering the prevailing character of the revised LCT as a whole, including the key characteristics identified in the 2020 LCA, these localised changes are considered to not be so substantial as to result in a material change to the individual susceptibility and value judgements or the overall levels of sensitivity to wind turbines and solar PV.

6.4.2.2 LCT 4 Undulating Clay Plateaux

The refined boundary for this LCT has been aligned more closely with the contours which has encompassed land with similar landscape characteristics to the north. There has also been an intensification of built development adjacent and close to the fringes of the LCT, including the 'Milton Keynes East' strategic allocation and the 'Western Expansion Area' as allocated in Plan:MK.

With reference to the 2016 LSA susceptibility criteria, these specific changes are likely to influence the perceptual qualities of the LCT.

The 2016 LSA identified the '*tranquil settled agricultural landscape with isolated settlements*' and '*elevated plateaux [providing] a rural backdrop*' as the key contributing factors to a medium susceptibility of the perceptual qualities to wind turbines and solar PV. The new development around the edge of the revised LCT introduces additional urbanising features which to some extent, have increased detracting influences in views out of the LCT, decreasing the susceptibility. The 2022 LCA however notes the existing wind turbines and electricity pylons as being visually intrusive in the LCT but otherwise refers to '*a tranquil rural landscape*' with '*limited visual detractors*' and '*despite proximity to Milton Keynes city...*'

On conclusion, it is evident that the urban development around the edges of the revised LCT remain inconsequential so the intensification of built form in these localised areas are considered to not be so substantial as to result in a material change to the individual susceptibility and value judgements or the overall levels of sensitivity to wind turbines and solar PV.

6.4.2.3 LCT 5 Clay Vales

The redefined LCT boundary has been aligned more closely with the bedrock geology which has encompassed land with similar landscape characteristics to the north. The LCT boundary revision has also removed the 'Milton Keynes East', 'South East Milton Keynes' and 'Eaton Leys' strategic allocations as well as recent development at Newport Pagnell from the LCT which has resulted in notably smaller and fragmented areas.

With reference to the 2016 LSA susceptibility criteria, these specific changes are likely to influence the perceptual qualities of the LCT.

The 2016 LSA recognised the LCT as forming '*an urban fringe landscape dominated by areas of ongoing residential and commercial development*' which contributed to the low susceptibility of the perceptual qualities to wind turbines and solar PV. The continued delivery of new development within the adjoining allocated sites will introduce further additional urbanising and detracting influences in views out of the LCT, which would partly decrease the susceptibility. The 2022 LCA also acknowledges the influence of '*residential and commercial development expanding from Milton Keynes city*' as well as '*the built form of Milton Keynes city [being] evident in views*' as key characteristics of the LCT.

Overall, new and existing development around the fringes of the revised LCT would continue to impart urbanising and detracting influences which contribute to the low susceptibility of the perceptual qualities to wind turbines and solar PV. It is also considered that this would result in no material change to the overall levels of sensitivity to wind turbines and solar PV.

6.4.3 Interim Summary

This section of the study has concluded that the landscape sensitivity to wind turbines and solar PV in Milton Keynes has not materially changed since 2016 and the judgements reported in the 2016 LSA remain valid.

This is based on an initial review of allocated sites within Plan:MK and development completed since 2016 within each revised LCT, and then an appraisal of landscape sensitivity for the LCTs affected by policy changes and/or completed development.

LCT 1, LCT 2 and LCT 6 were scoped out of the sensitivity appraisal on the basis that no new development or policy changes were identified.

Those considered within the sensitivity appraisal were LCT 3, LCT 4, and LCT 5. The identified changes were found to be relatively localised in each LCT and were considered to not result in a material change to the individual susceptibility and value judgements or the overall levels of sensitivity to wind turbines and solar PV.

The sensitivity judgements of the 2016 LSA have therefore been transposed on to the revised LCTs classified in the 2022 LCA as demonstrated in Table 23.

Table 23: Summary of LCT sensitivity by development typology

	Sensitivity to wind turbine development				**Sensitivity to solar PV development**			
2022 LCT name	**1no.**	**2-5no.**	**6-10no.**	**11-15no.**	**<5ha**	**5-10ha**	**10-15ha**	**>15ha**
LCT 1 Wooded Wolds	Low	Low	Med	High	Low	Low	Med	Med
LCT 2 Undulating Valley Slopes	Med	High	High	High	Low	Med	Med	High
LCT 3 River Floodplains (3a, 3b)	High	High	High	High	High	High	High	High
LCT 3 River Floodplains (3c, 3d)	Med	High	High	High	Med	Med	Med	High
LCT 4 Undulating Clay Plateaux	Low	Med	Med	High	Low	Low	Med	Med
LCT 5 Clay Vales	Low	Med	Med	High	Low	Low	Med	High
LCT 6 Wooded Greensand Ridge	High	High	High	High	High	High	High	High

7. Best Practice Policy Review

This section presents best practice policies in recent draft and adopted Local Plan policies in England to inform the Milton Keynes Carbon and Climate Study. It includes the following:

- An overview of current national policy and legislation on climate change and Biodiversity Net Gain (BNG).
- The current policy position in Milton Keynes and a comparison with policy examples from other planning authorities, structured under the ten categories proposed in the '*Framework for well-designed and sustainable places'* included in Section 8 of this report.

This section also includes the following Appendices at the end of the document:

- Appendix A.1 – provides more detailed information on legislative requirements, building on the overview in Section 6.1;
- Appendix A.2 – provides more detailed information on industry standards, building on the overview in Section 6.3.

The best practice policy review is intended to provide MKCC with context on the level of aspiration of other Local Planning Authorities (LPAs). In combination with the technical evidence produced in the 'Analysis' report of this study, MKCC will be informed about the opportunities to match or go beyond best practice policies in the New City Plan, as part of attaining their ambitious net zero targets.

7.1 Relevant legislation and policy

This section provides an overview of legislative requirements and best practice guidance, as context for how industry bodies should address climate change. More detailed information can be found in Appendix A.1.

7.1.1 Legislative requirements

Climate Change Act 2008 (2050 Target Amendment) Order 2019

In 2019 the Government amended the Climate Change Act to commit the UK to achieving net zero by 2050, compared to the original target of an 80% reduction in emission by 2050[86]. The Climate Change Act provides an overall framework to climate mitigation and adaptation action across the UK and is made up of four key pillars[87]:

1. A long-term goal – the Act contains a legally binding goal for reducing UK greenhouse gas (GHG) emissions by 2050 to 'at least 100%' below 1990 levels.
2. A pathway to the long-term goal – 'Carbon budgets' set legally-binding limits for the UK GHG emissions over five-year periods as interim milestones on the pathway towards the long-term emissions goal.
3. A requirement for policies to deliver the pathways – the Act obliges the Government to develop and publish policy programmes to deliver the legislated emissions reductions and to address the risks identified in the latest climate change risk assessment.

[86] Dray, S. (2021) 'Climate change targets: the road to net zero?'. Available at: https://lordslibrary.parliament.uk/climate-change-targets-the-road-to-net-zero/ [Accessed 18 August 2023]

[87] CCC (2020) 'CCC Insights Briefing 1: The UK Climate Change Act'. Available at: https://www.theccc.org.uk/wp-content/uploads/2020/10/CCC-Insights-Briefing-1-The-UK-Climate-Change-Act.pdf. [Accessed 18 August 2023].

4. An independent advisory body (the Climate Change Committee (CCC)) – the Act created the CCC as an independent statutory adviser.

LPAs have a legal duty[88] to ensure that plan policy contributes to the mitigation of, and adaptation to, climate change. This means that Local Plans have to demonstrate how policy contributes to the Climate Change Act 2008 target regime, and Local Plans have to set out their baseline carbon dioxide emissions and the actions needed to reduce emissions over time.

Building Regulations

Building Regulations govern the legal standards for the design and construction of buildings to ensure the health and safety of individuals in and around these buildings. They also encompass requirements on the fuel usage and energy efficiency of buildings. The updated Building Regulations[89] provide a thorough baseline position for any Local Plan policy. They standardise the expectations for achieving net zero carbon across all new building schemes, including by balancing competing considerations such as air tightness and indoor air quality. The upcoming Future Homes and Future Buildings Standards will strengthen this baseline position in 2025.

To initiate a net zero pathway towards Future Homes and Future Buildings Standards by 2025, there have been interim updates to the Building Regulations, following a recent Government consultation.

These updates involved an ambitious increase in the energy efficiency of new homes through changes to Part F (Ventilation) of the Building Regulations and Part L (Conservation of fuel and power). This resulted in changes to Approved Documents L and F, alongside the introduction of Approved Document O (Overheating) and Approved Document S (Infrastructure for charging electric vehicles) in June 2022.

These Documents came into force for developers who made a planning application on or after 15 June 2022. For developers who received planning permission before this date, the new requirements would not apply, provided building work began before 15 June 2023.

The Government's next step is to update the Building Regulations in 2025, following a full technical consultation. The consultation will consider improvements to the energy efficiency of non-domestic buildings, alongside energy efficiency and overheating in new and retrofitted homes.

Further information on the Building Regulation updates is provided in Appendix A.1.

Biodiversity Net Gain (BNG)

BNG is an approach to development that aims to leave the natural environment in a measurably better state than it was beforehand[90]. BNG has become a mandatory requirement for developments in England under the **Environment Act 2021.** The Act makes it mandatory for developments in England to achieve a minimum of 10% BNG from November 2023. Many LPAs have policies that require the 10% BNG, as per the legislation. In 2022 Planning Resource published an article that noted nine LPAs were looking to adopt policies which go beyond the Environment Act requirements, since then two of the Local Plans (Guildford and Worthing) have been adopted and the policies are summarised in Section 6.4.

BNG will be calculated using Natural England's Biodiversity Metric tool and approval of a biodiversity gain plan, which will be submitted with a planning application. The Biodiversity Metric tool will measure the biodiversity value of a habitat parcel, based on its area, quality and risk to delivery. The biodiversity gain plan will support this, by demonstrating how habitat impacts are minimised with consideration for both pre and post development biodiversity value of on-site habitat and off-site habitats. The plan will also outline if BNG is being achieved on or off-site, via biodiversity credits. Both on and off-site BNG enhancements need

[88] Section 19 of the Planning and Compulsory Purchase Act 2004, as amended by the Planning Act 2008; Climate Change Act 2008, Environmental Assessment Regulations 2004

[89] HM Government (2021) Approved Documents. Available at: https://www.gov.uk/government/collections/approved-documents [Accessed September 2023]

[90] Planning Advisory Service (2023) Biodiversity Net Gain for local authorities; https://www.local.gov.uk/pas/topics/environment/biodiversity-net-gain-local-authorities#:~:text=Biodiversity%20net%20gain%20(BNG)%20is,state%20than%20it%20was%20beforehand [Accessed August 2023].

to be maintained for 30 years after completion of works and should be secured via a conservation covenant or planning obligation.

Biodiversity Net Gain can be a supporting tool for delivering climate adaptation interventions through nature-based solutions, as well as enhancing carbon sequestration potential.

7.1.2 National Planning Policy Framework[91]

An updated version of the NPPF was published in December 2023. National planning policy[92] requires local policies and decisions to be in line with the Climate Change Act 2008 and paragraph 157 expects the planning system to '*shape places in ways that contribute to radical reductions in greenhouse gas emissions*.'

NPPF guidance on securing net zero new buildings is limited to paragraphs 159b) and 162b) – they advise that LPAs should support development that minimises energy consumption and greenhouse gas emissions, by considering the development location, orientation, massing, landscaping, and other factors.

The NPPF shows support for proposals involving decentralised, renewable, and low carbon energy generation (paragraphs 160 and 162 – 163), as long as their adverse impacts can be satisfactorily addressed. Paragraph 160 requires Local Plans to identify suitable areas for these energy generation proposals and consider opportunities for them to supply energy and heat to neighbouring development. Additionally, NPPF paragraph 162a) sets the expectation for developers to comply with any Local Plan policies requiring decentralised energy supply, unless it is not feasible or viable.

The updated NPPF includes a new paragraph (164) which requires local authorities to give significant weight to the need to support energy efficiency and low carbon heating improvements to existing buildings, both domestic and non-domestic, including heat pumps and solar panels.

7.1.3 Written Ministerial Statement: Planning - Local Energy Efficiency Standards Update[93]

In December 2023 Government issued a Parliamentary Statement which states that they not expect plan-makers to set local energy efficiency standards for buildings that go beyond current or planned buildings regulations.

It sets out that any planning policies that propose local energy efficiency standards for buildings that go beyond current or planned buildings regulation should be rejected at examination if they do not have a well-reasoned and robustly costed rationale that ensures:

- That development remains viable, and the impact on housing supply and affordability is considered in accordance with the National Planning Policy Framework.
- The additional requirement is expressed as a percentage uplift of a dwelling's Target Emissions Rate (TER) calculated using a specified version of the Standard Assessment Procedure (SAP).

7.2 Best Practice Guidance

7.2.1 National Design Guide[94]

The National Design Guide (NDG) aims to achieve good design through the planning system and should be used by LPAs when preparing local planning policy. The guide has been prepared in the context of social, economic and environmental change. The NDG has identified ten characteristics which work together to create well-designed places:

---

[91] Department for Levelling Up, Housing and Communities (2023) National Planning Policy Framework.

[92] Paragraph 158 of the NPPF; climate change section of the PPG; Climate Change Act (2050 Target Amendment) Order 2019.

[93] Written Ministerial Statement by Baroness Penn (13 December 2023) Planning – Local Energy Efficiency Standards Update. Available at Written statements - Written questions, answers and statements - UK Parliament [Accessed: January 2024].

[94] https://assets.publishing.service.gov.uk/media/602cef1d8fa8f5038595091b/National_design_guide.pdf

1. Context – enhancing the surroundings.
2. Identity – attractive and distinctive.
3. Built form – a coherent pattern of development.
4. Movement – accessible and easy to move around.
5. Nature – enhanced and optimised.
6. Public Spaces – safe, social and inclusive.
7. Uses – mixed and integrated.
8. Homes and buildings – functional, healthy and sustainable.
9. Resources – efficient and resilient.
10. Lifespan – made to last.

By using these characteristics in policy making, the aim is to provide desirable places which are sustainable for the whole lifespan of a development. The NDG goes on to highlight that sustainable places include a mix of uses that support everyday activities, allowing people to inherently live sustainably.

The NDG also explores how a place can be designed from the outset by considering natural resources, such as land, water, energy and materials. By considering these, it will help the design respond to climate change by being more energy efficient and minimising carbon emissions to meet net zero by 2050. It is also important to consider the whole lifespan of a space, with well-designed places adding to the quality of life of their users, which in turn encourages the space to be well looked after and extends its usable life.

7.2.2 National Model Design Code

The National Model Design Code (NMDG) provides a base for policy makers on preparing a deliverable Design Code. The NMDG is a high-level document that uses the ten characteristics identified in the NDG and distils these down into how they can effectively be delivered within the design of new places.

7.2.3 The New Homes Policy Playbook (UKGBC, 2021)[95]

The UK Green Building Council's Playbook (2021) seeks to push Local Authorities to go beyond national policy in setting sustainability policies. It proposes that Local Authorities match upcoming Building Regulations in carbon emissions targets and provides advice on net zero carbon, overheating, and assuring performance.

7.2.4 Planning for A Smart Energy Future (RTPI, 2019)[96]

This report was produced for planning policy and decision makers to create future planning policy that can 'catch up' to the clean growth opportunities offered by smart energy. The report makes several recommendations including the need for more top-down leadership in planning to deliver transformational change and for Local Authorities to improve access to resources and training to stay up to date on new energy technologies.

7.2.5 The Climate Crisis Guide, RTPI, TCPA (3rd edition, 2021) [97]

This guide focuses on the broad approaches to handling carbon reduction and climate adaptation through the planning system. It refers to the relationships between planning and other systems, such as Building Regulations, but focuses on the former.

It highlights that the core purpose of planning is to create places that enable people to live happy and healthy lives and that it is not possible to achieve this aim without addressing both climate change mitigation and

[95] UK Green Building Council (2021) "The New Homes Policy Playbook", p20. London: UK Green Building Council.

[96] RTPI (2019) Planning for a Smart Energy Future. Available at: https://www.rtpi.org.uk/media/1435/planning-for-a-smart-energy-future.pdf [Accessed August 2023]

[97] RTPI & TCPA (2021) The Climate Crisis: A Guide for Local Authorities on Planning for Climate Change. Available: https://www.rtpi.org.uk/media/14719/tcpa-rtpi-climate-guide-4th-edition.pdf. [Accessed August 2023].

climate change adaptation. It sets out the legal and policy background; advises on collating an evidence base and policy approaches for plan-making; and offers advice on decision-making. It provides case studies and advice in relation to, amongst other issues, district heat networks in new developments and binding net-zero standards for new development. This guide also provides advice on setting requirements for sustainable buildings with reference to the BRE and PassivHaus standards.

7.2.6 RTPI 20-minute Neighbourhood[98]

The Royal Town Planning Institute (RTPI) Scotland produced the above document which explores the concept of 20-minute neighbourhoods and how this has been the embedded in policy. 20-minute neighbourhoods look to provide daily services within a 20-minute walk of residents, by considering:

- Density – compact neighbourhoods reduce the distance between homes and jobs. This can be achieved via higher densities which can provide the critical mass of population needed to support local services.
- Transport – by delivering a well-integrated transport system and looking at land use planning, transport can encourage people to take alternative modes of transport rather than requiring a private car.
- Local services – this requires planning to look at the amenities provided in an area, to ensure people have the services they need within a walkable distance.
- Open Space – looks at Open Space Strategies to be provided. These can ensure high quality and sufficient open space and green/blue space infrastructure is being provided within 20-minute neighbourhoods.

By achieving a 20-minute neighbourhood, it will allow for residents to easily adopt a more sustainable way of living.

7.2.7 Cracking the Code (RTPI, 2022)[99]

To achieve net zero and nature recovery, the RTPI has prepared a guide on district and site level design codes. The advice builds on the National Model Design Code and was produced in collaboration with planning, climate and transport specialists, alongside the Royal Society for the Protection of Birds (RSPB).

This design code comprises a baseline carbon assessment, mapping of energy and potential energy sources, a high-level spatial vision for 2040, critical success factors for 2040 and lastly, design principles and core requirements for all types of allocations.

7.2.8 Greater London Authority's Healthy Street Approach[100]

Healthy Street for London looks at how the Greater London Authority plans to encourage Londoners to walk, cycle and use public transport more, in the aim of achieving the target for 80% of all trips in London to be made via sustainable modes of travel by 2041. It identifies 10 Healthy Street Indicators, and then provides steps to achieve these, such as:

- Providing more spaces for walking and cycling, by enhancing local environments;
- Prioritising better and more affordable public transport and safe and more appealing routes for walking and cycling; and
- Planning new developments in a way that encourage people to walk and cycle to local amenities and are well linked to public transport.

[98] RTPI (2021) 20 Minute Neighbourhoods Implementing 20 Minute Neighbourhoods in Planning Policy and Practice. Available at: RTPI | Implementing 20 Minute Neighbourhoods in Planning Policy and Practice [Accessed: December 2023].
[99] RTPI & RSPB (2022) Cracking the Code. Available: https://www.rtpi.org.uk/media/11054/design-codes-report-final.pdf. [Accessed August 2023].
[100] Mayor of London (2017) Healthy Streets for London Prioritising walking, cycling and public transport to create a healthy city. Available: Healthy Streets for London (tfl.gov.uk) [Accessed December 2023].

7.3 Technical Building Assessments

Table 24 below provides a summary of best practice in technical building assessments. For further details, follow the references in column 3 of Table 24 to Appendix A.2.

Table 24: Summary of Technical Buildings Assessments

Guidance	Summary	Appendix Reference
BREEAM, BREEAM Infrastructure and Home Quality Mark (HQM)	BREEAM has been developed for assessing the sustainability of buildings and BREEAM Infrastructure for assessing the sustainability of civil engineering, infrastructure, landscaping, and the public realm works.	A.2.1.2
UKGBC - Net Zero Carbon Buildings: A Framework Definition (UKGBC, 2019) & follow-up guidance (UKGBC, 2020 & 2021)	This Framework was published in 2019 to establish an industry definition of net zero carbon buildings and advises a 'reduction first' approach to achieving net zero carbon.	A.2.1.3
The Passivhaus Standard (Passive House Institute, 2022)	The Passivhaus Standard focuses on substantially reducing space heating and cooling requirements and establishing good indoor comfort levels, by adopting a fabric first approach and systems level ventilation, which achieve a minimum 75% reduction in space heating requirements, over standard UK new build practice.	A.2.1.4
Low Energy Transformation Initiative (LETI) Guidance	LETI have published several documents, which set out a range of guidance and standards to aid the built environment industry in reducing carbon emissions: Defining and Aligning: Whole Life Carbon and Embodied Carbon Whole Life Carbon 'One-Pager' Embodied Carbon Target Alignment Embodied Carbon 'One-Pager' Climate Emergency Retrofit Guide	A.2.1.5 – A.2.1.10

7.4 Best Practice Policy Review

This chapter provides an overview of MKCC's current policy position in relation to climate change, together with a summary of good practice policy in other Local Plans.

7.4.1 Milton Keynes City Council Current Policy Position

The currently adopted Local Plan for MKCC is made up of development plan documents listed below:

- Plan:MK (2016-2031) was adopted in March 2019. As this document was adopted in 2019, it can be considered up to date until March 2024 and therefore carries significant weight in planning decisions.
- Site Allocations Plan (2018) was adopted in July 2018. This plan only covers the period until 2026 and it is not part of the longer-term Plan:MK process.
- Minerals Local Plan was adopted in July 2017, it does not have a defined period which it covers but is part of the development plan which covers the period to 2032. It carries significant weight in planning decisions.

- Waste Development Plan Document (2007-2026) was adopted in February 2008, and carries significant weight in planning decisions.
- Milton Keynes currently has 26 designated neighbourhood areas of which 18 have made/adopted Neighbourhood Development Plans.

There are 21 adopted Supplementary Planning Documents (SPDs), including six site-specific SPDs. The SPDs that were adopted within the last five years - and are therefore considered to be up to date - are listed below:

- Planning Obligations SPD (February 2021)
- Affordable Housing (January 2020)
- Parking Standards (January 2023)
- Health Impact Assessment (March 2021)
- Biodiversity (June 2021)
- Sustainable Construction (November 2021)
- Dementia Friendly Neighbourhoods (April 2022)
- Milton Keynes East Development Framework SPD (March 2021)
- South East Milton Keynes SPD (January 2022)
- Central Bletchley Urban Design Framework SPD (March 2022)

The remaining SPDs which were adopted more than five years ago remain materials considerations for planning decisions, although may carry less than full weight based on other considerations such as changing context. These are:

- Urban Development Area Tariff SPD (November 2007)
- Strategic Land Allocation Development Framework SPD (November 2013)
- Western Expansion Area Development Framework (November 2005)
- Eastern Expansion Area Development Framework (October 2005)
- Houses in Multiple Occupation SPD (2012)
- Milton Keynes Drainage Strategy SPD (2004)
- Outdoor Advertising Policy (2005)
- New Residential Design Guide SPD (April 2012)
- Telecommunications Systems Policy (May 2005)
- Wind Turbines (October 2013)
- Transport and Sustainable Transport SPD (June 2009)

7.4.2 Review of Best Practice in Local Plan Policy

This section provides a summary of adopted policies in England. This means that they have been formally examined and found sound by a Planning Inspector.

The policies are presented within the '*Framework for well-designed and sustainable places'* which is set out in more detail in Section 8 of this report. Each section includes the relevant Plan:MK policies, to show the current MKCC policy position in relation to the indicators and allows for gaps in policy to be identified and allow for recommendations to be made.

The '*Framework for well-designed and sustainable places*' is as follows:

1. Complete neighbourhood – aims for new developments to prioritise local life and allows for local people to access their everyday needs within a short walk or cycle from their homes. This can be achieved by providing a good density and mix of uses and services, which are easily accessible.
2. People-centred mobility – aims to re-prioritise the streets and streetscape to focus on alternative modes of transport.
3. Connected places – to enable sustainable living and social mobility, it is key to ensure communities are well connected, not just physically, but also digitally.
4. Places for people – Places, whether new or existing, need to be designed to work for the local community, by improving living standards, creating job opportunities and enhancing public and environmental health for all.
5. Clean construction – Sustainability needs to be considered throughout the lifecycle of a development, being planned, designed, and operated to minimise emissions.
6. Green buildings and energy – development projects need to drive the reduction of domestic and commercial energy consumption and greenhouse gas emissions, while also addressing challenges of energy access and poverty.
7. Green and nature-based solutions – Green and blue spaces are critical features of a net zero, resilient and thriving urban neighbourhood.
8. Sustainable lifestyle – developments should enable communities to make sustainable choices throughout the lifecycle of the development. This can be achieved through facilitation well-designed and safe streets to promote active travel, a service-based and sharing economy and behavioural changes.
9. Green economy – New developments need to support MKCC in their goal to create a resource-efficient and low emissions economy.
10. Resilient and distinctive places – All developments should aspire to be resilient and distinctive, while responding positively to the features of the site itself and enhancing the surroundings and local character.

7.4.3 Complete Neighbourhoods

Table 25: Policies promoting complete neighbourhoods

LPA	Policy
Milton Keynes Plan:MK 2016–2031	Policy SD1: Place-making principles for development This policy sets out the key principles that developers should demonstrate they have considered while designing strategic urban extensions, strategic scale development, and where relevant, other development within or adjoining the Milton Keynes urban area. These principles cover: 1. Promoting good mental and physical health. 2. Integrates well with the surrounding build and natural environments. 3. The structure and layout of development within or adjoining the urban area of Milton Keynes, should be based on the original principles that shaped the city. 4. Development should relate well to the surrounding area. 5. The layout, form and detailed design of development should adopt passive design measures to reduce energy demand for heating, lighting and cooling, create comfortable and healthy environments for people, and be responsive to predicted changes in climate. 6. Development takes a strategic, integrated and sustainable approach to water resource management. 7. Development should enhance the character of the area within which it is located. 8. New social and commercial facilities and services are provided. 9. Shops, facilities and public transport stops are located in the most accessible locations.

LPA	Policy
	10. Housing is generally arranged according to perimeter block principles. 11. Where appropriate, different character areas are created through the use of varied densities, high quality landscaping, block and building layouts, architecture and the framing and treatment of open spaces and the public realm is informed by the surrounding context. 12. Development should incorporate visual cues to aid wayfinding. 13. The layout and design of development enables easy, safe and pleasant access for pedestrians and cyclists of all abilities. 14. Routes through the development should cater for the needs of all age groups. 15. Impacts on the road network should be identified through appropriate technical assessments and suitable mitigation and improvements should be put in place. 16. Transport solutions should be maximised the opportunities provided by smart, shared and sustainable mobility solutions to deliver real alternatives to the private car. 17. The provision of strategic grid road or highway infrastructure should build in measures for rapid public transport solutions. 18. Opportunities to provide new 'Park and Ride' or Parkway sites which would offer an alternative to the car for journeys into Milton Keynes. 19. Development should result in a net gain in biodiversity. **Policy HN1: Housing Mix and Density; Policy HN2 Affordable Housing; Policy HN3 Supported and Specialist Housing; Policy HN4: Amenity, Accessibility and Adaptability of Homes** These policies require a wide range of housing requirements, to ensure that the housing being built around MKCC meets the needs of the population now and in the future
Greater London Authority London Plan – adopted March 2021	**Policy SD6: Town centres and high streets** (A, 2) Identifying locations for mixed-use or housing-led intensification to optimise residential growth potential, securing a high-quality environment and complementing local character and heritage assets. (C) The potential for new housing within and on the edge of town centres should be realised through mixed-use or residential development that makes best use of land, capitalising on the availability of services within walking and cycling distance, and their current and future accessibility by public transport. **Policy GG2: Making the best use of land** This policy sets out the requirements that must be considered in order to create successful sustainable mixed-use places: • Enable the development of brownfield land. • Prioritise sites that are well connected to public transport. • Proactively explore the potential to intensify the use of land to support additional homes and workplaces, promoting higher density development. Plan for good local walking, cycling and public transport connections to support a strategic target of 80% of all journeys using sustainable travel.
Reading Borough Council Reading Borough Local Plan – adopted November 2019	**H2: Density and Mix** The appropriate density of residential development will be informed by: • the character and mix of uses of the area in which it is located, including the housing mix, and including consideration of any nearby heritage assets or important landscape or townscape areas; • its current and future level of accessibility by walking, cycling and public transport; • the need to achieve high quality design; • the need to maximise the efficiency of land use; and

LPA	Policy
	• the need to minimise environmental impacts, including detrimental impacts on the amenities of adjoining occupiers. Indicative densities for different types of area are set out, but the criteria above may indicate that a different density is appropriate. Residential development capacity figures within the site allocation policies are often based on these densities, but the capacity of each site will likewise depend on various factors that need to be addressed at application stage, including detailed design and layout, and may differ from the range set out in the allocation. Net densities of below 30 dwellings per hectare will not be acceptable. Wherever possible, residential development should contribute towards meeting the needs for the mix of housing set out, in particular for family homes of three or more bedrooms. As a minimum, on new developments for 10 or more dwellings outside the central area and defined district and local centres, planning decisions will ensure that over 50% of dwellings will be of 3 bedrooms or more, having regard to all other material considerations.

7.4.4 People-centred mobility

Table 26: Policies promoting people-centred mobility

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy CT1: Sustainable Transport Network** The Council will promote a sustainable pattern of development in Milton Keynes, minimising the need to travel and reducing dependence on the private car. Milton Keynes Council will: 1) Promote a safe, efficient and convenient transport system 2) Promote transport choice, through improvements to public transport services and supporting infrastructure, and providing coherent and direct cycling and walking networks to provide a genuine alternative to the car 3) Manage congestion and provide for consistent journey times 4) Promote and improve safety, security and healthy lifestyles 5) Promote the usage of shared transport schemes in the borough **CT2 Movement and Access; CT3 Walking and Cycling** This policy requires developments to minimise the need to travel and promote more sustainable modes of travel, to improve accessibility to services and support the transition to a low carbon future. **Policy CT5: Public Transport** Development proposals must be designed to meet the needs of public transport operators and users, this will be achieved with road layouts meeting the needs of public transport.
Greater London Authority London Plan – adopted March 2021	**Policy T1: Strategic approach to transport** 1. Development Plans should support, and development proposals should facilitate: a. the delivery of the Mayor's strategic target of 80 per cent of all trips in London to be made by foot, cycle or public transport by 2041 b. the proposed transport schemes set out in Table 10.1. 2. All development should make the most effective use of land, reflecting its connectivity and accessibility by existing and future public transport, walking and cycling routes, and ensure that any impacts on London's transport networks and supporting infrastructure are mitigated.
Cornwall Council Cornwall Climate Emergency Development Plan – adopted February 2023	**Policy T1: Sustainable Transport** New development should be designed and located in order to minimise the need to travel and support a modal hierarchy which prioritises walking, then cycling, then public transport, then car clubs, electric vehicles and lastly private fossil-fuelled vehicles. Development should be designed to: 1) Facilitate integration between different modes of travel, especially walking, cycling and public transport. Every opportunity should be taken to connect to, and benefit from,

LPA	Policy
	existing walking and cycling networks and to maximise permeability for these modes within and outside of sites; 2) Integrate with the existing settlement through inclusive, active travel networks ensuring easy and sustainable connections to community facilities and infrastructure and enabling connections to potential future travel modes; 3) Provide conveniently located and secure cycle parking, including private home provision throughout the development, including close to the development access points, and benefiting from natural surveillance; 4) Provide an appropriate level of safe, secure, accessible and usable parking provision having regard to policy T2 and reflecting principles set out in the Cornwall Design Guide and the level of accessibility by walking, cycling and public transport; 5) Deliver more sustainable streets including by; – Making it easier and more attractive to walk, cycle and considering access only streets to create green networks; – Enabling greater use of public transport; – Making streets accessible for users with disabilities; – Providing varied spaces for people to meet and rest, and for children to play, enabling greater social interaction; – Incorporating high levels of green and blue infrastructure. 6) Support the use of electric vehicles (including electric bikes) by providing electric vehicle charging points.
London Borough of Brent Brent Local Plan 2019-2041 – adopted February 2022	**Policy BT1: Sustainable Travel Choice** The council will prioritise active and sustainable travel over private motor vehicles. The council will work with its partners and, where appropriate, require developments to: Active Travel A. design public realm to meet healthy streets principles and provide access for all; publicly accessible private space will be managed in accordance with the Mayor's Public London Charter or locally adopted equivalent standard; B. protect the character of the Capital Ring walking route and, where appropriate, contribute to its improvement; C. provide for and make contributions towards connected, high quality, convenient and safe cycle routes and facilities in accordance with the Brent Cycling Strategy, including cycle parking, in line with or exceeding London Plan standards and TfL and WestTrans design standards, the implementation of new cycleways, and a borough wide cycle hire scheme; D. enhance the A5 corridor to reduce traffic dominance and improve the public realm; E. improve environmental quality and reduce severance along the North Circular and London Distributor Road Network; F. remove vehicle cross-overs or other public realm features no longer required; Sustainable Travel G. safeguard land for and enable the delivery of the West London Orbital overground; H. create a high quality pedestrian connection from Brent Cross West Thameslink station to Staples Corner and the wider area in parallel with the delivery of the station; I. create a high quality pedestrian and cycle connection between Harlesden and an upgraded Willesden Junction station; J. increase the number of tube and overground stations with step free access in the borough; K. support the bus network in Brent by identifying and implementing bus priority measures to improve journey time reliability; maintaining existing coverage and improving connectivity to areas of the borough with limited public transport access, and improving bus interchange facilities; Clean Technology

LPA	Policy
	L. increase coverage of Electric Vehicle charging points across the borough

7.4.5 Connected Places

Table 27: Policies promoting connected places

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy CT1: Sustainable Transport Network** The Council will promote a sustainable pattern of development in Milton Keynes, minimising the need to travel and reducing dependence on the private car. Milton Keynes Council will: 1) Promote a safe, efficient and convenient transport system 2) Promote improved access to key locations and services by all modes of transport and ensure good integration between transport modes 3) Manage congestion and provide for consistent journey times 4) Continue to engage with relevant stakeholders along the East-West Rail line and Expressway to identify operational benefits, which provide additional support for a more sustainable transport strategy and/or economic growth of the city 5) Engage with the National Infrastructure Commission to set in place connections from Central Milton Keynes to surrounding communities, including a fifth track constructed between Bletchley and Milton Keynes Central **Policy CT6: Low Emission Vehicles** MKCC will support the use of sustainable travel in development, and support low carbon public and personal transport, with the infrastructure to support low emission vehicles being integrated into all new major developments.
Ipswich Borough Council Local Plan Core Strategy and Policies Development Plan 2018-2036 – adopted March 2022	**Policy CS5: Improving Accessibility** Development should be located and designed to minimise the need to travel and enable access safely and conveniently on foot, by bicycle and by public transport (bus and rail). This will encourage greater use of these modes. The Council will support the expansion of electronic communications networks throughout the plan area as a means to support economic growth and enable home working, and thus reduce the need to travel.
Oxford City Council Oxford Local Plan 2036 – adopted Jun 2020	**Policy M2: Assessing and managing development** Point D: access to high quality public transport is facilitated, with layouts that maximise the catchment area for bus or other public transport services, and appropriate facilities that encourage public transport use.
Wyre Forest District Council Local Plan 2016-2036 – adopted April 2022	**Part Policy SP.36: Telecommunications and Broadband** All new development of 20 dwellings or more will be expected to include the provision of full fibre gigabit capable network infrastructure Fibre to the Premises (FTTP) to enable broadband services for all occupiers. On sites below 20 dwellings FTTP should still be installed where the costs are no more than copper line broadband infrastructure.

7.4.6 Places for People

Table 28: Policies promoting places for people

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy D5: Amenity and Street Scene** All proposed developments in MKCC will need to create and protect a good standard of amenity for new and existing buildings and surrounding areas. **Policy EH7: Promoting Healthy Communities**

LPA	Policy
	(A, 2) Aims to reduce loneliness by providing buildings and spaces where people can interact, encourage food supply and healthy eating by providing access to allotments and to a variety of food sources.
London Borough of Camden Camden Local Plan – adopted 2017	**Policy C1 Health and wellbeing** The Council will improve and promote strong, vibrant and healthy communities through ensuring a high quality environment with local services to support health, social and cultural wellbeing and reduce inequalities. Measures that will help contribute to healthier communities and reduce health inequalities must be incorporated in a development where appropriate. The Council will require: a. development to positively contribute to creating high quality, active, safe and accessible places; and b. proposals for major development schemes to include a Health Impact Assessment (HIA). We will: c. contribute towards the health priorities of the Health and Wellbeing Board and partners to help reduce health inequalities across the borough; d. support the provision of new or improved health facilities, in line with Camden's Clinical Commissioning Group and NHS England requirements; and e. protect existing health facilities in line with Policy C2 Community facilities.

7.4.7 Clean Construction

Table 29: Policies promoting clean construction

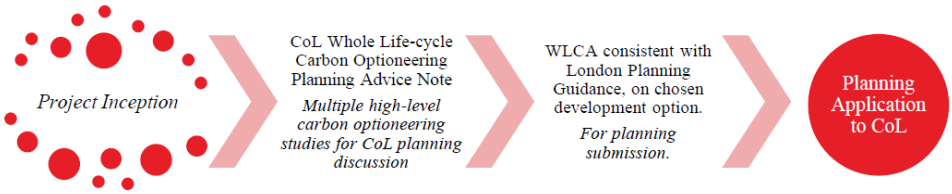
LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy D4: Innovative Design and Construction** For proposals of more than 50 dwellings, it will be encouraged that 10% of new dwellings will incorporate innovative design features and modern methods of construction. **Policy SC1: Sustainable Construction** Development proposals will be required to demonstrate how they have implemented the principles and requirements, based on materials and waste, energy and climate, water and retrofitting. With non-residential development of over 1,000sq.m or more demonstrating that it achieves BREEAM Outstanding. 1. Developments over 11 dwellings and more than 1,000sq.m will need to submit an Energy and Climate Statement, that demonstrates the development will achieve a 19% carbon reduction improvement upon the requirements within Building Regulations Approved Document Part L 2013.... a. Provide on-site renewable energy generation, or connection to a renewable or low carbon community energy scheme, that contributes to a further 20% reduction in the residual carbon emissions subsequent to 1) above. b. Make financial contributions to the Council's carbon offset fund to enable the residual carbon emissions subsequent to the 1) and 2) above to be offset by other local initiatives. c. Calculate Indoor Air Quality and Overheating Risk performance for proposed new dwellings. d. Implement a recognised quality regime that ensures the 'as built' performance (energy use, carbon emissions, indoor air quality, and overheating risk) matches the calculated design performance of dwellings in 4) above. e. Put in place a recognised monitoring regime to allow the assessment of energy use, indoor air quality, and overheating risk for 10% of the proposed dwellings for the first five years of their occupancy and ensure that the information recovered is provided to the applicable occupiers and the planning authority.
Oxford City Council Oxford Local Plan 2036 – adopted June 2020	**Policy RE1 – Sustainable Design and Construction** Requires applicants to demonstrate the use of sustainable design and construction principles incorporating energy efficiency and the use of low carbon energy, water conservation and efficiency, use of recycled and recyclable materials and responsible sourcing, minimising waste and maximising recycling during construction and operation, minimising flood risk, adaptability and flexibility to future occupier needs and enhancing biodiversity. In addition, this policy requires the submission of an Energy Statement for residential and non-residential schemes over 1,000m^2.
Cornwall Council	**Part Policy SEC1 – Sustainable Energy and Construction**

LPA	Policy
Cornwall Climate Emergency Development Plan – adopted February 2023	Overall this is a comprehensive policy that covers principles for development proposals to implement. The points below are specific to sustainable construction: 1) The energy hierarchy All proposals should embed the Energy Hierarchy within the design of buildings by prioritising fabric first, orientation and landscaping in order to minimise energy demand for heating, lighting and cooling. All proposals should consider opportunities to provide solar PV and energy storage. 2) Materials and Waste All development proposals should minimise the use of materials and creation of waste and promote opportunities for a circular economy through: a. Wherever possible reusing or adapting existing buildings as part of the development, whilst maintaining and enhancing local character and distinctiveness; b. Reuse and recycling of appropriate materials that arise through demolition and refurbishment, including the reuse of non-contaminated excavated soil and hardcore within the site; c. Prioritise the use of locally sourced and/or sustainable materials and construction techniques that have smaller ecological and carbon footprints; d. Using locally distinctive, resilient, low maintenance materials that are appropriate for Cornwall's damp maritime climate, for example locally won materials such as slate and granite (particularly for areas that will be harder to maintain once the building is occupied) as described in the Cornwall Design Guide; e. Considering the lifecycle of the development and surrounding area, actively prioritise design that delivers longevity and repairability including how developments can be adapted to meet changing needs and how materials can be recycled at the end of their lifetime; f. Providing adequate space to enable and encourage greater levels of recycling. Space requirements for residential developments should follow those outlined in the Cornwall Design Guide
Greater London Authority London Plan – adopted March 2021	**Policy SI 2: Minimising greenhouse gas emissions** Development proposals referable to the Mayor should calculate whole lifecycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions. **Policy SI7: Reducing waste and supporting the circular economy** 1. Resource conservation, waste reduction, increases in material re-use and recycling, and reductions in waste going for disposal will be achieved by the Mayor, waste planning authorities and industry working in collaboration to: a. promote a more circular economy that improves resource efficiency and innovation to keep products and materials at their highest use for as long as possible b. encourage waste minimisation and waste prevention through the reuse of materials and using fewer resources in the production and distribution of products c. ensure that there is zero biodegradable or recyclable waste to landfill by 2026 d. meet or exceed the municipal waste recycling target of 65 per cent by 2030 e. meet or exceed the targets for each of the following waste and material streams: i. construction and demolition – 95 per cent reuse/recycling/recovery ii. excavation – 95 per cent beneficial use f. design developments with adequate, flexible, and easily accessible storage space and collection systems that support, as a minimum, the separate collection of dry recyclables (at least card, paper, mixed plastics, metals, glass) and food 2. Referable applications should promote circular economy outcomes and aim to be net zero-waste. A Circular Economy Statement should be submitted, to demonstrate:

LPA	Policy
	a. how all materials arising from demolition and remediation works will be re-used and/or recycled b. how the proposal's design and construction will reduce material demands and enable building materials, components and products to be disassembled and re-used at the end of their useful life c. opportunities for managing as much waste as possible on site d. adequate and easily accessible storage space and collection systems to support recycling and re-use e. how much waste the proposal is expected to generate, and how and where the waste will be managed in accordance with the waste hierarchy f. how performance will be monitored and reported. Development Plans that apply circular economy principles and set local lower thresholds for the application of Circular Economy Statements for development proposals are supported.
Central Lincolnshire Local Plan – adopted April 2023	**Policy S11: Embodied Carbon** This policy sets out that the local authority has a presumption against demolition, with repair, refurbish, repurpose and reuse being the preferred options. All major developments should explicitly set out what opportunities to lower a building's embodied carbon content have been considered, and which opportunities, if any, are to be taken forward.
Whole Life Carbon Guidance	
Greater London Authority London Plan Guidance Whole Life-Cycle Carbon Assessments March 2022 edition	The London Plan Guidance (LPG) on whole life-cycle carbon assessments was initially published in 2020 (draft); a final version was published in March 2022, after the draft consultation period. It applies to major London projects which are referable to the Mayor of London and is complemented by London Plan Guidance: Circular Economy Statements. Several boroughs of London refer to this guidance in their own local plans (e.g. City of Westminster and City of London). The LPG provides complementary guidance to the RICS PS; it is generally aligned with a few exceptions, e.g. additional practical guidance for the assessment process, where the RICS PS 1st edition was insufficient or unclear. Some tangible examples include allowances for in-use phase maintenance and repair emissions, and advice for operational carbon emissions to align with other GLA guidance. In the RICS PS 2nd edition draft, some of the LPG practical guidance has been adopted (e.g. allowances for demolition), but differences still remain in the two latest guidance documents One substantial difference is the LPGs bespoke reporting templates, in addition to requiring that projects are reported to the UK Built Environment Carbon Database[101]. The LPG reporting templates standardise the embodied and operational carbon emissions reporting for a London project, but they differ from the RICS suggested reported requirements; and with the updated RICS PS, the reporting templates still differ.
Westminster City Council Westminster environment guidance – Section B (last updated 6 January 2023)[102]	The City of Westminster requires Whole Life Carbon Assessments (WLCA) for all major (non-referable) redevelopment schemes where there is substantial demolition, in addition to requiring a WLCA for all projects referrable to the Mayor of London (also required by the London Plan guidance). All "major" developments are at least encouraged to complete a WLCA12; the definition of "major" is defined in the Glossary to Westminster's City Plan: Strategic Policies. City of Westminster defer to RICS PS for guidance; no complementary Westminster guidance is publicly available. However, it is Arup's experience that planning application reviewers have additional preferences associated with WLCA methodology, which can require assessments to be revised after initial submission.
City of London Whole Life-Cycle Carbon Optioneering	The City of London (CoL) Whole Life-cycle Carbon Optioneering guidance intends to establish a consistent, early-stage approach to assessing and reporting carbon in pre-application discussions,

[101] BECD (2023) Built Environment Carbon Database. Available at: https://www.becd.co.uk/ [Accessed September 2023]

[102] Westminster City Council (2023) Westminster environment guidance - Section B. Available at: https://www.westminster.gov.uk/westminster-environment-guidance-section-b/section-b-embodied-and-whole-life-carbon [Accessed September 2023]

LPA	Policy
March 2023	and to facilitate discussions around the carbon impact of different options. This approach is an additional requirement for major developments and/or where substantial demolition is proposed. For relevant projects, a CoL planning application must still include a full WLCA consistent with the latest London Planning Guidance.  The CoL planning advice note includes additional activities not present in other guidance, in that it includes a methodology and reporting requirements for early-stage options studies, subsequently referring to London Plan Guidance for more detailed analyses of a chosen design which will be submitted to Planning for approval. The CoL guidance notably requires a third-party review of the options study exercise. This is an additional third-party review; London Plan Guidance for WLCA requires a third-party review only of the carbon assessment for the project designed and submitted for planning. From the perspective of the WLCA specialist and third-party reviewer, such an early-stage review may be challenging and necessarily requires professional judgement and subjectivity, as there is limited design development on any number of options.
Bath and North East Somerset Council Emerging Local Plan Partial Update policies issued January 2023	The B&NES local planning policy update in early 2023 is the first local policy to set a maximum embodied carbon impact (a limit); no other policies in the UK have done this. However, the limit that has been set (900kgCO2e/m2) is much higher than the benchmarks in London guidance from 2020 for the same related scope, i.e. for the relevant building elements/scope it would be unusual for a development to reach the limit. In terms of assessment requirements and scope, the policy is complemented by a Supplementary Planning Document (SPD / "Sustainable construction checklist"), which is essential for understanding all the policy requirements. The SPD guidance makes references to RICS and LETI methodologies, but differs in many respects. Some key differences in methodology are that the building elements to be included in the assessment are only substructure, superstructure (including envelope) and finishes; and only LCA modules A1-A5 are required (carbon up to practical completion of the building). Hence, the set limit (900kgCO2e/m2) is not onerous to meet, and differs substantially from benchmarks and aspirational carbon targets in the London Plan Guidance. The B&NES SPD also references reporting templates defined for B&NES planning, which are bespoke to this council.

7.4.8 Green Buildings & Energy

Table 30: Policies promoting green buildings and energy

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy SC2: Community Energy Networks and Large-Scale Renewable Energy Schemes** Low carbon and renewable energy schemes will be attributed significant weight in their favour. Proposals of over 100 dwellings or non-residential development of over 1,000sq.m will be expected to consider the integration of community energy networks. **Policy SC3: Low Carbon and Renewable Energy Generation** The council will encourage proposals for low carbon and renewable energy generation developments that are led by or meet the needs of the local community.
Cornwall Council Cornwall Climate Emergency Development Plan – adopted February 2023	**Part Policy SEC1 – Sustainable Energy and Construction** This policy requires proposals to embed the energy hierarchy within the design of buildings, with all major non-residential developments required to achieve BREEAM 'Excellent'. All new residential development will be required to achieve Net Zero Carbon and submit an 'Energy Statement' demonstrating how they will achieve: space heating demand less than 30kWh/m^2/annum, total energy consumption of less than 40kWh/m^2/annum, and onsite renewable energy generation to match total energy consumption, with a preference for roof-mounted solar PV.

LPA	Policy
	In addition, this policy gives significant weight to considerable improvements to the energy efficiency and reduction in carbon emissions in existing buildings and states that the council will support domestic and non-domestic renewables, such as solar panels, where they require planning permission. This policy is caveated so that proposals that affect the significance of heritage assets and their settings must ensure: • Not to cause harm to appearance or historic character. • Require minimal intervention with the fabric of the building • And be easily reversible. **Policy RE1: Renewable and Low Carbon Energy** Proposals for renewable and low carbon energy-generating and distribution networks, will be supported in the context of sustainable development and climate change, where: A. they contribute to meeting Cornwall's target of 100% renewable electricity supply by 2030; and B. they balance the wider environmental, social and economic benefits of renewable electricity, heat and/or fuel production and distribution; and C. It will not result in significant adverse impacts on the local environment that cannot be satisfactorily mitigated, including cumulative landscape and visual impacts, the special qualities of all nationally important landscapes, and the significance of heritage assets including their settings, including the outstanding universal value of Cornwall and West Devon Mining Landscape World Heritage Site and the character of wider historic townscapes, landscapes and seascapes; and D. In and within the setting of Areas of Outstanding Natural Beauty and undeveloped coast, developments will only be permitted in exceptional circumstances and should generally be very small scale giving due regard to the natural beauty of these areas; and E. Where the current use of the land is agricultural, the use allows for the continuation of the site for some form of agricultural activity proportionate to the scale of the proposal and provides for 10% biodiversity net gain; and F. Commercial led energy schemes with a capacity over 5MW shall provide an option to communities to own at least 5% of the scheme subject to viability; and G. There are appropriate plans and a mechanism in place for the removal of the technology on cessation of generation, and restoration of the site to its original use or an acceptable alternative use; and H. Opportunities for co-location of energy producers with energy users, in particular heat will be supported. Significant weight will be given to community led energy schemes where evidence of community support can be demonstrated, with administrative and financial structures in place to deliver/ manage the project and any income from it. Encouragement will be given to schemes to provide for a community benefit in terms of profit sharing or proportion of community ownership and delivery of local social and community benefits. *The policy goes on to provide criteria on how each type of energy generation (wind, solar, hydroelectric, deep geothermal and mine water) will be assessed.*
Central Lincolnshire Local Plan – adopted April 2023	**Policy S6: Design Principles for Efficient Buildings** When formulating development proposals, the following design expectations should be considered and in the following order: 1. Orientation of buildings – such as positioning buildings to maximise opportunities for solar gain, and minimise winter cold wind heat loss; 2. Form of buildings – creating buildings that are more efficient to heat and stay warm in colder conditions and stay cool in warmer conditions because of their shape and design; 3. Fabric of buildings – using materials and building techniques that reduce heat and energy needs. Ideally, this could also consider using materials with a lower embodied carbon content and/or high practical recyclable content; 4. Heat supply – net zero carbon content of heat supply (for example, this means no connection to the gas network or use of oil or bottled gas);

LPA	Policy
	5. Renewable energy generated – generating enough energy from renewable sources on-site (and preferably on plot) to meet reasonable estimates of all regulated and unregulated total annual energy demand across the year. Energy statements, as required by Policies S7 and S8, must set out the approach to meeting each of the above principles. **Policy S7: Reducing Energy Consumption – Residential Development** This policy sets out that unless in exceptional circumstances (such as technical or policy reasons, accreditation scheme, viability), that all new residential developments must include an Energy Statement which demonstrates that the development meets the requirements set out in Policy S6, and: • The targeted space heating demand should be around 15-20kWh/m2/yr and a site average total energy demand of 35kWh/m2/yr, and no single dwelling will have a total energy demand in excess of 60kWh/m2/yr. • The Energy Statement must include 'pre-built' estimates of energy performance and prior to occupation of each property 'as-built' figures must be provided. **Policy S8: Reducing Energy Consumption – Non-residential Buildings** The Energy Statement must demonstrate that: • The proposed development can at least generate the same amount of renewable electricity on-site (and preferably on-plot) as they demand over the year. • The target average space heating demand of around 15-20kWh/m2/yr and a site average total energy demand of 70kWh/m2/yr. No unit to have a total energy demand in excess of 90kWh/m2/yr. • The Energy Statement must include 'pre-built' estimates of energy performance and prior to occupation of each property 'as-built' figures must be provided. **Policy S9: Decentralised Energy Networks and Combined Heat and Power** Where an existing decentralised energy network exists in the locality, then development proposals in the vicinity can consider connection to such as an existing energy network. **Policy S16: Wider Energy Infrastructure** The Joint Committee is committed to supporting the transition to net zero carbon future and, in doing so, recognises and supports, in principle, the need for significant investment in new and upgraded energy infrastructure. Where planning permission is needed from a Central Lincolnshire authority, support will be given to proposals which are necessary for, or form part of, the transition to a net zero carbon sub-region, which could include: energy storage facilities (such as battery storage or thermal storage); and upgraded or new electricity facilities (such as transmission facilities, sub-stations or other electricity infrastructure. However, any such proposals should take all reasonable opportunities to mitigate any harm arising from such proposals and take care to select not only appropriate locations for such facilities, but also design solutions (see Policy S53) which minimises harm arising.
Salford City Council Development Management Policies and Designations – adopted January 2023	**Policy EG1: Sustainable Energy** Development will be expected to demonstrate compliance with the energy hierarchy in a manner that is proportionate to the scheme (in order of preference): Minimise energy demand; Maximise energy efficiency; Utilise renewable energy; Utilise low carbon energy; Utilise other energy sources.
The Royal Borough of Kensington & Chelsea Local Plan – adopted 2019	Set requirements for onsite renewables in site specific allocations in the borough, e.g. Policy CA1: Kensal Canalside Opportunity Area, point D requires on-site renewable energy sources to serve the site with the potential to contribute to the heat and energy demand of the wider community as part of a district heat and energy network.
Reading Borough Council Reading Borough Local Plan – adopted November 2019	**Policy CC4: Decentralised Energy** Schemes of over 20 residential dwellings or 1,000sq.m non-residential floorspace would be required to demonstrate that they have considered decentralised energy provision. Where an existing network was in place, the number of dwellings was reduced to 10 to consider connection to the energy network. In achieving Zero Carbon Homes for major residential developments, the preference is that new build residential of ten or more dwellings will achieve true carbon neutral development on-site. If this is not achievable, it must achieve a minimum of 35% improvement in regulated emissions

LPA	Policy
	over the Target Emissions Rate in the 2013 Building Regulations, plus a Section 106 contribution of £1,800 per remaining tonne towards carbon offsetting within the Borough (calculated as £60/ tonne over a 30-year period).
Greater London Authority London Plan – adopted March 2021	**Policy SI2: Minimising greenhouse gas emissions** 1) Major development should be net zero-carbon. This means reducing greenhouse gas emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy: a. be lean: use less energy and manage demand during operation b. be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly c. be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site d. be seen: monitor, verify and report on energy performance. 2) Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy. 3) A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major development. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided, in agreement with the borough, either: a. through a cash in lieu contribution to the borough's carbon offset fund, or b. off-site provided that an alternative proposal is identified and delivery is certain. 4) Boroughs must establish and administer a carbon offset fund. Offset fund payments must be ring-fenced to implement projects that deliver carbon reductions. The operation of offset funds should be monitored and reported on annually. Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment, that are not covered by Building Regulations, i.e. unregulated emissions. **Policy S13: Energy Infrastructure** Included a policy requesting developers and boroughs to engage with the local energy company to establish predicted energy requirements and infrastructure resulting from large scale development. Large scale development was also required to develop an Energy Masterplan to determine the most effective energy supply options.
Oxford City Council Oxford Local Plan 2036 – adopted June 2020	**Policy RE1: Sustainable Design and Construction** Requires at least a 40% reduction in carbon emissions from the 2013 building regulations, increasing to a 50% reduction from 31 March 2026 and increasing (for residential developments) to - 'zero carbon' from 31 March 2030. Non-residential developments are required to meet BREEAM Excellent standard. The policy also states that the council will encourage the development of city-wide heat networks and that if a heat network exists in proximity to a scheme, it will be expected to connect to it.
London Borough of Brent Brent Local Plan 2019-2041 – adopted February 2022	**Policy BSUI1: Creating a resilient and efficient Brent** The council will require establishment of district heating networks within the new Neasden Stations, Northwick Park and Staples Corner Growth Areas. All other Growth Areas will be expected to develop district heat networks, however the scale and type of network will vary depending on the location and scope of the projects. All major developments shall connect to or contribute towards a decentralised energy system unless it can be demonstrated that such provision is not feasible or the proposed heating system is 100% renewable. All major developments will be required to submit a Sustainability Statement demonstrating how sustainable design and construction methods have been used to enable the development to mitigate and adapt to climate change over its intended lifetime. All major non-residential development to achieve a BREEAM standard of 'Excellent'. **Policy BSUI2: Air Quality**

LPA	Policy
	Major developments within Growth Areas and Air Quality Focus Areas will be required to be Air Quality Positive and elsewhere Air Quality Neutral. Where on site delivery of these standards cannot be met, off-site mitigation measures will be required.

7.4.9 Green and Nature-based Solutions

Table 31: Policies promoting green and nature-based solutions

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy NE1: Protection of Sites** This policy sets out the requirements in order to protect sites of nature conservation, geological interest of internationally important sites, National Nature Reserves, SSSI and irreplaceable habitats. A) Policy NE3: Biodiversity and Geological Enhancement B) Development proposals will be required to maintain and protect biodiversity and geological resources, and wherever possible result in a measurable net gain in biodiversity. C) Planning permission should be refused if there is unavoidable significant harm to biodiversity, which cannot be sufficiently mitigated. D) Developments over 5 dwellings or non-residential floorspace over 1,000sq.m will be required to use the Defra metric to demonstrate any loss or gain of biodiversity. E) Mitigation, compensation and enhancement measures must be secured and be maintained for the lifetime of the development. **Policy NE6: Environmental Pollution** MKCC will ensure the proposed developments will not have an unacceptable impact on human health, groundwater, general amenity, biodiversity or the wider natural environment.
Salford City Council Development Management Policies and Designations – adopted January 2023	**Policy GI1: Development and Green Infrastructure** Point B: Within City Centre Salford, Salford Quays and other areas of high-density development, the provision of relief from high temperatures, and the efficient use of surfaces to maximise the provision of green infrastructure including through green roofs, green walls and street trees.
Reading Borough Council Reading Borough Local Plan – adopted November 2019	**Policy CC3: Adaptation to Climate Change** • Use of trees and other planting, where appropriate as part of a landscape scheme, to provide shading of amenity areas, buildings and streets and to help to connect habitat, designed with native plants that are carefully selected, managed and adaptable to meet the predicted changed climatic conditions; and All development shall minimise the impact of surface water runoff from the development in the design of the drainage system, and where possible incorporate mitigation and resilience measures for any increases in river flooding levels as a result of climate change.
Central Lincolnshire Local Plan – adopted April 2023	**Policy S17: Carbon Sinks** Existing carbon sinks must be protected, and where possible enhanced to continue to act as a carbon sink. Material weight will also be given to proposals where carbon sequestration through nature-based solutions is being proposed.
Wyre Forest District Council Local Plan 2016-2036 – adopted April 2022	**Policy SP.28: Green Infrastructure** This policy sets out a number of aims in order to protect and enhance the Green Infrastructure (GI) within the district: 1. The existing GI network will be protected from inappropriate development. 2. New GI should be incorporated into developments and contribute positively to the District's GI network. With greenfield sites exceeding 1ha (gross) providing 40% GI and greenfield sites less that 1ha but more than 0.2ha (gross) providing 20% GI. Brownfield sites have no specific GI figure. Developments that are unable to retain, protect and enhance the integrity of the GI will be considered inappropriate.

LPA	Policy
Welwyn Hatfield Borough Council Local Plan – adopted October 2023	**Policy SP12 Green Infrastructure** The Council will work with partners to actively support the creation and enhancement of strategic green infrastructure across the borough. Opportunities to link existing green spaces and to improve public access and amenity will be supported in order to provide a comprehensive network of functional and linked spaces for the benefit of wildlife, biodiversity and the community. The Council will aim to ensure there is no overall net loss in green infrastructure across the borough within the plan period. Development that would compromise the integrity, functionality or cause significant fragmentation of the green infrastructure network will not be permitted. Priorities for the creation and enhancement of green infrastructure include river corridors, sites designated for their nature conservation, heritage and/or landscape value and areas of Urban Open Land that are important for community recreation. Development proposals within the borough should plan positively for, and contribute to, the creation and management of high quality, multifunctional green spaces that are linked to the surrounding green infrastructure network. To ensure beneficial results for biodiversity and habitat creation, Hertfordshire's Ecological Networks Mapping should be used (where appropriate) and, once available, the Local Nature Recovery Strategy, to inform the location and nature of green infrastructure provision.
London Borough of Brent Brent Local Plan 2019-2041 – adopted February 2022	**Policy BGI1: Green and Blue Infrastructure in Brent** The council will expect the provision of additional public open space as set out in Growth Area policies… Where public open space is not being provided on site, a financial contribution will be sought to improving the quality and/or accessibility of existing open space provision… A. achieve a net gain in biodiversity and avoid any detrimental impact on the geodiversity of an area; B. in meeting the urban greening factor, place emphasis on solutions that support biodiversity; C. adjacent to green chains development should not undermine its biodiversity and seek to establish a connection to it; D. adjacent to the Blue Ribbon Network and other tributaries, or waterways, or which has the potential to negatively impact on its water quality, development will be required to contribute towards restoration and naturalisation of waterways, and seek to enhance water quality and biodiversity in accordance with the objectives of the Water Framework Directive and Thames River Basin Management Plan **Policy BGI2 Trees and Woodlands** Development with either existing trees on site or adjoining it that could affect trees will require: A. Submission of a BS5837 or equivalent tree survey detailing all tree(s) that are on, or adjoining the development site; B. In the case of major development to make provision for the planting and retention of trees on site. Where retention is agreed to not be possible, developers shall provide new trees to achieve equivalent canopy cover or a financial contribution for off-site tree planting of equivalent canopy cover will be sought. Replacement canopy cover will be measured as total canopy area of new trees at time of planting being equal to canopy area of existing mature trees proposed for removal; C. in the case of minor development which results in the loss of trees provision of appropriate replacements on site; D. Existing trees on site to be retained or proposed trees to be planted, to accord with the recommendations of BS5837 or equivalent; E. All agreed works to trees to accord with BS3998:2010
Guildford Borough Council Guildford Borough Local Plan: Development Management Policies – adopted March 2023	**Policy P7: Biodiversity in New Developments** Qualifying development proposals submitted after the national scheme comes into effect are required to achieve a biodiversity net gain of at least 20 per cent, or the advised national minimum amount, whichever is greater, measured using the national biodiversity net gain calculation methodology.
Worthing Borough Council Local Plan 2020-2036 – adopted March 2023	**DM18 – Biodiversity** New developments (excluding change of use and householder) should provide a minimum of 10% net gain for biodiversity - where possible this should be onsite. Where it is required/necessary to

LPA	Policy
	deliver biodiversity net gain offsite this should be part of a strategic ecological network having regard to Green Infrastructure and Local Nature Recovery strategies. Where it is achievable, a 20%+ onsite net gain is encouraged and is required for development on previously developed sites. Major developments will be expected to demonstrate this at the planning application stage using biodiversity metrics. This should be accompanied by a long term management plan.

7.4.10 Sustainable Lifestyles

Table 32: Policies promoting sustainable lifestyles (see also Table 11, 12 and 13)

LPA	Policy
Milton Keynes Plan:MK 2016–2031	See Table 11, 12 and 13.
Cornwall Council Cornwall Climate Emergency Development Plan – adopted February 2023	**Part Policy TC1: Town Centre Development Principles** All development should complement the local distinctiveness of our town centres, responding to the culture of the community and enhancing the historic environment, including public realm; where possible improving conditions for active travel, public transport, play and general amenity including green infrastructure and open space and be designed for safety and security. The conversion of ground floor retail units or redevelopment of buildings should encourage activity and vitality; where these are converted to residential use consideration should be given to retaining the historic street frontage and keeping an active use, such as for workspace or home office.
Greater London Authority London Plan – adopted March 2021	**Policy G8: Food Growing** In Development Plans, boroughs should: 1. Protect existing allotments and encourage provision of space for urban agriculture, including community gardening, and food growing within new developments and as a meanwhile use on vacant or under-utilised sites. Identify potential sites that can be used for food production.
Central Lincolnshire Local Plan – adopted April 2023	**Policy S54: Health and Wellbeing** Part C of this policy requires developments to safeguard, and where appropriate, create or enhance the roles of allotments, orchards, gardens and food markets in providing access to healthy, fresh and locally produced food.

In June 2022, the UK Government published the 'Government Food Strategy' for England. This strategy was published to provide a response following an independent review of the food system. The strategy includes policy initiatives to boost health, sustainability, accessibility of diets and to secure food supply, while ensuring that domestic producers and the wider food and drink industry contribute to the levelling up agenda.

In addition to the policies listed in Table 9, a number of local authorities have started to put together food strategies, which are non-statutory planning documents:

- Leeds Food Strategy 2022-2030
- Lambeth's Food Poverty and Insecurity Action Plan 2021-2024
- Bath and North East Somerset Local Food Strategy 2014-2017
- The London Food Strategy 2018.

7.4.11 Green Economy

Table 33: Policies promoting a green economy

LPA	Policy
Milton Keynes Plan:MK 2016–2031	While Plan:MK has economy-based policies, there are no specific policies for promoting a green economy.
Central Lincolnshire Local Plan – adopted April 2023	**Policy S10: Supporting a Circular Economy** The Joint Committee is aware of the high energy and material use consumed on a daily basis, and therefore, support the principles of a circular economy. Accordingly, and to complement any policies set out in the Minerals and Waste Development Plan, proposals will be supported, in principle, which demonstrate their compatibility with, or the furthering of, a strong circular economy in the local area (which could include cross-border activity elsewhere in Lincolnshire).
Cornwall Council Cornwall Climate Emergency Development Plan – adopted February 2023	**Policy SEC1** promotes the principles of a circular economy, particularly through the construction phase of a development. Please see the policy wording in Table 30.

There are few existing examples of Local Plan policies that specifically target the growth of green industry and green jobs.

7.4.12 Resilient & Distinctive Places

Table 34: Policies promoting resilient and distinctive places (see also Table 16)

LPA	Policy
Milton Keynes Plan:MK 2016–2031	**Policy FR1: Managing Flood Risk; Policy FR2: Sustainable Drainage Systems (SuDSand Integrated Flood Risk Management); and Policy FR3 Protecting and Enhancing Watercourses** All new developments must incorporate a surface water drainage system at the early possible stage in the design, and demonstrate a suitable water supply, foul sewerage and sewerage treatment capacity is available, to reduce flooding to the lowest possibility of flooding.Requires development to be set back by 8m from main rivers and 9m from other ordinary watercourses, and resists proposals that would adversely affect the natural functioning of rivers and lakes.
Central Lincolnshire Local Plan – adopted April 2023	**Policy S12: Water Efficiency and Sustainable Water Management** Water management: in addition to the wider flood and water related policy requirements (Policy S21), all residential development or other development comprising new buildings should consider the potential to incorporate a green roof and/or walls in accordance with Policy S20. **Policy S20: Resilient and Adaptable Design** <u>Heat resilience</u> In order to prevent and minimise the impacts of overheating in the built environment, applicants must demonstrate, commensurate with the scale and location of the proposal, consideration of: 1. How the design of the development minimises overheating and reduces demand on air conditioning systems, including considering: a. orienting buildings to maximise the opportunities for both natural heating and ventilation and to reduce wind exposure; and b. measures such as solar shading, thermal mass and appropriately coloured materials in areas exposed to direct and excessive sunlight; In considering the above, the balance between solar gain versus solar shading will need to be carefully managed. 2. The potential to incorporate a green roof and/or walls to aid cooling, add insulation, assist water management and enhance biodiversity, wherever possible linking into a wider network of green infrastructure; unless such roof space is being utilised for photovoltaic or thermal solar panels; or on a whole life cycle basis, it is demonstrated that a lower specification roof has a significantly lower carbon impact than a green roof; or the nature of the development makes it impracticable to incorporate a green roof.

LPA	Policy
	Adaptable design Applicants should design proposals to be adaptable to future social, economic, technological and environmental requirements in order to make buildings both fit for purpose in the long term… To meet this requirement, applicants should undertake the following, where applicable: … Is resilient to flood risk, from all forms of flooding (see Policy S21). **Policy S21: Flood Risk and Water Resources** Developments should demonstrate: • That they are informed by and take account of the best available information for all sources of flood risk and site-specific flood risk assessments. • That developments are safe from flooding during their lifetime taking into account the impacts of climate change and will be resilient to flood risk from all sources. • That they do not negatively affect the integrity of existing flood defences and any necessary flood mitigation measures and have taken a positive approach to reducing the risk in the wider area. • Incorporated Sustainable Drainage Systems into the development. Developments must also be able to show that they protect the water environment, by showing there is water available to support the development proposed, that there is adequate main foul water treatment and disposal already available, that they meet the 110 litre per occupier per day Building Regulation standard, water reuse and recycling and rainwater harvesting measures have been incorporated wherever possible.
Reading Borough Council Reading Borough Local Plan – adopted November 2019	**Policy CC3: Adaptation to Climate Change** Proposals involving both new and existing buildings shall demonstrate how they have been designed to maximise resistance and resilience to climate change for example by including measures such as solar shading, thermal mass, heating and ventilation of the building and appropriately coloured materials in areas exposed to direct sunlight, green and brown roofs, green walls, etc.
Bath and North East Somerset Local Plan Partial Update – adopted January 2023	**Policy CP5: Flood Risk Management** Development in the District will take a sequential approach to flood risk management and will aim to avoid inappropriate development in areas at risk of flooding and directing development away from areas at the highest risk of flooding. Any development in an area at risk of flooding will be expected to be made safe throughout its lifetime by incorporating mitigation measures. All development will be expected to incorporate sustainable drainage systems to reduce surface water run-off and minimise its contribution to flood risk elsewhere.
Greater London Authority London Plan – adopted March 2021	**Policy SI131: Sustainable Drainage** a. Lead Local Flood Authorities should identify – through their Local Flood Risk Management Strategies and Surface Water Management Plans – areas where there are particular surface water management issues and aim to reduce these risks. Increases in surface water run-off outside these areas also need to be identified and addressed. b. Development proposals should aim to achieve greenfield run-off rates and ensure that surface water run-off is managed as close to its source as possible. There should also be a preference for green over grey features, in line with the following drainage hierarchy: 1. rainwater use as a resource (for example rainwater harvesting, blue roofs for irrigation) 2. rainwater infiltration to ground at or close to source 3. rainwater attenuation in green infrastructure features for gradual release (for example green roofs, rain gardens) 4. rainwater discharge direct to a watercourse (unless not appropriate) 5. controlled rainwater discharge to a surface water sewer or drain 6. controlled rainwater discharge to a combined sewer. c. Development proposals for impermeable surfacing should normally be resisted unless they can be shown to be unavoidable, including on small surfaces such as front gardens and driveways.

LPA	Policy
	Drainage should be designed and implemented in ways that promote multiple benefits including increased water use efficiency, improved water quality, and enhanced biodiversity, urban greening, amenity and recreation.
London Borough of Brent Brent Local Plan 2019-2041 – adopted February 2022	**Policy BSUI3: Managing Flood Risk** Proposals requiring a Flood Risk Assessment must demonstrate that the development will be resistant and resilient to all relevant sources of flooding including surface water. Proposed development must pass the sequential and exceptions test as required by national policy. The design and layout of proposals requiring a Flood Risk Assessment as set out in paragraph 6.7.37 must contribute to flood risk management and reduction and: A. minimise the risk of flooding on site and not increase the risk of flooding elsewhere; B. wherever possible, reduce flood risk overall; C. ensure a dry means of escape; D. achieve appropriate finished floor levels which should be at least 300mm above the modelled 1 in 100 year plus climate change flood level; and E. not create new basement dwellings in areas of high flood risk. Proposals that would fail to make appropriate provision for flood risk mitigation, or which would increase the risk or consequences of flooding, will be refused. Opportunities will be sought from the redevelopment of sites in functional floodplain (flood zone 3b) to restore the natural function and storage capacity of the floodplain. Proposals that result in an increase in natural flood storage capacity and the environmental quality of the watercourse, will be encouraged. **Policy BSUI4: On site water management and surface water attenuation** Substantial weight will be afforded to the target for mains water consumption of 105 litres or less per person per day and to the achievement of greenfield runoff rates for surface water. Where greenfield run-off rates cannot be achieved this should be clearly justified by the applicant. Major development proposals or minor developments and changes of use which would impact on the current drainage regime must be accompanied by a drainage strategy. The design and layout of major development proposals will be required to: A) use appropriate sustainable drainage measures to control the rate and volume of surface water run-off; B) ensure where feasible separation of surface and foul water systems; C) make reasonable provision for the safe storage and passage of flood water in excessive events; and D) demonstrate adequate arrangements for the management and maintenance of the measures used. Proposals for minor developments, householder development, and conversions should make use of sustainable drainage measures wherever feasible and must ensure separation of surface and foul water systems. Proposals that would fail to make adequate provision for the control and reduction of surface water run-off will be refused.

7.5 Conclusions and Recommendations

The legislation, guidance and policies set out in this section provide an understanding of the current expectations for development in relation to sustainability. The best practice policy review also provides MKCC with a range of opportunities to address objectives for net zero emissions and climate resilience in the new City Plan, set within the context of the *'Framework for well-designed and sustainable places'*.

While the policy review was structured around the framework, many of these policies also reflect the key themes that MKCC have previously identified:

- Net zero building performance standards;
- Offsetting arrangements;

- Design features of net zero homes:
  - flood resilience;
  - Biodiversity Net Gain;
  - Green infrastructure;
  - Street layout patterns;
- Mixes of land uses within new development sites; and
- Design and landscaping principles/features that support local food security.

In more recent adopted Local Plans, many LPAs have taken a pragmatic approach to climate change, by adopting policies that promote sustainable development and lifestyles. This has been achieved through encouraging non-motorised modes of transport and active travel, to well-designed places and streets, with buildings being orientated in a way to minimise energy demand for heating, lighting and cooling.

While Building Regulations are largely responsible for enforcing the requirements for net zero building performance, it is possible for LPAs to adopt policies that go beyond the Building Regulations, although this was strongly discouraged in the recent Written ministerial Statement.

There are prominent examples of this, such as the London Plan, Central Lincolnshire Local Plan and Cornwall Climate Emergency Development Plan. For example, the London Plan requires substantive supporting documentation to demonstrate additional carbon reduction and energy efficiency measures.

This review has identified that Milton Keynes already has a comprehensive set of policies, however there is the opportunity for existing policies to be updated and go further in their requirements. From this policy review the following areas have been identified as potential areas for new/updated policies. This list will be used alongside the wider findings of the Carbon and Climate Study to make policy recommendations:

- Circular economy – Milton Keynes's waste policies could go further to require the consideration of circular economy principles, potentially including the setting of a target to be net-zero waste
- Embodied carbon – future policy could require applicants to demonstrate what opportunities have considered and taken forward to lower the embodied carbon content of buildings
- Air Quality - future policy could set the expectation that certain developments should be Air Quality Positive or Air Quality Neutral. Where on site delivery of these standards cannot be met, off-site mitigation measures will be required
- Digital connectivity – future policy could set out circumstances where it is expected that full fibre cable networks should be provided to enable broadband connectivity
- Green buildings – future policy could go further in requiring buildings to be energy efficient, for example establishing design principles for energy efficient buildings or targets for reduced energy consumption
- Adaptation to climate change – there could be more explicit recognition in policy of the need for development to maximise resistance and resilience to climate change
- Carbon sinks – future policy could include a requirement to protect, and/or enhance, carbon sinks
- Food growing – existing policy could be expanded to provide greater protection of food growing spaces and encourage new spaces to be provided
- Green economy – future policy could seek to expand the green economy, for example by encouraging green jobs.

8. Net Zero Building Typologies

8.1 Drivers for high energy performance buildings

The main driver of performance in the building sector is the Building Regulations[103] that contain the minimum requirements of compliance for new and retrofitted buildings. The energy performance and carbon emissions are mainly influenced by the Approved Documents:

- L: Conservation of fuel and power;
- F: Ventilation;
- O: Overheating; and
- S: Infrastructure for the charging of electric vehicles.

Commonly referred to as Part L, Part F, Part O and Part S.

Under the Planning and Energy Act 2008 and the NPPF, Local Planning Authorities can require higher energy requirements, that exceed the current Building Regulations' minimum compliance requirements. Section R.1 Energy of the National Model Design Codes guidance[104] states that *"Local authorities can set policies for higher energy efficiency standards for their area or in relation to specific development sites in local plans"*. However this is discouraged in a Written Ministerial Statement on Planning – Local Energy Efficiency Standards Update published in December 2023. This Statement requires a well-reasoned and robustly costed rationale, and any additional requirement to be expressed as a percentage uplift of a dwelling's Target Emissions Rate (TER).

The current edition of Part L is the 2021 edition incorporating 2023 amendments. The latest amendments in Part L and F are considered an interim update introducing an uplift to energy efficiency requirements towards the Future Homes Standard (FHS) in 2025, when another update of the approved documents is expected. Consultation on the FHS[105] launched in December 2023, this seeks view on changes to Part 6, Part L and Part F of the Building Regulations for dwellings and non-domestic buildings and seeks evidence on Part O.

All performance requirements in the consultation are based on notional buildings with an efficient air source heat pump or a 4th generation heat network that uses air source heat pumps. In respect of Solar PV, the consultation includes two options, one with and one without solar PV panels. In respect of building fabric the performance requirements in the consultation closely resemble the fabric standards in the 2021 Part L uplift to the Building Regulations. The consultation does not include an option where homes need to meet high fabric efficiency standards similar to Passivhaus and that are capable of being net zero immediately. The consultation is seeking views on two domestic notional building options:

- Option 1 is the most cost-effective option to maximise carbon savings, balanced against reducing energy bills for households. Although this option is cost-effective at reducing carbon overall, it comes with additional upfront costs for developers and may therefore affect overall housing supply.
- Option 2 is the minimal approach to achieve 'zero-carbon ready' homes that deliver at least 75% carbon savings compared to 2013 energy efficiency requirements. While a home built to Option 2 would be more expensive to run than Option 1, Option 2 still delivers expected bill savings for households moving from a typical home.

[103] DESZN, DLUHC (2023) Building Regulations and Approved Documents. Available at: https://www.gov.uk/government/collections/approved-documents [Accessed September 2023]

[104] DLUHC (2021) National Model Design Code. Available at National Model Design Code - GOV.UK (www.gov.uk) [Accessed January 2024].

[105] DLUHC (13 December 2023) The Future Homes and Buildings Standards: 2023 consultation. Available at: The Future Homes and Buildings Standards: 2023 consultation - GOV.UK (www.gov.uk) [Accessed January 2024].

The Government is also consulting on a concurrent notional building for new homes connected to heat networks.

The level of ambition in the FHS is expected to be the typical requirement for all new development in Milton Keynes. The final requirements will become known in 2025 when the FHS comes into force.

The Future Building Standard (FBS)[106] sets the requirements for energy performance of non-domestic buildings from 2025 onwards. The FBS recognises that electrification of heating will become the standard approach for non-domestic buildings while being flexible on the solutions used from developers. Heat pumps and heat networks are expected to be the principal means for low and zero carbon heat generation.

Science-based near-term targets and net zero commitments for developers and the construction supply chains are increasingly becoming important parts of their Environment, Sustainability and Governance (ESG) strategy. The commitment of building sector actors, including investors and financial institutions, to near-term emissions reduction targets could lead to reduction of carbon intensity for materials and services that in turn will reduce the embodied carbon of new developments. This is an opportunity to intensify the engagement with the supply chain and developers to understand their net-zero related ambitions and plans. Planning policy could be a significant lever of construction sector decarbonisation by requiring environmental certifications and Environmental Product Declarations for materials and systems used in developments. At the same time, all developers should submit their latest ESG or Sustainability reports as part of the planning applications and declare if they have a corporate decarbonisation strategy, any emissions related targets, and show how this fed into their design choices.

Current UK industry trends are calling for a whole-building approach considering all stages of the life cycle of buildings and setting ambitious targets for energy use intensity (EUI, $kWh/m^2.yr$), low space heating demand and low-carbon energy supply with on-site renewable energy systems. The EUI accounts for the annual energy consumption (energy used) per square meter of building floor area. Low EUI corresponds to low energy consumption. Fossil-fuel free homes with on-site solar PV generation and electricity storage has been showcased as the optimal solution to achieve low EUI, reduce risk of increasing utility bills for occupants due to electrification of heating, and maximise benefits associated with indoor environment quality and comfort.

Best current industry practice in building energy performance and effective decarbonisation come from Royal Institute of British Architects (RIBA)[107] , Passiv Haus[108] and the Low Energy Transformation Initiative[109] (LETI).

LETI is a voluntary network of over 1,000 built environment professionals who are working to facilitate the transition of the construction industry and the built environment towards a net zero carbon path. LETI Climate Emergency Design Guide has been widely acknowledged for the high level of ambition and aspirational targets for domestic and non-domestic buildings sectors.

Passiv Haus adopts an early passive design approach to minimise heating and cooling loads and achieve comfortable conditions. It follows a whole-building design approach with high thermal specifications for fabric and windows, independent quality assurance, increased air tightness and mechanical ventilation with heat recovery systems.

RIBA has considered the design and construction stages and introduced the 2030 Climate Challenge. The 2030 Climate Challenge sets a series of targets to reduce operational energy, embodied carbon and potable water use, whilst increasing health and wellbeing.

---

[106] DLUHC (2021) The Future Buildings Standard consultation. Available at: https://www.gov.uk/government/consultations/the-future-buildings-standard [Accessed September 2023]

[107] Royal Institute for British Architects (RIBA) (2023) 2030 Climate Change. Available at: https://www.architecture.com/about/policy/climate-action/2030-climate-challenge. [Accessed September 2023]

[108] Passive House Institute (2015) Energy standards and Criteria for Buildings. Available at: https://passivehouse.com/03_certification/02_certification_buildings/08_energy_standards/08_energy_standards.html [Accessed September 2023]

[109] Low Energy Transformation Initiative (LETI) (2020) Climate Emergency Design Guide. Available at: https://www.leti.uk/cedg [Accessed September 2023]

According to resiliency based, “no regrets” approaches, the priority for new and retrofitted buildings should be the reduction of energy demand and consumption. This shall ensure that there are no utility cost increases, and comfort and indoor environmental quality are achieved to support health and wellbeing of the residents. The “no regrets” approach is consequently interpreted into a “fabric first” approach with focus on construction elements and design strategies to reduce heat/cooling demand as much as possible. The technology, knowledge and materials largely exist but cost and budget considerations are important to achieve optimum results and maximise the benefits and energy use reduction within any added construction costs margins.

The expectations are that building regulations will progressively lead to new buildings being high energy performing and achieving net zero emissions. High performance buildings will still require energy to heat and operate. This is where the “Net Zero ready” specifications and building design need to be complemented by technology and building services that are future-proof in terms of changing between heating fuels and supporting on-site renewable power generation. For example, if for the next two years new buildings are still connected to the gas grid, there should be an inherent capability to change to heat pumps without extensive retrofit requirements.

8.2 Methodology

In this analysis, five building typologies have been selected to represent the local development trends and align with Milton Keynes Housing and Economic Development Needs Assessment (HEDNA) recommendations on domestic and non-domestic development needs.

The residential building typologies were selected based on the housing mix of permitted developments in Milton Keynes from 2019/20 to 2022/23. The results were compared and aligned with the latest HEDNA recommendations for housing and population growth in the area. The record of permitted developments provides a breakdown of the number of different house types and tenure for all major developments approved in a financial year. The last four years provide a representative sample for the identification of new development types and the current local market trends in the housing sector.

The quarterly reported entries have been aggregated and clustered into “Developers for sale” and “Affordable Housing”. For each category the percentage of total developed houses was calculated for each building type. For example, 1, 2, 3+ bedroom flats (BF) or 1-5+ bedroom houses (BH). In this four-year period there were 16,294 plots permitted for development. Affordable housing was reported to be around 27.5% of the annual total major developments in the last two years. The target for affordable housing is 31% per major application. This difference however is explained by lack of relevant information in outline applications, delivery of legacy sites approved when the previous local plan was in force, and prior notifications.

Planning use classes for non-domestic buildings were adopted from the HEDNA recommendations. The economic development assessment has concluded that warehouses for light industrial, storage and distribution (GIA >1,000m^2) (Use Class B2 & B8) and small office space (Use Class E, Commercial, Business and Services) should be the focus of new non-domestic development.

The five building typologies as agreed for this study are:

- 2 Bedroom flats (market);
- 3 Bedroom semi-detached (market);
- 2 Bedroom flats (affordable);
- Small offices with a gross internal area < 1,000m^2; and
- Warehouses with a gross internal area > 1,000m^2.

The typical floor areas for each typology were based on a review and comparison of the technical housing standards – nationally described space standard[110], and the floor space in English homes report by the DLUHC[111]. For non-domestic buildings, small office buildings were assumed to have a GIA <1,000m^2 and warehouse units with a GIA > 1,000m^2.

8.3 Stranding risk and energy use intensity benchmark

The Carbon Risk Real Estate Monitor (CRREM)[112] is a tool, developed with EU and Laudes Foundation funding, that monitors the transition of real estate assets to net zero. The CRREM Decarbonisation Target Tool aims to evaluate the stranding risk due to climate change and offers the possibility to assess energy and emissions reduction pathways aligning to the Paris Conference (COP21) 1.5ºC global warming target. The stranding risk is the risk of an asset becoming obsolete earlier than expected or lose market value as a result of lagging behind in the net zero transition of different industry sectors. The methods used for the decarbonisation pathways align with the Science Based Targets initiative[113] (SBTi) requirements for science-based decarbonisation pathways and target setting. The tool includes a grid decarbonisation projection for countries globally and it calculates the benchmarks for different regional sectors – such as UK dwellings, UK warehouses etc. Assets above the benchmark values are "stranded" – in risk of early obsolescence. CRREM follows a "whole building approach" that accounts for the total landlord and tenant emissions.

In this analysis, the latest CRREM targets for UK dwellings, offices, and warehouses in 2025, 2030 and 2035 (Table 35) were assessed to inform the level of ambition required in planning policy to achieve reduction of building energy consumption and emissions at scale and pace.

Table 35: CRREM energy use and GHG emissions intensity targets for UK sectors.

	Energy use intensity (kWh/m^2.yr)			GHG Emissions intensity (kgCO_2e/m^2.yr)		
	2025	2030	2035	2025	2030	2035
Multi-family residential (flats)	103.1	72.7	55.0	17.8	10.1	4.8
Offices	166.7	122.7	90.4	32.8	19.3	9.5
Warehouses (refrigerated)	108.5	84.0	65.0	19.1	10.6	4.9
Warehouses (non-refrigerated)	47.7	35.6	26.5	9.3	5.5	2.7

The CRREM EUI and GHG emissions intensities have been considered in combination with LETI, RIBA and Passiv Haus recommendations to define the EUI targets for the five different building typologies.

[110] DLUHC (2015) Technical housing standards – nationally described space standard. Available at: https://www.gov.uk/government/publications/technical-housing-standards-nationally-described-space-standard [Accessed September 2023]

[111] DLUHC (2018) English Housing Survey. Floor space in English homes report. Available at: https://www.gov.uk/government/publications/floor-space-in-english-homes [Accessed September 2023]

[112] Carbon Risk Real Estate Monitor (CRREM) (2023) Real estate stranding risk and decarbonisation targets tool. European Union, Laudes Foundation. Available at: https://www.crrem.eu/ [Accessed September 2023]

[113] Science Based Target initiative (SBTi) (2023) Science based target setting. The corporate Net-Zero Standard. Available at: https://sciencebasedtargets.org/net-zero [Accessed September 2023]

9. Framework for well designed and sustainable places

9.1 Sustainable design exemplars in practice

Three schemes have been identified by Arup as being recognised by the built environment industry as being exemplar in respect of their sustainable design and credentials. The following sites have been identified as case studies:

a. Perry Barr, Birmingham;
b. Bream Street, London; and
c. New Lodge Community, York.

9.1.1 Perry Barr, Birmingham[114] [115] [116]

Perry Barr in Birmingham is a large-scale redevelopment scheme of a former university campus. This scheme won the RTPI 'Best Project of the Year 2023'. The proposals for the scheme were shaped by the community and focused on people, greener transport, accessible green spaces, and economic growth.

The scheme is the first phase of a wider regeneration programme, the design of which is centred around creating meaningful redevelopment principles, focusing on environmental sustainability and community cohesion.

Key Features
a. Mix of tenures: private market housing, build to rent, affordable rent, discounted market sale, First Homes and an extra care facility, to provide a multi-generational offer of housing. b. Shared open spaces, tree lined streets and a mature community garden at the heart, along with a linear park and central park at the heart of the scheme. c. Mix of uses, including a small amount of commercial space, a sports centre, secondary school and sixth form. Key features of the scheme also involved retaining key landscaping features, providing active play space and useable public realm.
Sustainability
a. The proposal involves retaining and reusing an old bus depot rather than demolishing and rebuilding – reducing embodied carbon. b. The developers worked collaboratively with the regeneration of Perry Bar Bus and Rail Interchange, in order to promote sustainable travel options. c. The masterplan supported reducing car parking provision by at least 25%, making it an exemplar 'low car' development. d. Building form and orientation which optimises connections between buildings, public realm and permeability to the nearby retail shopping centre at Franchise Street. e. The scheme prioritised natural light, but also reduced the likelihood of overheating. f. Green roofs were installed across 30% of the plots. g. A number of plots were provided as 100% electric with no gas installed.

[114] RTPI (2023) 2023 Awards Winners. Available at: https://www.rtpi.org.uk/find-your-rtpi/rtpi-english-regions/rtpi-west-midlands/west-midlands-awards-for-planning-excellence/previous-west-midlands-winners/2023-winners/ [Accessed February 2024]

[115] Arup (2023) How can technical expertise help to reshape the inner city? Available at: https://www.arup.com/projects/perry-barr-masterplan [Accessed December 2023]

[116] Housing Design Awards (2023) Bream Street. Available at: https://hdawards.org/scheme/perry-barr-residential-scheme-phase-1/ [Accessed December 2023]

9.1.2 Bream Street / Navigators Walk, London[117]

Bream Street is a residential site of 202 dwellings in East London. The site was completed in December 2021 and won a Housing Design Award.

Key Features
a. Residential-led, mixed use redevelopment scheme, including an on-site convenience store. b. Provision of permeable public space, including the refurbishment of the historic Old Ford Lock Canalside public realm. c. Provides 202 new homes including a notable proportion of 3-bedroom homes for families. 50% are also assigned to be affordable homes.
Sustainability
a. Buildings have been orientated to maximum daylight and reduce overshadowing to the gardens. b. The carbon emissions baseline for the scheme was identified at 283,926 kgCO_2/yr for space heating, domestic hot water, lighting and auxiliary (regulated emissions). In order to be compliant with the planning requirements, the scheme needed to reduce its carbon emission by 127,767kgCO_2/yr. c. The project aimed to be low-carbon, with the design considering how to reduce carbon emissions and consider the low-carbon lifestyle. d. Followed the Great London Authority's Energy Hierarchy and achieved a 49.37% improvement in CO_2 emissions over the 2013 minimum Building Requirements. e. Installed energy efficiency measures such as: – Combined Heat and Power systems; and – Photovoltaic system. f. Buildings were designed to be highly insulated. g. Construction undertaken using loose fit and long-life concrete slabs and columns, allowing internal layouts to be adapted. h. Designed with large windows to maximise daylight and ventilation. i. Provision of electric vehicle charging points and secure bike parking. j. Connection provided for a potential district heating scheme.

9.1.3 New Lodge Community[118]

New Lodge Community, is a development of 149 new homes on Haxby Road, York. It also won a 2023 Housing Design Award. The scheme is made up of 105 affordable extra care apartments and a 44-bed care home.

[117] Housing Design Awards (2022) Citizens House. Available at: https://hdawards.org/wp-content/themes/housingdesignawards2.0/hd-foundry/download.php?scheme=22003 [Accessed December 2023]

[118] Housing Design Awards (2023) Wembley Park Gardens. Available at: https://hdawards.org/scheme/new-lodge-community/ [Accessed December 2023]

Key Features
a. The masterplan was shaped by connections to the wider village and a clearly defined vision for the landscape and public realm, with a central green space and green routes to provide permeability and connectivity.
Sustainability
a. A Climate Change and Resilience Report was prepared during the RIBA Stage 3, which recommended changes to ensure sustainability and resilience up until 2050. These changes included concerns round overheating and window sizes, shading, insultation values and ventilation. b. A Sustainability Strategy was design to respond to planning policies and, where possible, surpass the requirements. c. The scheme was also assessed through its Socio-Economic and Environmental Credentials in order to build a full picture of sustainability. d. The care home achieved a BREEAM score of 'Very Good' under the BREEAM 2014 with a score of 56%. e. Flood Risk Assessment was provided to include climate change considerations. f. Low and zero carbon feasibility assessment was produced to establish the most appropriate technologies to implement in development. This led to PV panels being installed. g. Low flow and flush water fittings provided to ensure potable water consumption is kept to a minimal. h. Used strategies to reduce embodied carbon in buildings: – Locally sourced / domestic materials, with recycling taking place where possible. – Use of appropriate materials – ensuring durability and resilience throughout the lifespan of the development.

9.2 Sustainable design indicators

9.2.1 Introduction

This section sets out the proposed framework, and includes indicators for well-designed, sustainable places. This framework has taken influence from - and is consistent with - the National Design Guide framework, but adjusted to meet Milton Keynes priorities, as per '*Milton Keynes New City Plan Sustainability Appraisal Scoping Report'* and '*Milton Keynes City Council – Our New City Plan*,' which sets out the ambitions and objectives for the New City Plan. We have also incorporated the principles of Arup and C40 Cities' *Green and Thriving Neighbourhoods* guidance, which sets out the critical aspects of a net zero, resilient and inclusive neighbourhood development, drawing on international research. The policy recommendations, and therefore this Framework, will take into consideration the design heritage of the city having been built as a new town in the 1960s, and the needs of its residents today.

The indicator framework presented here is designed to promote an integrated and strategic approach to sustainable place-making. There will be additional indicators which will be considered as part of the wider Local Plan making process but which are outside the sphere of influence of the Carbon and Climate Study. This Framework will therefore not duplicate indicators used in the other Local Plan evidence base documents. The indicators are interconnected and should be viewed as a package, rather than individually.

Furthermore, it is acknowledged that quantitative data relevant to every indicator may not be available at every stage of plan-making, but assessments can be made on the basis of assumptions, precedent examples, and modelled data. It may be appropriate to assess policies using a red-amber-green rating based on qualitative information.

9.2.2 Proposed Framework

The proposed indicators are set out below:

9.2.2.1 Complete neighbourhood

New developments need to be looked at in the context of a complete neighbourhood, which prioritises local life, allowing local people to access their everyday needs within a short walk or cycle from their homes. Complete neighbourhoods provide safe and equitable access to key services, such as healthcare, jobs, and fresh groceries. Anglian Water suggested complete neighbourhoods should also include access to blue and green infrastructure.

To achieve a complete neighbourhood, development needs to be looked at in relation to existing and proposed development, to achieve a good density and provide a mix of uses and services, which are easily accessible by walking, cycling or other non-motorised modes of travel.

Indicator:

- *Percentage of homes within 500m walking distance of key amenities*[119].

9.2.2.2 People-centred mobility

People-centred mobility is required to promote non-motorised modes of transport, by re-prioritising streets and streetscapes to focus on alternative modes of transport and ensure people have a choice of modes. This can be achieved by widening footways, creating segregated cycle lanes and greening the streetscape to encourage active travel around Milton Keynes. Coupled with complete neighbourhoods and having easy and affordable connections to live, work and play facilities, this will allow people to live more sustainably. The Anglian Water consultation response also noted these routes can provide additional flood attenuation.

Indicator:

- *Proximity (in km) to a Redway (pedestrian and cycle paths).*

9.2.2.3 Connected Places

To enable sustainable living and social mobility, it is key to ensure that communities are well connected, not just physically, but also digitally, looking at connectivity both within the site and beyond its boundaries. Without equal connectivity across Milton Keynes, it would be easy for groups to become isolated. Promoting strong physical and digital connectivity will help reduce social inequalities. The location of new developments needs to be looked at on a wider level and not in isolation, while considering existing and proposed public transport routes, such as the planned Mass Rapid Transit network, and other forms of connectivity. Achieving connected places will help MKCC meet their aim of having a prosperous, diverse, inclusive, and resilient economy by 2050.

Indicator:

- *Percentage of homes within walking distance*[120] *of bus/train stops giving direct access to Central Milton Keynes and major rail hubs (MK Central and Bletchley); and*
- *Percentage of homes within 5G coverage.*

9.2.2.4 Places for people

Places, whether new or existing, need to be designed to work for the local community, by improving living standards, creating job opportunities and enhancing public and environmental health for all. This will include providing a mix of good-quality housing, including affordable housing, which meets local housing needs. Places should set out to be equitable, diverse, accessible, and inclusive.

---

[119] Key amenities include healthcare facility, grocery outlet, primary school, recreation facility and bus or train stop.

[120] Based on the 20 minute neighbourhood concept, 10minute walk each way is a reasonable walking distance. An average walking speed of 5 km/h equates to a distance of 0.83km.

Historic England highlighted that places for people are at the heart of the historic environment which has been shaped the places around us over millennia.

At the heart of the development process, there should be sufficient and effective public consultation and engagement with local people, to harness their knowledge of what they need and how they use spaces, to ensure new and existing places are socially inclusive, and promote cohesive communities, and an equitable distribution of benefits.

Indicator:

- *Annual average PM10/2.5 concentrations in relation to UK air quality limits.*

9.2.2.5 Clean construction

Sustainability needs to be considered throughout the lifecycle of a development, being planned, designed, and operated to minimise emissions. This should also be considered throughout the construction phase of the development, in order to minimise the impact of materials use, manage embodied emissions, and minimise construction phase environmental and social impacts. This can be achieved through optimising existing assets, planning adaptable spaces to meet the changing needs of the community, using materials effectively and selecting low-carbon material options and clean construction sites. This is important for both new assets and retrofit of existing assets to minimise emissions.

The Anglian Water consultation response noted that MKCC has the opportunity to be a leader in reducing embedded carbon, both through setting policy for low GHG emissions in construction and in spatially planning growth to minimise the need for new infrastructure.

Indicator:

- *Floor area of buildings reused or repurposed through development plans (sq metres); and*
- *Emissions (embodied and operational) from new construction (tCO_2e/sqm).*

9.2.2.6 Green buildings and energy

Buildings are typically the largest energy consumers in urban neighbourhoods. Therefore, over the plan period, development projects need to drive the reduction of domestic and commercial energy consumption and greenhouse gas emissions, while also addressing challenges of energy access and poverty. Adopting passive design principles, investing in high-efficiency neighbourhood-wide energy infrastructure, integrating renewable energy generation, and decarbonising grid energy supply, would aid MKCC in achieving this.

Consultation responses highlighted the importance of retrofitting existing buildings, and doing this in a way that respects the natural and historic environment. Anglian Water also suggested that designing buildings to reduce water demand and the quantity of wastewater needing treatment will reduce the emissions associated with those homes and businesses.

Indicator:

- *Percentage of homes with installed renewable energy generation;*
- *Percentage of new buildings that achieve New City Plan policy requirements for energy efficiency and building performance; and*
- *Number of homes that have greywater recycling solutions in place.*

9.2.2.7 Green, blue and nature-based solutions

Green and blue spaces are critical features of a net zero, resilient and thriving urban neighbourhood, and so providing equal opportunities for everyone to have easy and safe access to well-connected and well-designed open space should be a key target for MKCC. Urban green and blue

infrastructure are proven to improve physical and mental health and well-being; inspire social interaction; improve footfall for local businesses; support biodiversity, and provide ecosystem services, such as stormwater attenuation, localised cooling, carbon sequestration and improved air quality.

As the Canal and Rivers Trust highlighted in their consultation response, canals and rivers contribute to the health and wellbeing of local communities and economies by creating attractive and connected placed to live, work, volunteer and spend leisure time. Anglian Water also noted the role they play in climate moderation. Multi-functional and accessible open green spaces and waterways create healthy places and build resilience.

The integral relationship between green infrastructure and the historic environment was also highlighted by Historic England, who suggested considering these holistically to make sustainable places.

Indicator:

- *Percentage of homes within 1km of a medium sized neighbourhood natural greenspace (10ha);* [121]
- *Area (square metres) used for food growing (allotments, orchards and community growing areas) per 1,000 population; and*
- *Percentage increase in Urban Tree Canopy Cover*[122] .

9.2.2.8 Sustainable lifestyles

Developments should enable communities to make sustainable choices throughout the lifecycle of the development. This can be achieved by facilitating well-designed and safe streets that promote active travel, a service-based and sharing economy and behavioural changes. As all goods and services procured within a neighbourhood have an emissions footprint, places need to be planned and designed to enable this to be reduced. It is important to ensure that sustainable choices are available to everyone within the community. This also links to behaviour change - for example, Anglian Water noted that more efficient white goods and showers reduces water use and energy bills, thereby reducing the need to provide and manage water.

Indicator:

- *Percentage of homes with electricity smart meters installed;*
- *Percentage of homes with water smart meters installed;*
- *Percentage of homes and businesses with EV charging infrastructure;*
- *Number of new developments that provide on-street EV charging points;*
- *Domestic water consumption (litres/person/day);*
- *Percentage of homes within 500m of a community logistics hub; and*
- *Percentage of journeys by active/public transport.*

9.2.2.9 Green economy

New developments need to support MKCC in their goal to create a resource-efficient and low emissions economy. Local opportunities should be provided for education, skills development, and general employment. Neighbourhoods should create and support green jobs by providing opportunities for learning and skills development and spaces for sustainable businesses. Planning policy and regulations should aid in the transition to a green economy by prioritising green technologies and resource efficiency.

---

[121] Based on Appendix 2 – Accessible Greenspace Standards in Green Infrastructure Standards for England Summary (naturalengland.org.uk)

[122] Based on S5 Urban Tree Canopy Cover Standard in Green Infrastructure Standards for England Summary (naturalengland.org.uk)

Indicator:

- *Number of new green jobs or apprenticeships created in sustainable industries[123]; and*
- *Household reuse/Recycling rate (% of waste diverted from landfill).*

9.2.2.10 Resilient and distinctive places

All developments should aspire to be resilient and distinctive, while responding positively to the features of the site itself, such as its natural and historic environment; and enhancing the surroundings and local character. It is key to have a coherent relationship between the development blocks, streets, buildings and open spaces, rather than looking at a development in isolation from its surroundings. It is the interrelationship between these elements that creates an attractive place to live, work and visit, and which optimises the resilience of the site – taking into account the impacts and benefits of all assets working as a system.

Well-designed homes, buildings and public realm are functional, accessible and sustainable. They provide internal environments and external spaces that support the health and wellbeing of their users and all who experience them, both today and under a changing climate. They must meet the needs of a diverse range of users, considering factors such as the aging population and cultural differences.

Indicator:

- *Percentage of homes and buildings with passive cooling solutions;*
- *Volume of stormwater attenuated through sustainable drainage solutions (cubic metres); and*
- *Percentage of homes and buildings built with flood resistant design measures;*
- *Percentage of homes built in areas of flood risk; and*
- *Percentage of homes compliant with CIBSE TM59.*

[123] Green jobs is defined using the United Nations System of Environmental Economic Accounting: Any job in areas of the economy engaged in producing goods and services for environmental protection purposes, as well as those engaged in conserving and maintaining natural resources. Further information available: How to measure current and potential green jobs in your city (c40knowledgehub.org)

Appendices

A.1 Landscape classification changes 2016 to 2022 LCA

Table extracted from Appendix B of Milton Keynes Landscape Character Assessment May 2022

2016 LCT / LCA	Notes	2022 New LCT / LCA names
LCT 1 Wooded Wolds		
LCT 1 Clay Plateau Farmland	Name changed to reflect the mixed bedrock geology, and to fit with the classification of the adjacent Northamptonshire and Bedfordshire Landscape Character Assessment. Boundaries defined along 90m contour	LCT 1 Wooded Wolds
1a Yardley Chase Clay Plateau Farmland		1a Yardley Chase Wooded Wolds
1b Hanslope Clay Plateau Farmland	Name changed to 'Wooded Wolds' as this is a key landscape feature. Gayhurst and Stokepark are large woodlands.	1b Gayhurst and Stokepark Wooded Wolds
LCT 2 Undulating Valley Slopes		
LCT 5 Undulating Clay Farmland	Name changed to reflect the gentle slopes of the valley sides of the Great Ouse and Tove rivers. Boundaries defined by rise of valley slope above the floodplain, and the change to more level plateau to the Clay Plateau or Wooded Wolds	LCT 2 Undulating Valley Slopes
5a Ouse North Undulating Clay Farmland		2a Ouse Northern Undulating Valley Slopes
5b Ouse South Undulating Clay Farmland		2b Ouse Southern Undulating Valley Slopes
5c Tove Undulating Clay Farmland		2c Tove Undulating Valley Slopes
LCT 3 River Floodplains		
LCT River Valley	Name changed to 'floodplain' as the type does not include the valley sides, with 'floodplain' or 'lakes and parkland floodplain', to distinguish between rural and more urban-influenced areas.	LCT 3 River Floodplains
2a Tove Rural River Valley		3a Tove Floodplains
2b Ouse Rural River Valley		3b Ouse Floodplains
2c Ouse Urban River Valley		3c Ouse Lakes and Parkland Floodplains

2016 LCT / LCA	Notes	2022 New LCT / LCA names
2d Ouzel North Urban River Valley	Land south of A422 now within Milton Keynes East strategic allocation. Remaining area is included in LCA 3c Ouse Lakes and Parkland Floodplains.	
2e Ouzel South Urban River Valley		3d Ouzel Parkland Floodplains
LCT 4 Undulating Clay Plateaux		
LCT 3 Clay Plateau Farmland with Tributaries	Name changed to describe the topography of gently undulating bedrock incised by tributaries. Boundaries defined by 80-85m contour	LCT 4 Undulating Clay Plateaux
3a North Crawley Clay Plateau Farmland with Tributaries	Boundary extended north to include areas of clay bedrock around Top Farm and Petsoe Manor wind farm.	4a North Crawley Undulating Clay Plateau
3b Weald Clay Plateau Farmland with Tributaries	Boundary extended in north-west to the edge of the Ouse floodplain.	4b Weald Undulating Clay Plateau
LCT 5 Clay Vales		
LCT 4 Clay Lowland Farmland	Name changed to align with the Bedfordshire LCA	LCT 5 Clay Vales
4a Broughton to Tickford Clay Lowland Farmland	Name changed to reflect key landscape character features rather than settlements. Boundary modified to Tickford Abbey and confluence of the Ouse and Ouzel to reflect change in bedrock geology from limestone to clay, and the updated development boundary at Newport Pagnell. The Milton Keynes East strategic allocation has separated the LCA into two sections.	5a Lower Ouzel Clay Vale
4b Wavendon Clay Lowland Farmland	Name changed to reflect key landscape character features rather than settlements. The South East Milton Keynes and Eaton Leys strategic sites have decreased the extent of this LCA.	5b Upper Ouzel Clay Vale
LCT 6 Wooded Greensand Ridge		
LCT 6 Greensand Ridge	Name changed to includes 'wooded' as this is a key landscape feature.	LCT 6 Wooded Greensand Ridge
6a Brickhill Wooded Greensand Ridge	Boundary refined along the 100m contour line.	6a Brickhill Wooded Greensand Ridge

A.2 Review of Legislative Requirements

UK Building Regulations & associated Approved Documents (Department of Levelling Up, Housing & Communities, 2022)

Updates to Approved Document F (Ventilation)

The updated Approved Document F (ADF) (Volume 1 for dwellings)[124] comprises the following key changes:

- Introduction of a requirement for highly airtight dwellings to install continuous mechanical extraction ventilation systems. While highly airtight dwellings are energy efficient, the Government's consultation document highlighted that they could result in poorer air quality.
- Introduction of more stringent air quality and ventilation standards for homes, including air flow rate testing of mechanical ventilation fans and higher threshold requirements for background ventilators per mm^2 equivalent area.

ADF Volume 2[125] for non-domestic buildings stipulates similar approaches and standards to ventilation and air quality. It also contains a new requirement for monitoring of air quality in occupiable rooms (such as by using a CO_2 monitor or other air quality sensor).

Updates to Approved Document L (Conservation of fuel and power)

The updated Approved Document L (ADL) (Volume 1 for dwellings)[126] comprises the following key changes:

Overall approach

- The new ADL emphasizes early consideration of designing a dwelling or group of dwellings at a systems level, by analysing the technical, environmental, and economic feasibility of using high-efficiency alternative systems.
- It is advisable to consider the interdependency between the new ADL and the other Approved Document requirements, given that there are more stringent requirements between energy, overheating and ventilation.

More stringent compliance standards

The new ADL has:

- Increased minimum standards of dwelling fabric thermal performance by 13% (known as the Target Fabric Energy Efficiency Rate (TFEER))
- Removed the ability to compensate a lower fabric energy efficiency rate with another measure (such as the additional of on-site renewables)
- Reduced overall dwelling carbon emissions performance by 31% (known as Target Emission Rate (TER))
- Altered the carbon factors used to calculate carbon emission performance. The carbon factors are governed by the dwelling's primary fuel source (such as electricity and heat networks, alongside gas,

[124] HM Government (2021) Approved Document F Ventilation Volume 1: Dwellings. London: HM Government.

[125] HM Government (2021) Approved Document F Ventilation Volume 2: Buildings other than dwellings. London: HM Government.

[126] HM Government (2023) Approved Document L Conservation of fuel and power Volume 1: Dwellings. London: HM Government.

liquid and solid fuel sources, as set out in the updated Standard Assessment Procedure (SAP)[127], and is measured in kilograms of carbon dioxide equivalent per Kilowatt Hours (or Emissions kg CO_2e per kWh).

- Established a new metric, the Target Primary Energy Rate (TPER). This is a measure of maximum primary energy use for the dwelling in a year – it is calculated by applying a factor (in Kilowatt Hours per square metre per year (or $kWh_{PE}/(m^2 \cdot year)$) according to the dwelling's primary fuel source[128].
- A new requirement for 'as built' photographic evidence of key energy efficiency elements of dwellings (such as insulation, and ventilation systems). This evidence would also be provided to the new occupier, as assurance, alongside a standardised user guide on using the building services efficiently.

The following real-world impacts are expected as a result of the new ADL:

- The carbon factor (for calculating carbon emissions performance) for electricity is now lower than gas, in anticipation of the electricity grid being decarbonised. This will therefore mean electrically heated buildings will more easily comply with Regulations[129].
- Mainstreaming the use of energy efficiency measures (such as heat pumps, photovoltaic panels and electric vehicle charging) will require greater grid infrastructure capacity, and connections to the grid[130].
- As lower fabric efficiency rates can no longer be compensated with other measures (such as renewables), it is anticipated that there will be a shift to thicken external walls and install high performance (and potentially smaller) windows[131].

ADL Volume 2 for non-domestic buildings also introduces a TPER metric, alongside the TER. On building fabric, while Volume 2 does not stipulate an equivalent TFEER, it introduces new minimum efficiency standards for new and replacement thermal elements[132] (such as a wall, floor or roof).

Approved Document O (Overheating)[133]

The new Document O arose from an inquiry into heatwaves (conducted by the Environmental Audit Committee) which recommended new regulations to mitigate the overheating of new buildings.

Document O is only applicable to new residential buildings. It includes:

- Limits to glazing to reduce unwanted solar gain;
- Requirements for shading in locations at high risk of overheating;
- Standards for cross ventilation in order to remove excess heat;

---

[127] BEIS (2022) The Government's Standard Assessment Procedure for Energy Rating of Dwellings. Available at: https://files.bregroup.com/SAP/SAP%2010.2%20-%2021-04-2022.pdf?_its=JTdCJTIydmlkJTIyJTNBJTIyYjQ0OTIzNTEtZWQzZC00Nzc4LTliZWUtM2I0MmM0YWNhNDllJTIyJTJDJTIyc3RhdGUlMjIlM0ElMjJybHR%2BMTY2ODE1NjQ4N35sYW5kfJfNzc4NzlfZGlyZWN0X2UwMjAxYzY5Y2Y1NTM1NTAxNzc5YTEzM2U4M [Accessed September 2023]

[128] RIBA (2022) New Building Regulations Changes to Part L are now in effect. Available at: https://www.architecture.com/knowledge-and-resources/knowledge-landing-page/new-building-regulations-changes-to-part-l-are-now-in-effect [Accessed September 2023]

[129] RIBA (2022) New Building Regulations Changes to Part L are now in effect. Available at: https://www.architecture.com/knowledge-and-resources/knowledge-landing-page/new-building-regulations-changes-to-part-l-are-now-in-effect [Accessed September 2023]

[130] Future Homes Hub (2022) Part L 2021: Where to start – A guide for housebuilders and their advisors for Masonry Construction. Available at: https://irp.cdn-website.com/bdbb2d99/files/uploaded/2436_PartLGuide_Masonrylatest.pdf [Accessed September 2023]

[131] RIBA (2022) New Building Regulations Changes to Part L are now in effect. Available at: https://www.architecture.com/knowledge-and-resources/knowledge-landing-page/new-building-regulations-changes-to-part-l-are-now-in-effect [Accessed September 2023]

[132] RIBA Journal (2022) Building regs what's changed: Part L, F and introducing Part 0 on ventilation. Available at: https://www.ribaj.com/intelligence/changes-to-part-l-part-f-part-o-future-buildings-standard [Accessed September 2023]

[133] HM Government (2021) Approved Document O Overheating. London: HM Government.

To demonstrate compliance with Document O, developers can either use the 'Simplified method' (with threshold reference values) or a dynamic thermal modelling method to account for the site-specific circumstances.

Approved Document S (Infrastructure for charging electric vehicles)[134]

The new Document S sets out the electric vehicle charging and cable route requirements for:

- New residential and non-residential buildings.
- Changes of use.
- Major renovations to existing residential and non-residential buildings; and
- Mixed use buildings undergoing relevant building work.

The number of charging points or cable routes is dependent on the number of units arising from development, and the associated number of parking spaces.

[134] HM Government (2021) Approved Document S Infrastructure for the charging of electric vehicles. London: HM Government.

A.3 Best Practice Guidance: Technical Building Assessments

The best practice guidance is sourced from Government Ministries and the below organisations:

- Building Research Group (BRE): BRE is a 'profit-for-purpose' organisation comprising scientists, engineers and technicians seeking to raise standards in the built environment sector. By undertaking independent research, BRE continue to set and enhance industry standards, products and qualifications[135].
- UK Green Building Council (UKGBC): The UKGBC is a membership organisation formed in 2007 which aims to radically transform the way that the built environment in the UK is planned, designed, constructed, maintained and operated, in order to build more sustainable buildings[136].
- Passive House Institute (PHI): The PHI (a UK affiliate of the International Passivhaus Association) promotes the adoption of the Passivhaus standard and methodology[137].
- Low Energy Transformation Initiative (LETI): Established in 2017, LETI has published key reports on supporting the UK's path to a zero-carbon future through the built environment[138].

BREEAM, BREEAM Infrastructure & Homes Quality Mark

As established by BRE, the BRE Environmental Assessment Method (BREEAM) and BREEAM Infrastructure are technical standard assessment methodologies to promote sustainability in the built environment. They are commonly used as tools to drive best practice and increasingly commonly seen as requirements in planning decision-making.

BREEAM has been developed for assessing the sustainability of buildings (incorporating net zero and health metrics)[139] and BREEAM Infrastructure for assessing the sustainability of civil engineering, infrastructure, landscaping and the public realm works (incorporating climate change and resilience metrics)[140]. BRE has produced a suite of guidance documents for local authorities to promote these standards within Local Plans.

Home Quality Mark (HQM), also developed by BRE, has been created to help developers assess and provide assurance on the quality and performance of all types of new-build homes, which can easily be communicated to buyers, financers, and the wider sector[141]. The assessment framework was recently revised, and now considers new dwellings against 39 assessment issues, encompassing its environs, quality of indoor living environment and construction quality. For each issue, assessors determine an appropriate number of credits to grant, depending on performance against specified criteria.

While HQM is not currently as widely adopted as BREEAM or BREEAM Infrastructure, its use as a 'preferred option' within Local Plans is growing.

To ensure robust integration into the Local Plan, the Planning Practitioner Guidance report[142] suggests the local authorities must first understand the local area need and the viability of raising efficiency standards. Local authorities should look to neighbouring authorities to define levels that complement their ambitions.

---

[135] Building Research Group (2023) About us. Available at: https://bregroup.com/about-us-2/ [Accessed September 2023]

[136] UKGBC (2023) Our Vision. Available at: https://www.ukgbc.org/our-mission/ [Accessed September 2023]

[137] Passivhaus (2023) About. Available at: https://passivhaus.uk/about/ [Accessed September 2023]

[138] LETI (2023) About. Available at: https://www.leti.uk/about [Accessed September 2023]

[139] BRE (2023) BREEAM. Available at: https://bregroup.com/products/breeam/ [Accessed September 2023]

[140] BRE (2023) BREEAM Infrastructure. Available at: https://bregroup.com/products/ceequal/ [Accessed September 2023]

[141] BRE (2022) HQM ONE Technical Standard. Available at: https://bregroup.com/products/home-quality-mark/ [Accessed September 2023]

[142] BRE (2019) BREEAM, Home Quality Mark and CEEQUAL Practitioner Guidance for Planning Professionals. Available at: PowerPoint Presentation (bregroup.com) [Accessed January 2024].

Other local authority approaches have set different requirements by development type and/or local priority. It may be appropriate to increase requirements through the Local Plan period, as standards generally increase nationally. Plan:MK currently only requires residential development of 11 or more dwellings, and commercial development of 1,000 sq. metres or more, to meet higher carbon emissions reductions targets.

Crucially, Authorities must ensure that their requirements for BREEAM, BREEAM Infrastructure and HQM or alternative building standards are clearly outlined in the Local Plan, to prevent a potential challenge if these standards are conditioned in a permission.

Net Zero Carbon Buildings: A Framework Definition (UKGBC, 2019) & follow-up guidance (UKGBC, 2020 & 2021)

The Framework was originally published in 2019 to establish an industry definition of net zero carbon buildings, accounting for both construction and operational energy. The Framework defined:

- Achieving net zero carbon for building construction as, "When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy".
- Achieving net zero carbon for building operations as, "When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset".

The Framework goes on to advise on a 'reduction first' approach to achieving net zero carbon, by following the carbon reduction hierarchy in Figure A.1 below[143].

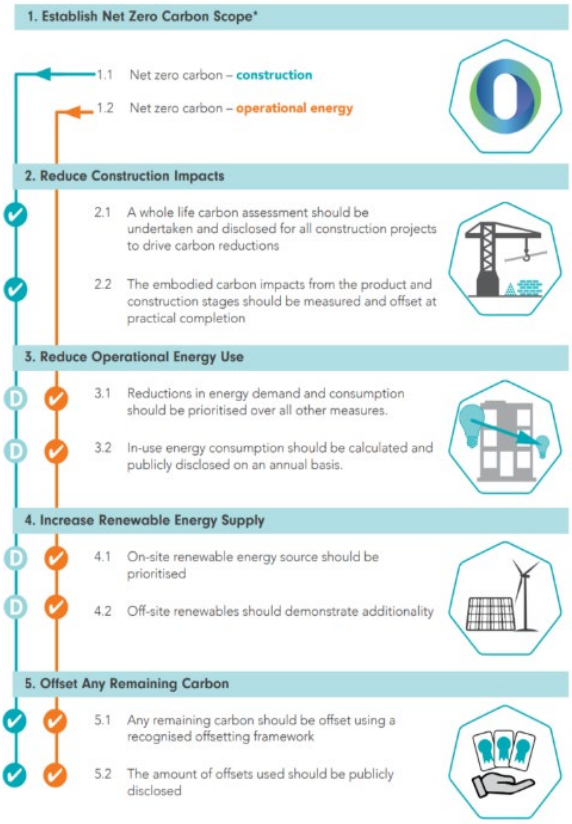


Figure A.1: Carbon reduction hierarchy to achieve net zero carbon buildings

[143] UKGBC (2022) Net Zero Carbon Buildings Framework. Available at: https://ukgbc.org/resources/net-zero-carbon-buildings-framework/ [Accessed September 2023]

To achieve each element of the 'carbon reduction hierarchy,' the UKGBC have now produced a document to signpost relevant best practice standards, produced in-house and by other organisations[144]. This includes LETI's Climate Emergency Design Guide and the RIBA 2030 Climate Challenge (see below).

The UKGBC have also produced guidance with additional technical requirements which, on some matters, supersede the original high-level guidance. This includes operational energy performance standards for residential and non-residential buildings[145], renewable energy procurement and carbon offsetting.

Going forward, the UKGBC are now involved in developing a UK Net Zero Carbon Standard with several other industry leading organisations such as BRE, LETI and RIBA. This is intended to establish a single and comprehensive method of verifying the net zero carbon status of buildings, in line with the nation's climate targets and so is likely to supersede the 2019 Framework Definition[146].

The Passivhaus Standard (Passive House Institute, 2022)

The Passivhaus Standard focuses on substantially reducing space heating and cooling requirements and establishing good indoor comfort levels, by adopting a fabric first approach and systems level ventilation[147]. Passivhaus buildings achieve a minimum 75% reduction in space heating requirements, over standard UK new build practice[148].

A Passivhaus building is one in which thermal comfort can be achieved solely by post-heating or post-cooling the fresh air flow required for a good indoor air quality, without the need for additional recirculation of air[149].

The Passivhaus certification is a quality control process that aims to ensure that buildings will perform as designed. It provides performance certification for the following: products/components, designers/ consultant, tradespeople/installers and buildings[150].

Achieving Passivhaus Standard in the UK typically involves design modelling using Passive House Planning Package (PHPP) software, very high insulation levels, extremely high-performance windows with insulated frames, airtight building fabric, 'thermal bridge free' construction and a mechanical ventilation system with highly efficient heat recovery[151].

LETI Client Guide (LETI, 2021)

This document pulls together key details from numerous documents and publications with the aim of mitigating climate risks. It also provides case studies of model development. Page 92 of this document onwards provides an extensive summary of sustainability assessment and certification, some of which are included in the review of best practice (section 4).

Defining and Aligning: Whole Life Carbon & Embodied Carbon

LETI have worked with a number of industry groups to align definitions, scopes, measurement methodologies and targets. As part of this work, LETI have pulled together a suite of documents intended for reading in conjunction with

---

[144] UKGBC (2022) UKGBC's Net Zero Carbon Buildings Framework Definition. Available at: https://ukgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/11/04164208/221024-Framework-Definition-Clarifications-v2-.pdf [Accessed September 2023]

[145] UKGBC (2019) Net Zero Carbon: One-Pager for New Buildings. Available at: https://ukgbc.org/resources/net-zero-carbon-one-pager-for-new-buildings/ [Accessed September 2023] and UKGBC (2020) Net Zero Carbon: Energy Performance Targets for Offices. Available at: https://www.ukgbc.org/ukgbc-work/net-zero-carbon-energy-performance-targets-for-offices/ [Accessed September 2023]

[146] UKGBC (2022) Net Zero Carbon Buildings Framework. Available at: https://ukgbc.org/resources/net-zero-carbon-buildings-framework/ [Accessed September 2023]

[147] BRE (2022) The Passivhaus Standard. Available at: https://bregroup.com/a-z/the-passivhaus-standard/ [Accessed September 2023]

[148] JMP Architects (2022) Passivhaus. Available at: http://www.jmp-architects.com/copy-of-sustainability#:~:text=Passivhaus%20designed%20buildings%20can%20reduce,you%20money%20on%20heating%20bills [Accessed September 2023]

[149] Passivhaus Trust (2014) Delivering Nearly Zero-Energy Building (NZEB) with Passivhaus. Available at: https://www.passivhaustrust.org.uk/news/detail/?nId=416 [Accessed September 2023]

[150] Passivhaus Trust (ND) What is Passivhaus? Available at: https://www.passivhaustrust.org.uk/what_is_passivhaus.php [Accessed September 2023]

[151] Passivhaus Trust (ND) What is Passivhaus? Available at: https://www.passivhaustrust.org.uk/what_is_passivhaus.php [Accessed September 2023]

one another to aid understanding of operational, embodied and Whole Life Carbon and of how to achieve a net zero 'Paris-Proof'[152] approach. This dictates that the built environment industry should only use the limited amount of carbon apportioned to it in order for the UK economy to reach net zero emissions by 2050.

Whole Life Carbon one-pager (LETI, 2021)

In a one-pager produced in collaboration with RIBA and the Whole Life Carbon Network (WLCN), LETI defines Whole Life Carbon emissions – their definition encompasses the sum of all asset-related GHG emissions and removals, encompassing both the operational and embodied carbon of an asset over its life cycle, including its disposal. Overall, Whole Life Carbon asset performance includes separately reporting the potential benefit from future energy recovery, reuse, and recycling.

To reduce Whole Life Carbon, LETI advises to:

1. Define the energy and embodied carbon targets, as well as the WLC measurement and verification process at project conception and track throughout. Formal disclosure should be made at post-completion and then annually.
2. Use WLC analysis during design to optimise embodied carbon, reduce operational energy and integrate Circular Economy[153] principles. For example, testing energy reductions, increased envelope specification or calculating carbon payback periods for Mechanical, Electrical & Plumbing (MEP) equipment or renewables.
3. Address upfront embodied carbon emissions (A1-5 in 0) by using minimal material.
4. Consider the carbon cost/ benefit between upfront carbon, operational carbon, and life cycle carbon due to replacement cycles.
5. At each replacement cycle, prioritise low carbon materials and Circular Economy principles to reduce WLC emissions.
6. Operational energy loads must be minimised and meet local energy targets, such as LETI Energy Usage Intensity (EUI) targets. A future decarbonised grid depends on reducing overall energy requirements. A further effect of grid decarbonisation is to make embodied carbon an even larger proportion of WLC.
7. Utilise Circular Economy principles at the beginning and end of the building and component life cycle. This includes retrofit, re-use of materials, recycled materials and design for future adaptability. Project end-of-life scenarios and quantify the potential future carbon benefits.

[152] United Nations Climate Change (ND) The Paris Agreement. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement [Accessed September 2023]

[153] A circular economy aims to maintain the value of products, materials and resources for as long as possible by returning them into the product cycle at the end of their use, while minimising the generation of waste. The fewer products we discard, the less materials we extract, the better for our environment.

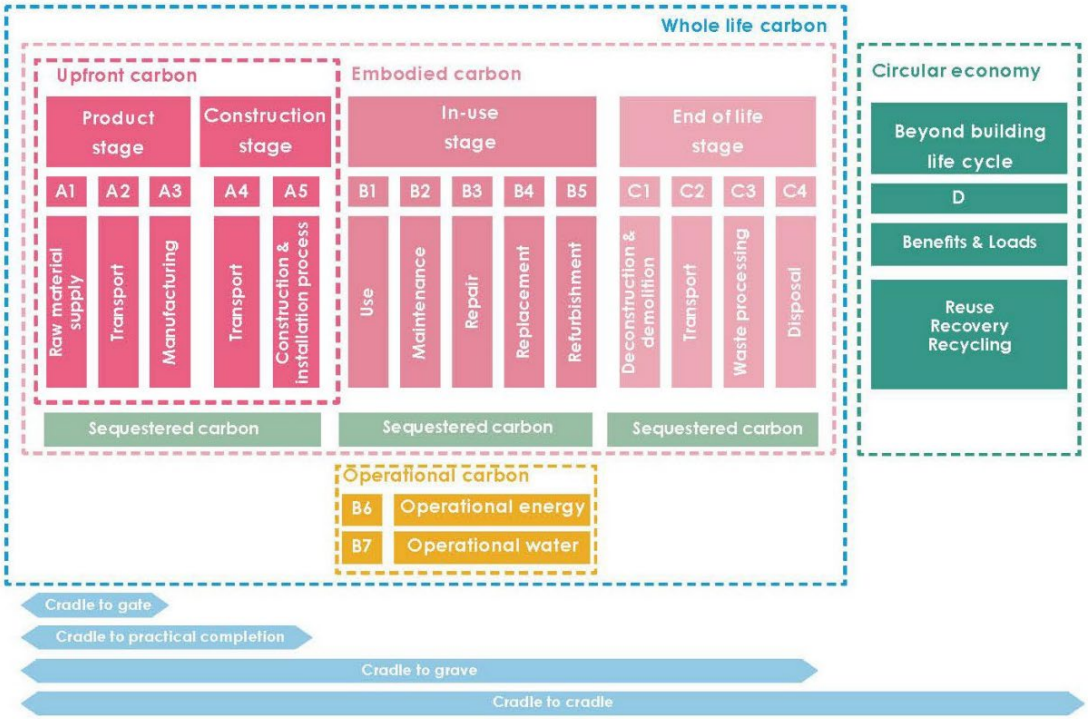


Figure A.2: Life Cycle Stages (defined by BS EN 15978:2011)

Embodied Carbon Target Alignment (LETI, 2021)

In LETI's 2021 guidance, it defines a letter banding scale (similar to the EPC band scale) for rating embodied carbon targets across typologies. Letter banding for a building is determined according to two thresholds in $kgCO^2/m^2$: the upfront embodied carbon involved in construction (Greenhouse Gas emissions associated with materials and construction processes); and the total embodied carbon (Greenhouse Gas emissions over lifecycle, excluding disposal)[154].

On LETI's scale, average buildings in the design stage currently achieve an 'E' rating, good design can achieve a 'C' rating, and the LETI 2030 design target for embodied carbon would achieve an 'A' rating.

Embodied Carbon one-pager (LETI, 2021)

This document defines embodied carbon emissions as the GHG[155] emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset. It presents a hierarchy for reducing embodied carbon which is shown in 0.

LETI also present a series of Elemental reduction strategies in order of highest to lowest for reducing embodied carbon:

- Structure: Options should be compared at an early stage, review loadings and rationalize or reduce structural grids and consider basement omission or test ground conditions.
- Façade and roof: Options should be compared at an early stage, and consideration should be given to the effect of replacement cycles.
- Mechanical, Electrical and Plumbing (MEP): Interrogate comfort metrics, avoid the over-provision of plant, and reduce duct-runs and consider natural ventilation as this can reduce upfront carbon, maintenance burden and

[154] LETI (2021) Improving Consistency in Whole Life Carbon Assessment and Reporting. Available at: https://www.leti.uk/_files/ugd/252d09_879cb72cebea4587aa860b05e187a32a.pdf [Accessed September 2023]

[155] GHG emissions = Greenhouse Gas emissions

energy use. Specification of refrigerants with low GWP and consideration of leakage in analysis and design for easy access through finishes, recycling and deconstruction as MEP is regularly replaced.

- Finishes, furniture, and fitting: eliminate materials where possible and utilise self-finishing surfaces with low maintenance, ensure replacement cycles are considered from the outset (especially on loose items and high footfall areas) and replacement cycles should generally be reduced where possible.

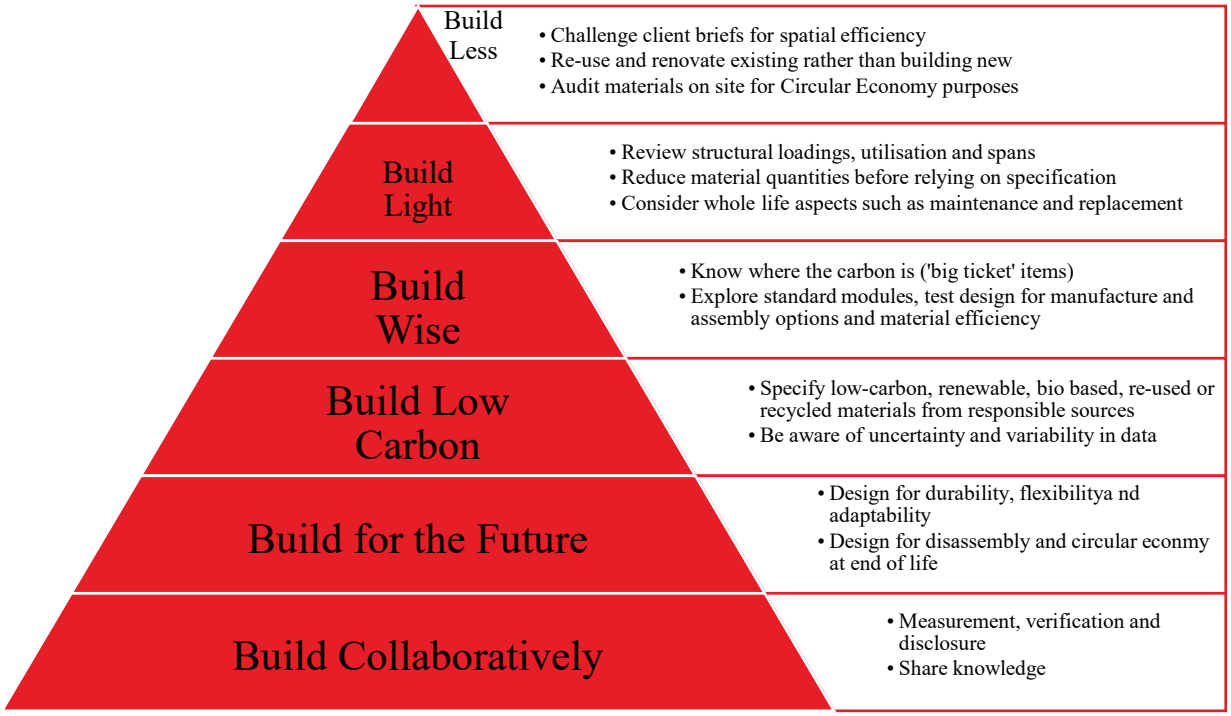


Figure A.3: LETI Hierarchy for Embodied Carbon Reduction

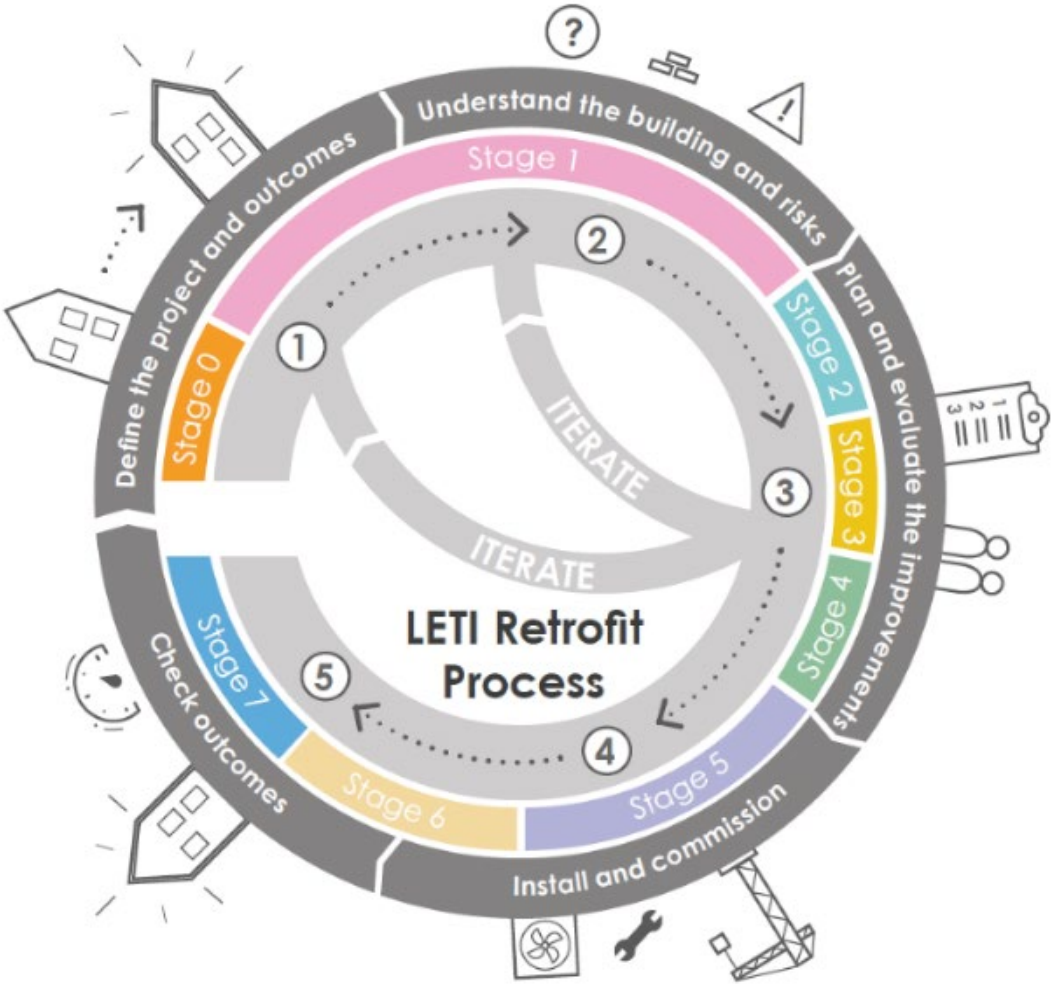
Climate Emergency Retrofit Guide (LETI, 2021)

This guide follows from the LETI Climate Emergency Design Guide[156] which was published in 2020 and provides guidance on defining good design in the context of the climate emergency for new buildings. This guide makes clear that retrofit should focus on reducing energy demands of homes specifically, but references heat sources as a critical part of this plan.

They have introduced six principles for best practice in building retrofit:

1. Reduce energy consumption
2. Prioritise occupant and building health
3. Have a whole building retrofit plan
4. Measure the performance
5. Think big
6. Consider impact on embodied carbon

[156] LETI (2020) LETI Climate Emergency Design Guide. Available at: https://www.levittbernstein.co.uk/site/assets/files/3494/leti-climate-emergency-design-guide.pdf [Accessed September 2023]



LETI also emphasise the importance of tailoring retrofit to the property type and determining whether or not properties are constrained (by factors such as heritage asset, form factor and space) and unconstrained (all other homes).

Figure A.4: LETI Retrofit Process (LETI, 2021)

A.4 Urban Heat Island modelling

Milton Keynes

Urban Heat Island Assessment (PowerPoint)

15th February 2024

Background

Urban Heat Island

The Urban Heat Island (UHI) effect is where urban areas experience warmer temperatures compared to their rural surroundings.

Climate change is exacerbating the effects of UHI. Higher average summer temperatures and more frequent heatwaves will increase the severity of the UHI throughout the century.[1][157]

Understanding the UHI during both typical and extreme summer conditions enables understanding of both frequency and severity.

Typical summer conditions are more frequently occurring thus affecting urban residents more often. Extreme conditions denote heatwave periods where temperature peaks are experiences. These conditions may be associated with severe consequences such as increased hospitalization and mortality for people, as well as negative impacts on other urban systems such as infrastructure and energy.

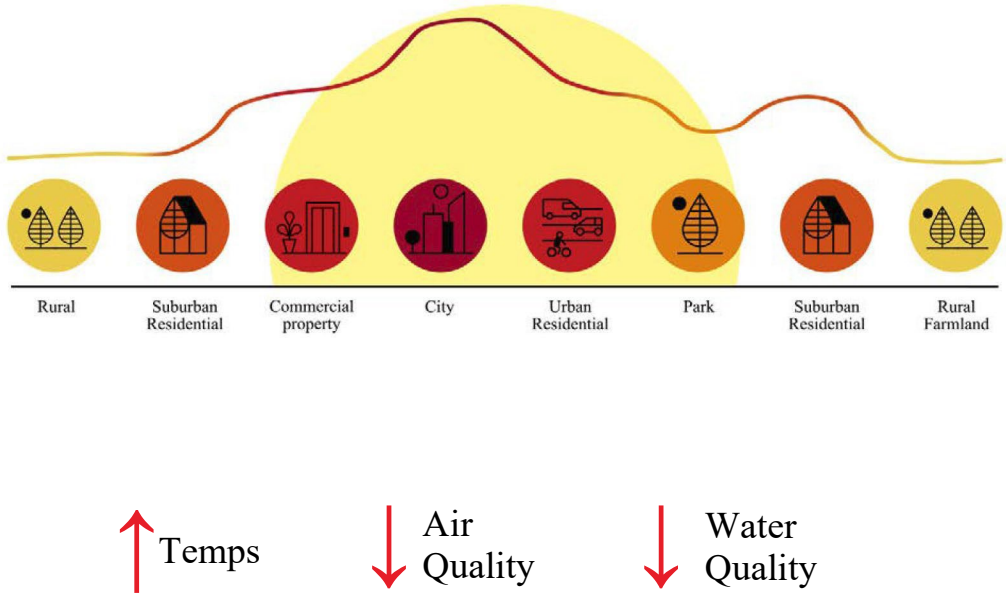


Figure 1: *Urban Heat Island effects in cities*

[157] Climate change in the UK (2020). https://www.metoffice.gov.uk/weather/climate-change/climate-change-in-the-uk.

Introduction

Milton Keynes

This study calculates the intensity of the urban heat island for across the wider Milton Keynes area. The urban centre of Milton Keynes was included with surrounding rural areas and the town of Olney.

Milton Keynes urban heat island (UHI) was analysed using Arup's UHeat. UHeat combines remote sensing data with a climate model, to calculate urban heat island effects at a local level, across an entire city.

UHeat analysis was carried out across the area of interest (AOI) shown in Figure 2.

The analysis covers the full 2022 summer period, which includes a severe heatwave along with milder summer days.

The urban heat island intensity (UHII) is calculated across the AOI and is defined as the difference between the urban air temperatures to a rural reference temperature.

The rural reference represents a typical UK farmland (90% grass, 10% trees).

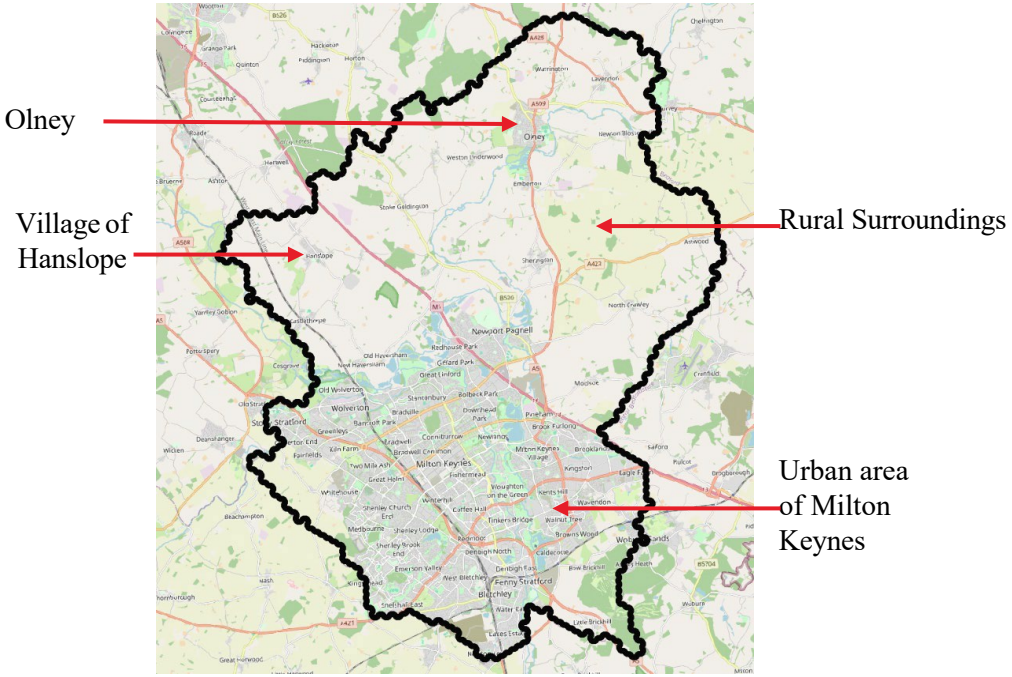


Figure 2: *Milton Keynes AOI, showing the boundaries of the analysis*

Milton Keynes Land cover

Vegetation

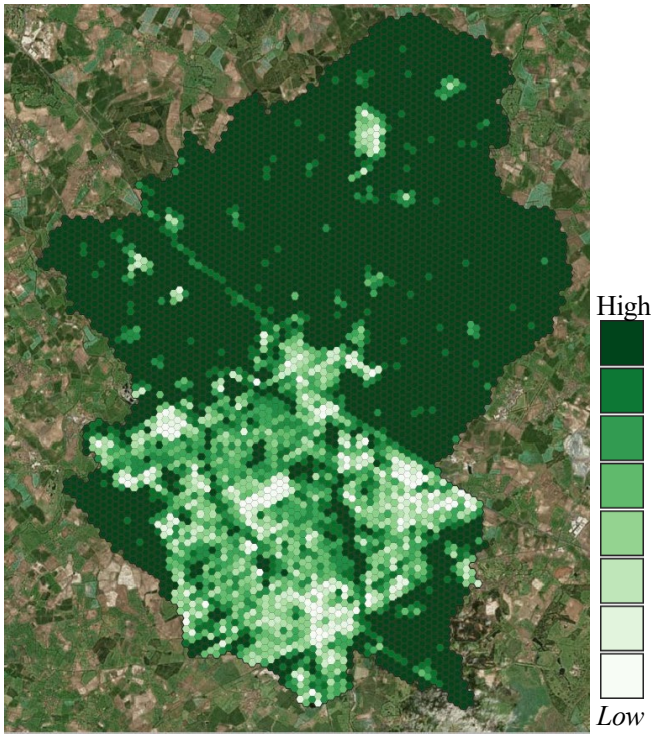


Figure 3: *Vegetation cover across analysis area*

Paving

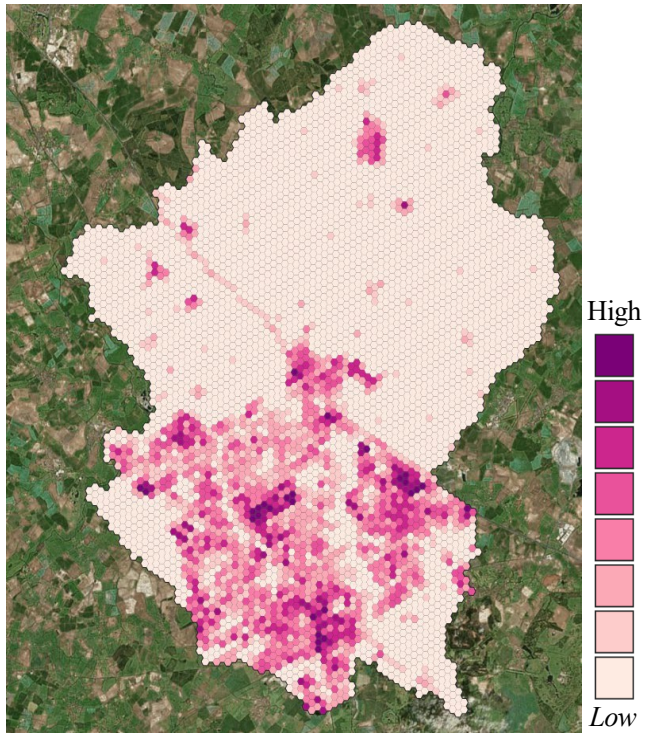


Figure 4: *Paving cover across analysis area*

Buildings

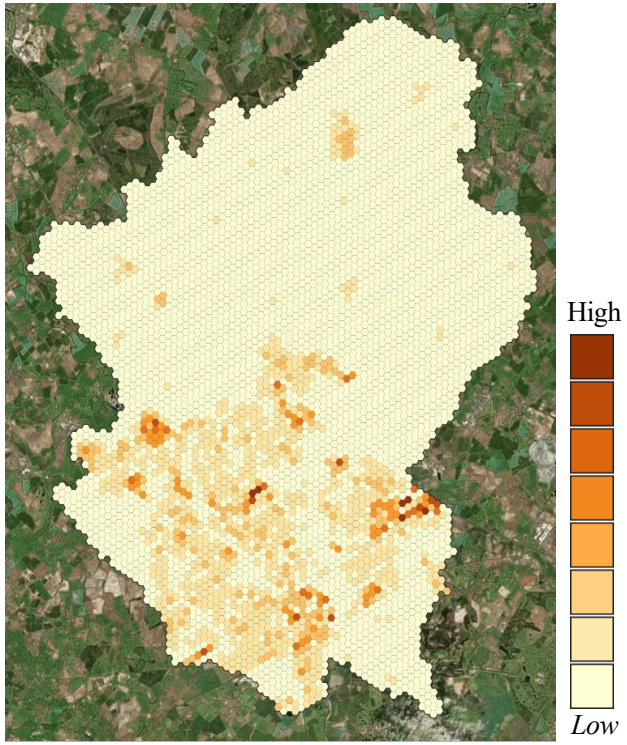


Figure 5: *Building cover across analysis area*

Figures 3 to 5 show areas of high and low land cover for vegetation, paving and buildings, respectively. The urban area of Milton Keynes has low vegetation, high paving and higher building densities compare to the rural surroundings.

Results

Urban heat maps are presented for an extreme summer and typical summer period:

Extreme Summer Results

- Peak daytime UHII hour
- Peak nighttime UHII hour
- Maximum daily temperature hour

Typical Summer Results

- Average summer mid-night
- Average summer mid-day

Mid-day hours cover 12:00 – 14:00 and mid-night 00:00 – 02:00.

Time periods

The 22nd July 2022 was selected as an extreme summer day. This aligns to the maximum recoded temperature in England of 40.3°C.[158] Extreme conditions where temperatures are highest are usually associated with the most severe consequences, such as increased hospitalization and mortality and negative impacts on infrastructure and energy. The typical summer results cover a week of 1st – 8th July 2022, where the average daily maximum temperature of 22°C for the week corresponds with the average for the whole 2022 summer. Typical summer conditions occur more frequently, thus affecting urban residents more often.

Sensitivity Study

Soil moisture saturation will have an impact on the urban heat island effect, especially when assessing large rural areas. The saturation will vary across the summer period and is difficult to determine the correct level without more data.

Results presented in Figures 4 – 10 are a low soil saturation case.

An additional sensitivity study evaluating low and high soil saturation during a typical and extreme summer is also presented in Figure 11.

The Urban Heat Island Intensity (UHII) is the difference in temperature compared to the rural area definition which represents farmland cover.

Peak UHII hour is when the UHII is at its maximum for a given period

[158] Hot weather and its impacts (2018). https://www.metoffice.gov.uk/weather/warnings-and-advice/seasonal-advice/health-wellbeing/hot-weather-and-its-impacts.

Extreme Summer: Daytime UHII hour

19th July 2022 - 11am

- The peak UHII on the extreme summer day occurs in the daytime at 11:00.
- The peak UHII is 4.5°C (when compared to the rural reference.) This hotspot is at Wolverton, where the air temperature is 37°C.
- Cold spots are found across the rural surroundings of Milton Keynes. A cold spot within the urban area of Milton Keynes is at Ouzel Valley Park, where the temperature is 33°C.
- There is a clear distinction between the higher temperatures within central urban boundary of Milton Keynes and the lower temperatures of the surrounding rural areas, with the exception of the town of Olney, north of Milton Keynes.

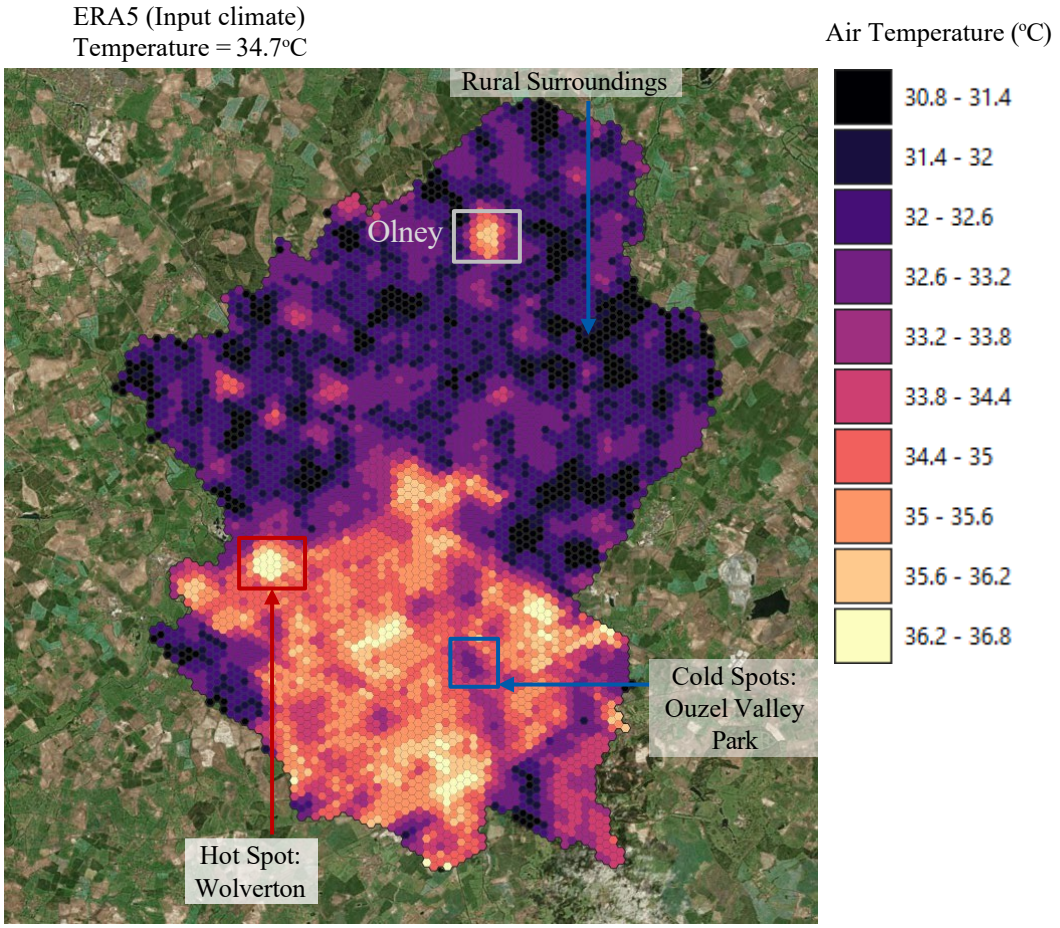
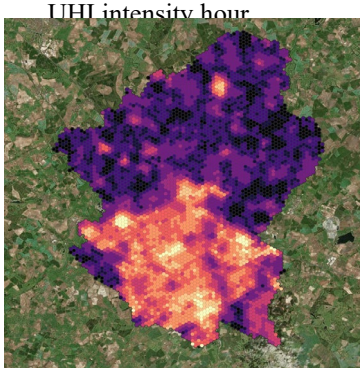


Figure 6: Air temperatures across Milton Keynes during the peak of the extreme summer day.

UHI intensity hour



Extreme Summer: Nighttime UHII hour

19th July 2022 - 5am

- For Milton Keynes, the peak nighttime UHII on the extreme summer day occurs at 05:00.
- The peak UHII is 4.0ºC (when compared to the rural reference.).
- Central Milton Keynes appears as a more prominent hotspot in the night than in the day, as well as Bletchley, Fenny Stratford, Broughton and the previously identified Wolverton area.
- Temperature differences are starker between urban and rural areas at nighttime.
- Cold spots are found across the rural surroundings of Milton Keynes. The strip of rural land running through Milton Keynes which includes Ouzel Valley Park is noticeably cool within the urban realm, along with Loughton Valley Park, Linford Wood, Shenley Wood, Furzton Lake and The National Bowl.
- Olney and villages such as Lavendon, Hanslope and Sherington show higher temperature than the rural surroundings. The M1 is also visibly warmer on the map.
- Solar panel farms appear as hot spots due to classification of paving in land classification data from the ESA World Cover dataset. This paving will exhibit different thermodynamic behaviour than an actual solar panel farm.

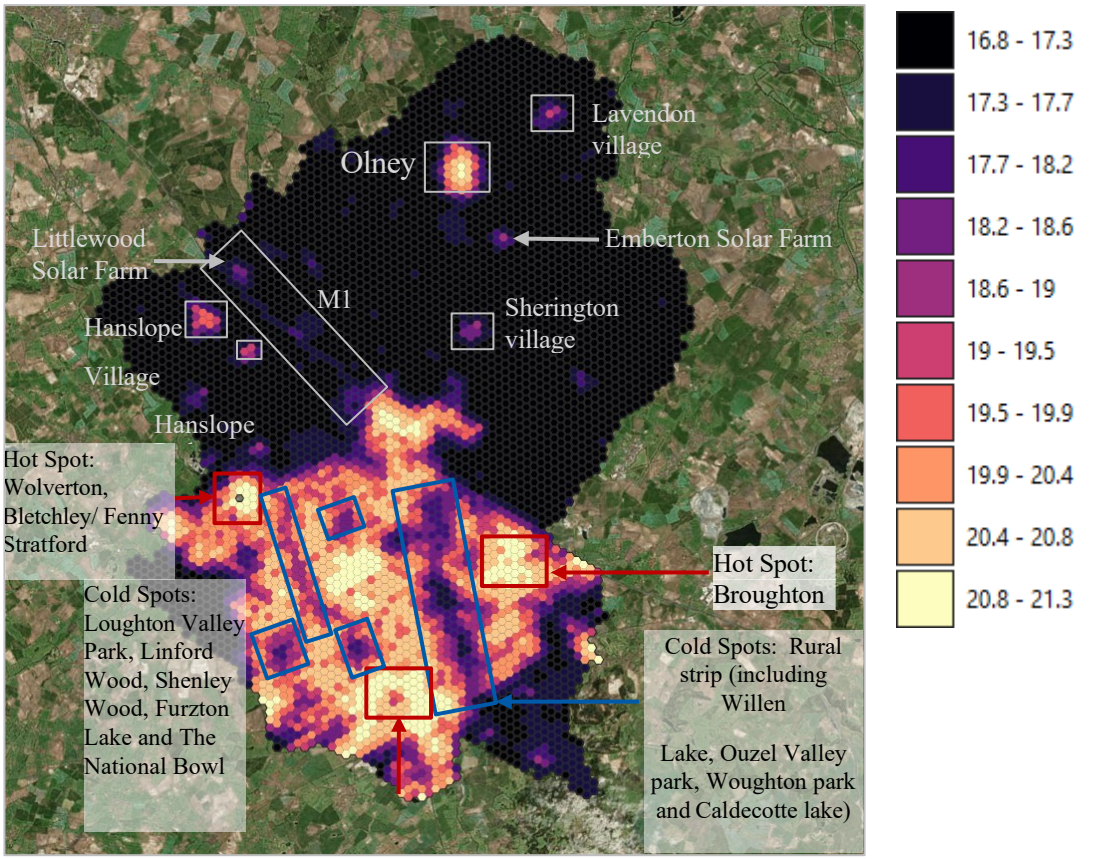
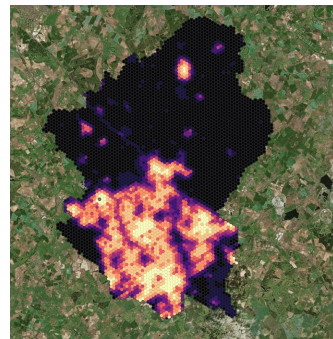


Figure 7: Air temperatures across Milton Keynes during the peak nighttime UHI intensity hour of the extreme summer day.



Extreme Summer: Max Temperature Hour

19th July 2022 – 2pm

- The maximum temperature on 19th July 2022 occurs at 14:00.
- The peak UHII is 4.5°C (when compared to the rural reference.).
- The hot spot seen at this hour is at Wolverton, which experiences temperatures of 39.3°C.
- Cold spots in the urban area can be seen in the rural strip which includes Ouzel Valley park, however this is less stark than in the nighttime.

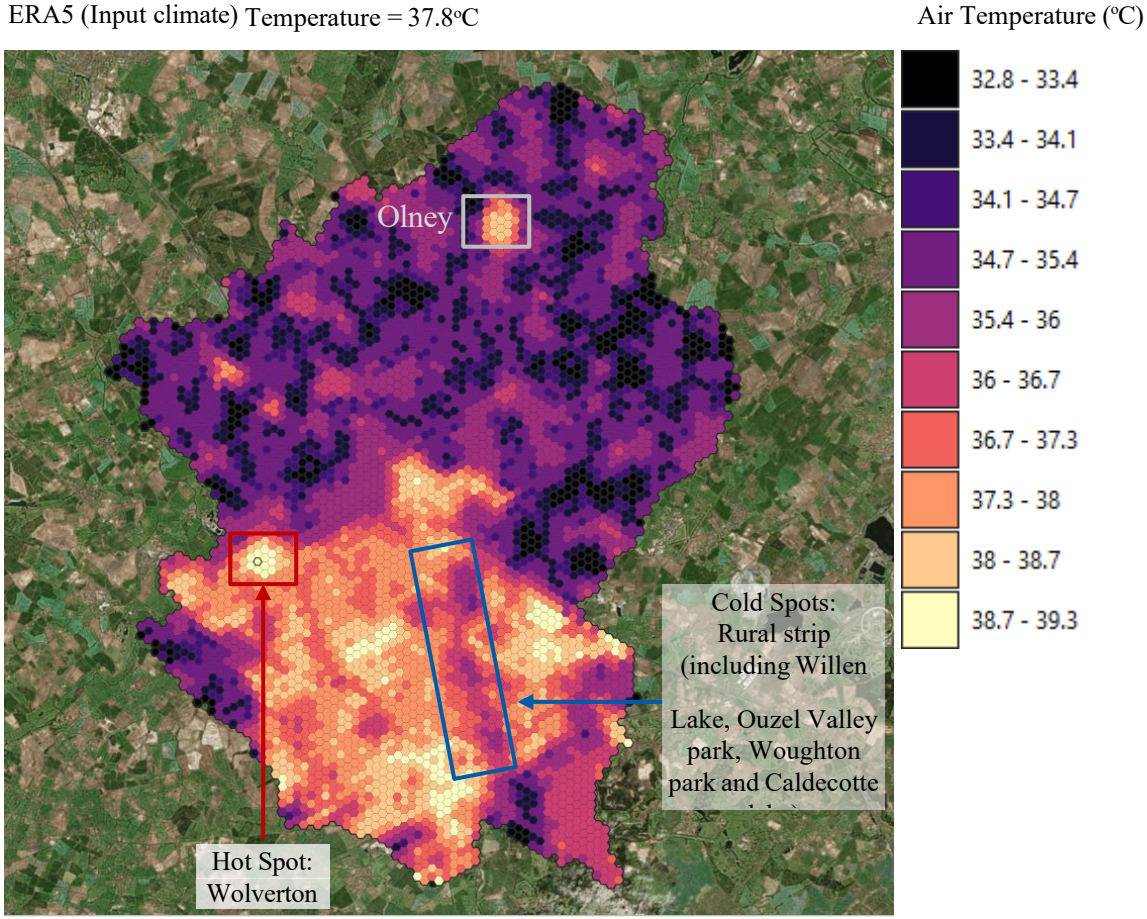
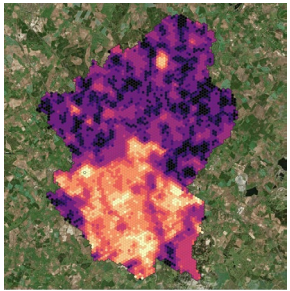


Figure 8: Air temperatures across Milton Keynes during the maximum temperature hour of the extreme summer day.



Average Summer Mid-day

1st – 8th July 2022

- The average summer mid-day temperatures are averaged between 1st and 8th July between 12:00 and 14:00.
- The water bodies in Milton Keynes (highlighted in Figure 9) are prominent cold spots, indicating the effectiveness of water at reducing daytime temperatures, compared to vegetation. The circled cool spots are, form north to south:
  - River Great Ouse and Linford Lakes Nature reserve
  - Willen Lake
  - Caldecotte Lake
- Wolverton is still the most prominent hotspot. The town of Olney can still be clearly identified as a warm spot in the rural surroundings

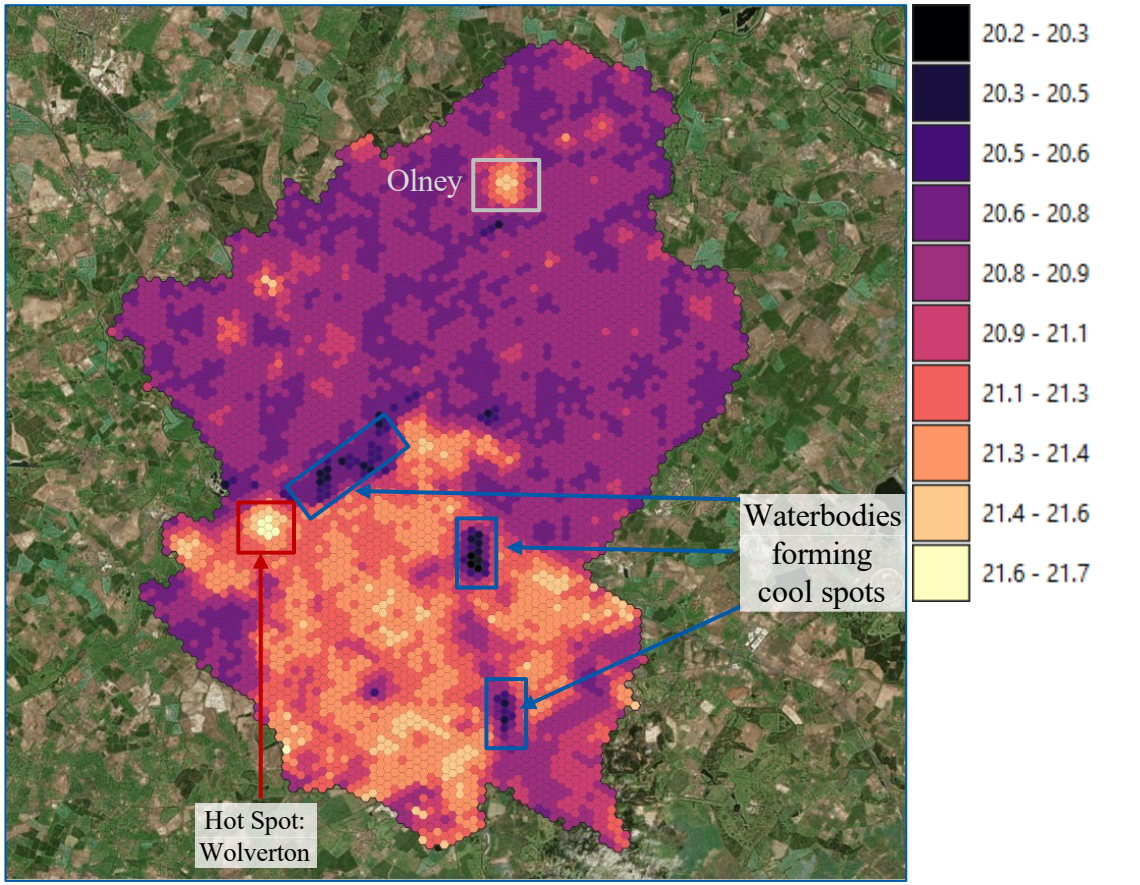
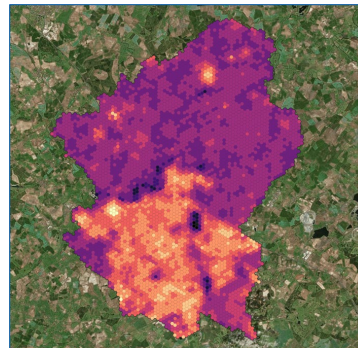


Figure 9: Daytime air temperatures across Milton Keynes during a typical summer week



Average Summer Mid-night

1st – 8th July 2022

- The average summer mid-night temperatures are averaged between 1st and 8th July between 00:00 and 02:00.
- Unlike the daytime period, during the nighttime the water appear as much less noticeable cool spots.
- The grassy, vegetated areas appear as cool spots.
- Wolverton is still the most prominent hotspot. The town of Olney can still be clearly identified as a warm spot in the rural surroundings

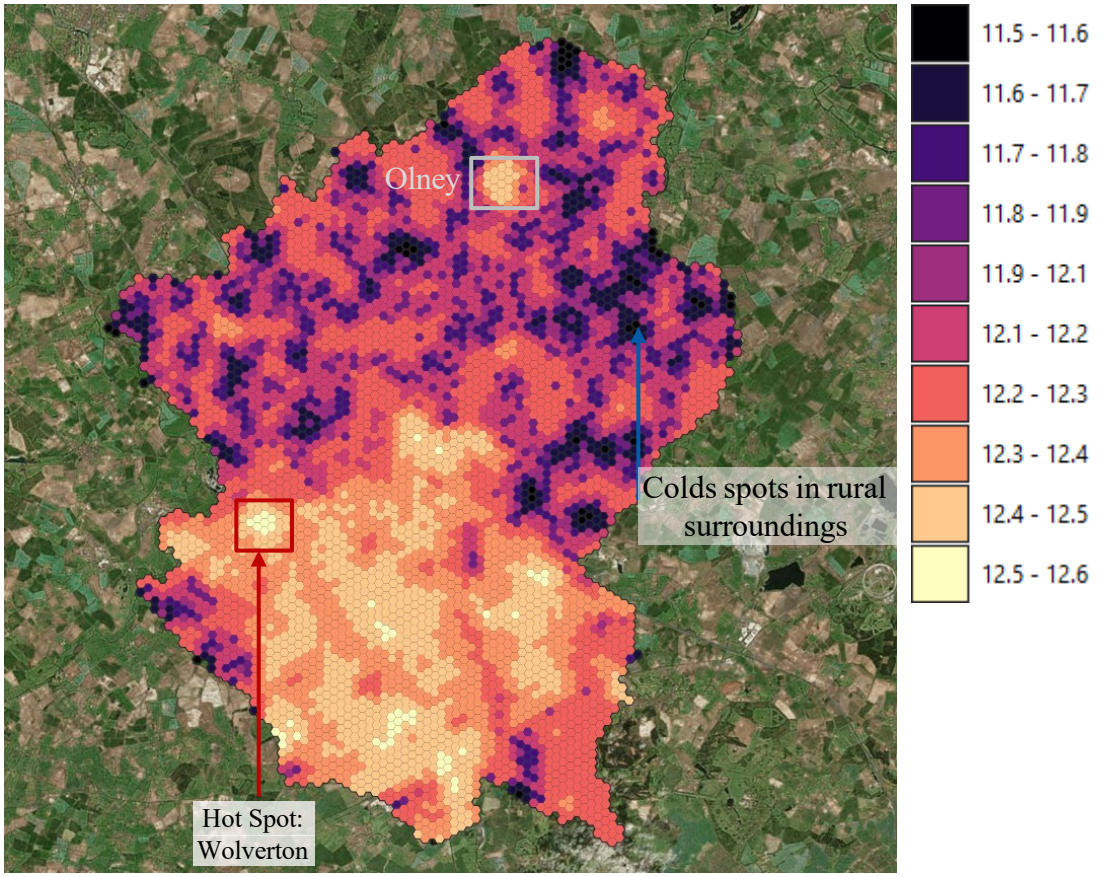
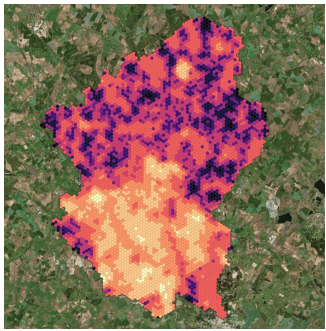


Figure 10: Nighttime air temperatures across Milton Keynes during a typical summer week



Sensitivity to soil saturation

1st – 8th July 2022

- Soil saturation relates to the moisture in the soil. A high saturation is when pores in the soil are filled with water.[159]
- As information pertaining to soil moisture levels was not available, a sensitivity study analysing the effect of soil moisture on the results was carried out for both the typical and extreme summer periods.
- High soil saturation (0.7, left-hand side of Figure 11) vs low soil saturation (0.4, right-hand side of Figure 11) was tested to represent different heat scenarios. Soil saturation may vary during the summer.
- During the heatwave period for the 2022 summer, there was a period of drought[160], so earlier analysis results are shown for low soil saturation levels.

Figure 11: Weekly average air temperatures (oC) across Milton Keynes for soil sensitivity study

[159] CHAPTER 2 - SOIL AND WATER (no date). https://www.fao.org/3/r4082e/r4082e03.htm#2.3.2%20saturation.

[160] Met Office Press Office (2023) Working for climate resilience with the UK water sector. https://blog.metoffice.gov.uk/2023/02/27/working-for-climate-resilience-with-the-uk-water- sector/.

Summary and Conclusions

Summary Table

		Hot spot		Cold spot	
		Low soil moisture	High soil moisture	Low soil moisture	High soil moisture
Extreme Summer	Peak daytime UHII hour | 11:00	37.0°C	36.0°C	31.0°C	30.0°C
	Peak nighttime UHII hour | 05:00	21.5°C	21.0°C	17.0°C	16.5°C
	Maximum daily temperature | 14:00	39.5°C	38.5°C	33.0°C	31.5°C
Typical Summer	Average Mid-day	22.0°C	21.5°C	20.0°C	19.5°C
	Average Mid-night	12.5°C	12.5°C	11.5°C	11.5°C

Hot or cold spot location colour code	Area characteristics
Wolverton	61% Paved, 39% Buildings
Surrounding Rural Farmland	100% Grass
Lakes	100% Water

Table 1: Milton Keynes Results rounded to nearest 0.5°C

- Table 1 gives a summary of the results for the analysis over Milton Keynes.
- The analysis found that Wolverton was the location for the hot spot in all scenarios. This area is made of 61% paved surfaces and 39% buildings.
- The coolest spots were found in the surrounding rural farmlands which are typically 100% grass.
- For a low moisture, typical summer, average daytime the coolest area was found to be in the lakes (100% water).

ARUP

Methodology and Validation

Modelling

UHeat is a digital tool that allows rapid complex modelling of the urban climate and provides the air temperatures of cities, which is much closer to what people actually feel (compared to more commonly recorded surface temperatures).

UHeat uses the Surface Urban Energy and Water Balance Scheme (SUEWS), an academic model developed by Professor Sue Grimmond's team at the University of Reading[5][161]. Arup has integrated the model into UHeat to provide rapid analysis that can be used to understand the impact of design on urban heat. It accounts for several factors including building heights, surface albedos (reflectiveness), the amount of green and blue infrastructure, impervious surfaces, population density and the urban climate. The tool comprises of three core units as shown in Figure 12:

- **Data Processing**: Processing of remote sensing data to define the urban landscapes and surface characteristics
- **Calculate UHI**: Modelling of the urban climate modelling using the SUEWS model
- **Output**: Postprocessing and visualisation of the city-scale climate data.

The output of UHeat are a set of maps of the urban climate conditions across different neighbourhoods of the city, showing the average air temperature, surface temperature and urban heat island intensity (UHII). For this project, air temperatures were outputted. These maps are provided as a geopackage alongside this report.

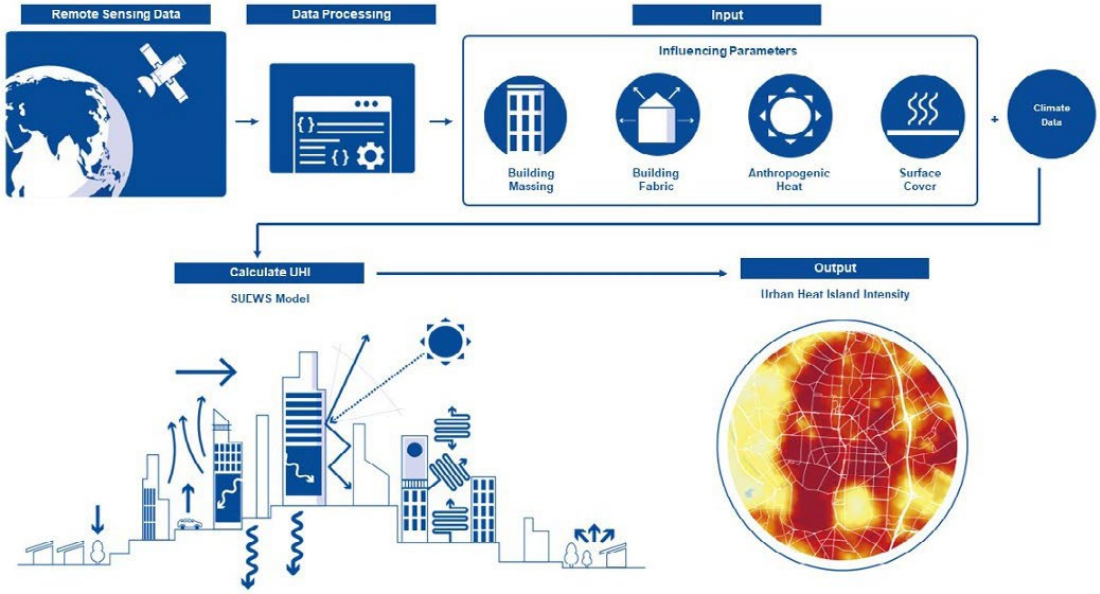


Figure 12: *UHeat methodology workflow*

[161] SUEWS: Surface Urban Energy and Water Balance Scheme — SUEWS v2020a documentation (no date). https://suews.readthedocs.io/en/latest/.

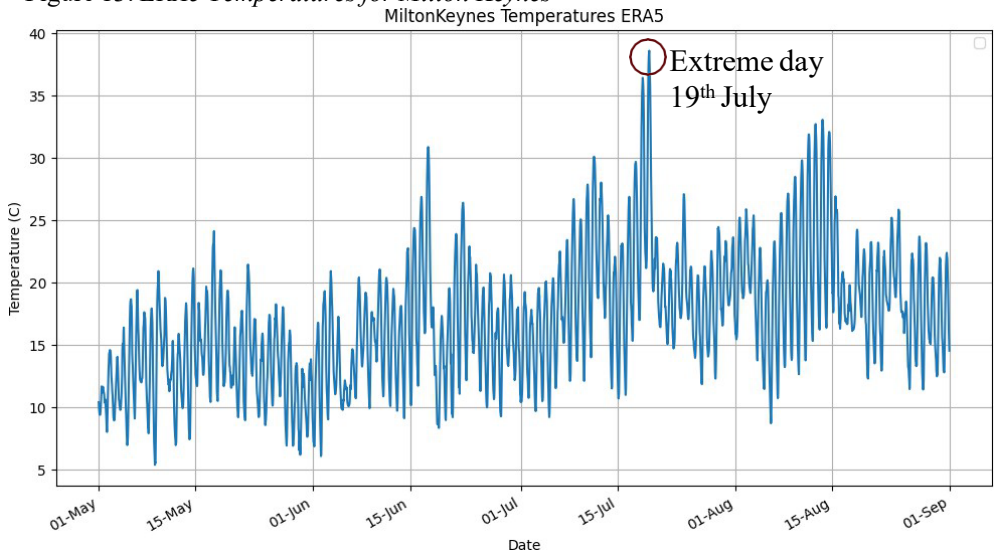
Modelling

Climate data input

ERA5 data[162] is used as forcing data input to drive the model. ERA5 is a global reanalysis dataset of a wide variety of climate variables from various data sources, produced by ECMWF (European Centre for Medium-Range Weather Forecasts) and accessible via CDS (Climate data store).

It is available on a 30km grid covering the whole globe. It is widely used in academia and has been validated for use in macroscale meteorological models such as WRF (Weather Research Forecasting).[163]

Figure 13: *ERA5 Temperatures for Milton Keynes*



The input climate data is historical data obtained for the whole summer period of 2022 for Milton Keynes (see Figure 13). A severe heatwave occurred in the summer of 2022 with record-breaking temperatures of 40.3C experienced in England on 19th July.

Weather station data was used to validate and cross-check both the UHeat output temperatures and the input ERA5 data.

Weather stations are limited in that the data is only captured at a single point which, depending on the location, could be:

- Very far from the AOI due to unavailability of nearby weather stations
- Already affected by UHI due to location inside city (making it inappropriate to use for modelling)
- Unavailable due to the weather station being privately owned

There were no NOAA weather stations in the AOI which could be accessed. Data from the nearest station at Cranfield[164] was used to check outputs from UHeat.

[162] Muñoz Sabater, J. (2019): ERA5-Land hourly data from 1950 to present. Copernicus Climate Change Service (C3S)Climate Data Store (CDS). DOI: 10.24381/cds.e2161bac

[163] Weather Research & Forecasting Model (WRF) | Mesoscale & Microscale Meteorology (no date). https://www.mmm.ucar.edu/models/wrf.

[164] Cranfield Weather Station Code: 03557399999

Data

Spatial input data

As shown in Figure 12, UHEAT uses climate and spatial/remote sensing data as an input to the model. The spatial/remote sensing data is processed to define the urban environment at each hex grid cell, see Figure 14.

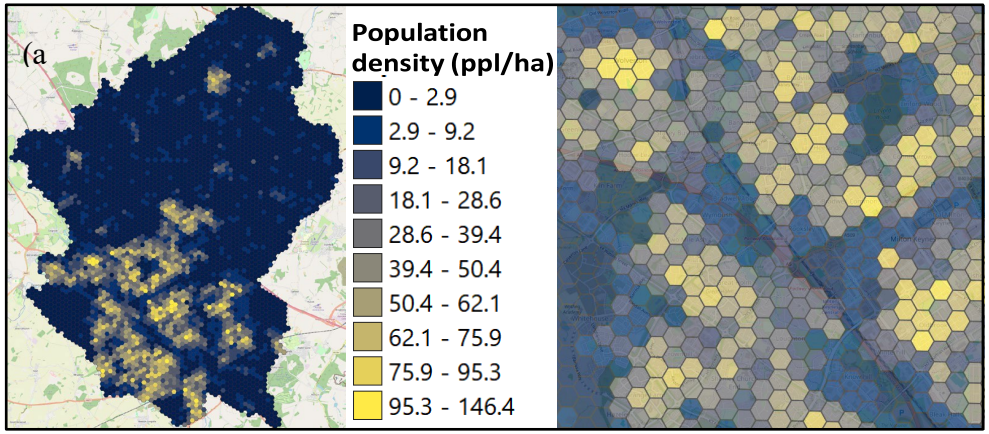


Figure 14: *Urban information, in this image population density, is collected and processed to the 300m hex grid shown (a) across the full area of interest (b) zoomed in to show the grid hex size.*

Urban category	Variable	Data Source	Processing
Surface Cover	Buildings	ESA WorldCover[165]	AWS SageMaker
	Paved	ESA WorldCover	AWS SageMaker
	Trees	ESA WorldCover	AWS SageMaker
	Grass	ESA WorldCover	AWS SageMaker
	Bare Soil	ESA WorldCover	AWS SageMaker
	Water	ESA WorldCover	AWS SageMaker
Surface typology	Albedo	Sentinel 2[166]	AWS SageMaker
Anthropogenic emissions	Population Density	Global Human Settlement Layer (GHS-POP) [167]	AWS SageMaker
Surface topology	Building heights	Global Human Settlement Layer (GHS-BUILT-H) [168]	AWS SageMaker

Table 2: *Data sources used to generate urban grid information.*

A variety of datasets are used to obtain information on the urban landscape, these are listed in Table 2 above.

[165] © ESA WorldCover project 2021 / Contains modified Copernicus Sentinel data (2021) processed by ESA WorldCover consortium

[166] Copernicus Sentinel-2 (processed by ESA), 2021, MSI Level-2A BOA Reflectance Product. Collection 1. European Space Agency. https://doi.org/10.5270/S2_-znk9xsj

[167] Schiavina M., Freire S., Carioli A., MacManus K. (2023): GHS-POP R2023A - GHS population grid multitemporal (1975-2030).European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/2ff68a52-5b5b-4a22-8f40-c41da8332cfe, doi:10.2905/2FF68A52-5B5B-4A22-8F40-C41DA8332CFE

[168]Pesaresi, M.; Politis, P. (2023): GHS-BUILT-H R2023A - GHS building height, derived from AW3D30, SRTM30, and Sentinel2 composite (2018).European Commission, Joint Research Centre (JRC) PID: http://data.europa.eu/89h/85005901-3a49-48dd- 9d19-6261354f56fe, doi:10.2905/85005901-3A49-48DD-9D19-6261354F56FE

Methods and Assumptions

The *'Surface Urban Energy and Water Balance Scheme' (SUEWS)* is an open-source model that simulates the variation of urban climate with the site characteristics and meteorological conditions. The model accounts for different surface types including paved surfaces, buildings, greenery, soil and water.

Model Sensitivities

The surface properties, including albedo (reflectiveness) of the solid surfaces and transpiration of green elements, are taken from the remote sensing data and included in the model to estimate the heating effects of solar radiation on the surfaces, as well as the cooling of spaces due to evapotranspiration.

The cooling/breeze effect of the wind on the urban climate is accounted in the SUEWS model using a combination of the wind information included in the climate data and an equivalent surface roughness across the city derived from the building and tree properties. Detailed information on the wind direction and building orientation are not considered in the SUEWS model.

Limitations

The limitations of the modelling primarily arise due to the assumptions and data sources used:

- The accuracy of the model is dependent on the accuracy and resolution of the input data on variable such as land surface classification, land surface cover etc. There may be small features and updates that may not be captured in the model.
- Data on anthropogenic heat emissions i.e., heat from buildings, transport and people was not readily available. Population density was used in the model to make predictions for these variables.
- SUEWS is a surface model and limited to the resolution of the data available. It does not account for detailed 3D features.
- SUEWS is not a computational fluid dynamics model and does not account for advection across the city. In reality this would have an impact on the urban heat island but would require more complex modelling to be carried out which is outside the scope of this work.
- Other climate variables such as solar radiation and humidity will have an impact on thermal comfort and heat stress. These are not accounted for in the temperature maps. These are microclimate features and should be considered when surveying areas in more detail.

Mitigating UHI

Cool roofs: These are reflective roofs (high albedo) which reflect more solar radiation than traditional roofs, which have low albedo) and thus don't reach as high surface temperatures. This is also a low-cost mitigation option that usually involves painting flat roofs with reflective paint. This mitigation has the additional benefit of reducing internal building temperatures.

Reducing impervious surfaces: By reducing paved surfaces, the amount of surface area that is available to absorb high amounts of solar radiation and reach high temperatures is also reduced. Impervious surfaces can also retain more moisture leading to cooler temperatures.

Green roofs: These roofs are vegetated and experience lower surface temperatures due to a combination of shading effects, higher albedo and evapotranspirative cooling. Like cool roofs, this mitigation has the additional benefit of reducing internal building temperatures, however it is more complex/costly to implement

Shading structures: These will reduce incident radiation on surfaces occupied by pedestrians and thus surface temperature.

Urban greening: increasing vegetation reduces surface temperatures and air temperatures through increased shading and evapotranspiration.

Increasing blue features: increasing blue spaces and adding water features reduces temperatures though evaporative cooling. Furthermore, water collection such as rainwater harvesting for sustainable irrigation enhances vegetative cooling during dry season.

ARUP