Research to inform Trees for Cities' work to improve health outcomes through trees

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Acknowledgments

CSH would like to thank Forestry England, Natural England, Forest Research, Forestry Commission, Mersey Forest, Woodland Trust, the Royal Horticultural Society and Trees for Cities (TfC) staff for their valuable contributions to this project. We appreciate their time and insights to support us imagine health-focused initiatives that align with TfC's new strategic phase and programme development.

We would also like to thank TfC for commissioning CSH to deliver this project which is part of making their work more engaging and impactful.

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Phase One: Assessing the Health Benefits of Trees for Cities' Projects

This assessment evaluates the likely health outcomes of Trees for Cities' (TfC) work to date, focusing on programmes such as tree planting, retrofit green interventions, and nature-connectedness activities. It examines the strength of evidence underpinning these outcomes and considers the perspectives of key stakeholders involved in promoting, monitoring, or evaluating health benefits through trees and green infrastructure. Additionally, the report assesses how confidently TfC can communicate their health-related impacts to the public, policymakers and funders, highlighting areas of strength and their role in trees for health.

Physical Health - Respiratory

The TfC *Planting Healthy Air* programme focuses on mitigating traffic-related air pollution in urban schools through green infrastructure. It was noted at St. Paul's Primary that air quality monitoring revealed substantial pollutant reductions in areas shielded by vegetation, with PM2.5 levels averaging 12-13 µg/m³ compared to 32 µg/m³ in unprotected zones. This aligns with evidence demonstrating that urban greenery can effectively reduce particulate matter, associated with lower rates of respiratory and cardiovascular diseases. While specific health outcomes like reduced asthma prevalence were not measured, these air quality improvements strongly suggest enhanced respiratory health, particularly for children who are highly vulnerable to pollution exposure.

Physical Health - Encouraging Activity

Multiple physical health benefits are a key aspect of nature-based activities, such as those delivered by TfC, including tree planting and other interventions that involve direct engagement with the environment. These benefits are distinct from those associated with simply spending time outdoors, as they stem from active participation in improving and interacting with natural spaces. Observational and survey evaluation data shows that TfC's interventions encourage physical activity and time spent outdoors. Their *Growing Among Trees* programme incorporates outdoor activities including tree planting and nature-based play in school environments, which increases students' outdoor engagement and physical activity. This demonstrates a clear benefit to physical health and is particularly significant for schools in urban areas where green space access may be limited.

The TfC *Childhood Obesity in Southwark* project adopted both a quantitative and qualitative approach to demonstrate the health benefits of redesigned playgrounds, with a strong emphasis on creating environments that encourage greater opportunities for physical activity through active play outdoors. By incorporating features such as trees, woodland shelters, and wildlife habitats, the project transformed traditional playgrounds into greener spaces becoming focal points for movement, addressing sedentary behaviours and childhood obesity risks. These redesigned spaces facilitated increased Moderate to Vigorous Physical Activity (MVPA), which was tracked using activity monitors and showcased notable gains among girls, who are typically less active in school settings. Similar programmes, like Sport England's Active Environments report 20-30% increases in MVPA through environmental design, supporting the replicability of TfC's model.

TfC's work in parks and estates has likely contributed to increased physical activity by creating and enhancing accessible green spaces. In the *Forgotten Places* project, the addition of trees and improved green spaces in underused areas created environments conducive to walking, running, and recreational activities.

Projects such as these promote physical movement and interaction with natural environments, which have been shown to reduce obesity risks, enhance cardiovascular health, and improve overall fitness at a higher rate than physical activity indoors or outdoors in nature-poor environments. Research demonstrates that access to green spaces correlates with reduced prevalence of conditions such as type-2 diabetes, hypertension, and obesity. Similarly, projects like the Green Gym initiative by The Conservation Volunteers (TCV) have shown measurable improvements in physical health by integrating physical activity with environmental conservation. Aside from their targeted *Childhood Obesity in Southwark* project, TfC have not consistently tracked physical health outcomes, relying instead on reference to relevant published research and benefits supported by qualitative evidence.

Mental Health and Emotional Wellbeing

The mental health benefits of being near trees and green infrastructure are well documented, with exposure to nature being linked to reduced stress, improved mood, and enhanced cognitive functioning. TfC contributes to this area through its focus on nature connectedness, using tools like the Nature Connectedness Index to track positive changes in participants' relationships with nature. While their surveys indicate improved nature connectedness, direct links to enhanced mental health outcomes remain inferred. Evidence suggests that a closer relationship with nature may play a role in the pathway linking nature exposure with improved health outcomes. This highlights the importance of incorporating nature connection into interventions as part of a broader picture in a health-focussed project.

Research demonstrates that time spent in natural environments reduces symptoms of anxiety and depression. Organisations such as the Mersey Forest and Forestry England provide measurable mental health improvements through nature-based interventions using standardised tools for mental health and wellbeing outcomes (e.g. Warwick-Edinburgh Mental Wellbeing Scale and ONS Personal Wellbeing Survey – further information is provided in Phase Three). TfC's work aligns with these findings, offering promising but currently under-quantified contributions to mental wellbeing. Integrating direct mental health metrics could strengthen their evidence base and impact.

While TfC does not use standardised tools to measure mental health and wellbeing outcomes, they collect a variety of qualitative data that highlights potential health benefits. For instance, surveys from students and teachers participating in the *Growing Among Trees* programme report improved mood and engagement during outdoor learning. Teachers also noted fewer behavioural issues and greater enthusiasm for learning in natural settings. The data aligns with broader research linking nature exposure in schools to reduced stress and improved emotional regulation in children.

In addition, this programme is a key example of how environmental education can successfully enhance pollution awareness and eco-conscious behaviours among children. Surveys and workshops revealed a 40% increase in children's understanding of pollution sources and mitigation strategies. Many children subsequently adopted active travel methods (e.g. walking or cycling to school) or chose

greener areas for play. While the outcomes measured weren't directly health related, the higher environmental literacy, conscious behaviour changes, and active green space use are associated with both physical and mental health benefits. These outcomes align with findings from the Eco-Schools Initiative, which highlights long-term behavioural changes stemming from outdoor activity and environmental responsibility improving overall wellbeing.

Similarly, TfC's *Forgotten Places* project highlights the engagement of over 20,000 participants in events such as community tree planting and tree identification training, offering opportunities for individuals to connect with nature and their communities. Feedback from participants indicated increased feelings of pride, community belonging, and reduced stress. Events like celebration days attracted diverse groups, including families and young people, fostering social connections and enjoyment of outdoor spaces. Their *Racecourse Estate* project also incorporated co-designed greening activities that encouraged residents to spend time outdoors. While there was limited direct evidence of improved mental health outcomes, increased nature connection scores among participants suggest benefits, as research supports that time in nature is associated with reduced anxiety and depression. Additionally, further evidence pointed to enhanced perceptions of safety and the aesthetic appeal of green spaces, which can indirectly support emotional wellbeing. These projects, through their focus on engagement, inclusivity, and co-design, align with broader evidence that access to and interaction with green spaces can contribute positively to mental health.

Ecosystem Services

TfC tree planting and green infrastructure projects provide ecosystem service benefits, including urban cooling, flood regulation, and biodiversity enhancement. These regulating and supporting services can indirectly support human health by reducing heat stress risks, particularly in vulnerable populations, and by promoting mental wellbeing through access to high-quality natural spaces. Research emphasises the importance of urban greenery in mitigating climate-related health risks. For example, their *Forgotten Places* project aimed to address identified issues such flooding and poor air quality in the target areas, contributing to better environmental conditions for residents.

While TfC's work does not currently measure these indirect benefits, existing evidence shows that urban cooling can reduce heat-related illnesses and that enhanced biodiversity in green spaces is likely to improve mental health and wellbeing. These connections, though underexplored in TfC's current approach, represent a potential area for further contribution. By integrating tools to monitor local environmental changes and pairing biodiversity assessments with mental health and wellbeing metrics, TfC could better demonstrate the health impacts of their projects, reinforcing the link between ecosystem services and improved health outcomes. However, the relationship between ecosystem services and health remains complex, influenced by confounding factors such as socio-economic disparities, access inequalities, and lifestyle differences. As such, expert support in designing robust monitoring frameworks is recommended to maximise the credibility and impact of their work.

Community and Health Equity Benefits

TfC engages communities through citizen science, co-design workshops, and tree-planting activities, ensuring sustained environmental benefits in urban spaces. For example, their work with Sunnyhill Primary involved engaging parents in air quality monitoring, fostering environmental stewardship and empowering neighbourhoods to advocate for local clean air initiatives. These efforts mirror successful community-based projects through Groundwork and Edible Cities Network, which emphasises sustained community involvement as key to urban greening success.

A prominent area of focus in their programmes is school engagement, where they target their work in under-served areas of high air pollution with limited access to green space. For example, in London boroughs like Southwark and Lambeth, where over 50% of students in intervention schools qualify for free meals, TfC provides vital green infrastructure and improves exposure and connection to these areas. This aligns with existing studies which highlight the role of equitable green space distribution in reducing urban health disparities.

Their Urban Forest programme prioritises socio-economically disadvantaged areas, including coastal towns through the *Forgotten Places* project and urban housing estates with limited green space access, such as the *Racecourse Estate*. These aimed to promote health and community equity by engaging under-served groups, including asylum seekers and people with disabilities. It was acknowledged that participants appreciated the enhanced aesthetics and functionality of these spaces, and co-designed greening efforts fostered community pride and engagement. Some residents reported greater respect for these green spaces, fostering community cohesion and a sense of ownership of these areas, which may have provided health benefits by improving social connectedness and reducing stress.

TfC's Urban Forest programme is likely to deliver some community health benefits by enhancing local green infrastructure and fostering social connectedness. However, they have not consistently measured how these projects and their associated environmental benefits translate into reduced health inequities. Broader evidence and complementary initiatives, such as the Tree Equity Score UK (American Forests, Woodland Trust, and CSH, 2024), highlight the importance of addressing disparities in urban tree cover to support improved health outcomes. The Tree Equity Score maps inequalities in tree canopy across the UK, revealing that under-served communities often have fewer trees and lower canopy cover, which limits access to health benefits like reduced heat stress, cleaner air, and improved mental wellbeing. Many of TfC's projects align with this thinking, recognising that improving access to high-quality green infrastructure in deprived areas is not only an environmental intervention but also a crucial step toward improving public health and social justice.

Strength of Evidence for Supporting Health Outcomes

While TfC's work has not directly measured many health outcomes, there is reasonable confidence that the long-term delivery of their projects with participants' sustained engagement contributes to improvements in physical, mental and community health. Their projects are likely to contribute to addressing key public health challenges such as obesity, type 2 diabetes, and depression by creating opportunities for physical activity, reducing sedentary behaviours, and fostering mental wellbeing through access to and interaction with green spaces. The projects have the potential to encourage healthier lifestyles and provide supportive environments that benefit health outcomes.

Evidence from the sector provides additional reinforcement for the likelihood of health impacts from TfC's work. Other organisations, such as the Mersey Forest, Forestry England and The Conservation Volunteers have successfully demonstrated health outcomes through similar nature-based interventions, including improved mental wellbeing and improved cardiovascular health. These examples indicate that TfC's projects are likely to deliver comparable health benefits, lending weight to the assumption that their work positively impacts health.

To strengthen their position within the sector and substantiate their outcomes for health, it is important for TfC to integrate more direct, regular and standard measurements of health into their projects. While inferred benefits are plausible and supported by existing research, the lack of robust, project-specific data limits their ability to confidently link interventions to health outcomes. Their projects provide compelling short-term data on environmental improvements, such as air pollutant reduction. The demonstration of their health impacts could be significantly strengthened with the introduction of long-term studies that track participants' health over time. Implementing comprehensive health assessments, such as respiratory health checks and mood and physical activity tracking, would provide robust evidence linking interventions to health outcomes. Long-term tracking could also help TfC understand the sustained impacts of their work on community health and confirm sustained behavioural shifts, such as continued use of active travel or lifelong environmental stewardship, further demonstrating the value of their work. Through these efforts, TfC can better align their projects more closely with public health priorities, enhancing their credibility and positioning them as leaders in delivering health-focused urban greening initiatives.

Key Stakeholder Interviews - Thematic Analysis of Measuring Health Outcomes

There are several recurring themes and insights into how stakeholders approach monitoring and evaluating health outcomes from tree and wider green infrastructure projects. Key considerations include the challenges of consistent measurement, the role of mixed methods, the importance of population-specific data, and the broader socio-economic and environmental contexts in which health outcomes are assessed. Below is a thematic analysis referencing specific stakeholders.

Challenges of Measuring Health Outcomes

Forestry England

Forestry England covered aspects of their Active Forests programme, which focuses on using their woodlands for improving health outcomes for the communities they serve. They described the challenges of using tools like the Warwick-Edinburgh Mental Wellbeing Scale (WEMWBS) questionnaires in practice, where the outdoor conditions may not be appropriate, and it may be emotionally triggering for some participants. They shifted towards a simpler system of ONS wellbeing surveys and qualitative case studies to reduce administrative burden. They cautioned against creating overly long surveys, particularly in outdoor settings suggesting that simpler tools will likely lead to more consistent data collection and make it more practical to implement.

Forest Research

Forest Research emphasised the difficulty of linking trees to direct health outcomes due to confounding factors like socio-economic variables and lifestyle choices. They highlighted the importance of considering the maturity of trees in delivering health benefits and noted that monitoring tree survival and growth is often overlooked but critical for assessing long-term outcomes, as many health benefits depend on trees reaching maturity and contributing to canopy cover. They suggested that evaluations should include ecological metrics, such as canopy growth and biodiversity indices, to provide a more comprehensive understanding of the ecosystem services underpinning health benefits.

Mixed Methods Approaches

Mersey Forest

Mersey Forest has implemented a robust mixed-methods approach, combining Short WEMWBS, the International Physical Activity Questionnaire and qualitative case studies. This approach allows them to measure both quantitative changes and the nuanced impacts on participants, such as how connected they feel to nature or their enjoyment of specific programmes. This model demonstrates the value of integrating both statistical and qualitative data to provide a comprehensive evaluation of health outcomes.

Natural England

Natural England also advocated for mixed methods to balance quantitative metrics with qualitative insights. They emphasised the importance of tailoring evaluation tools to the project's scale and

objectives, suggesting that data collection should adapt to the complexity of health outcomes expected from green infrastructure interventions. They highlighted green social prescribing projects as a practical example, where metrics like the Social Return on Investment are used alongside personal testimonials to evaluate the wider benefits of green infrastructure.

Focusing on Population-Specific Benefits

Forestry England

They highlighted the need for urban greening projects, such as TfC's initiatives, to identify and serve populations who may lack access to nature. For example, ensuring projects target under-served groups, such as socio-economically disadvantaged communities, would enhance equity and make outcomes more relevant to public health priorities.

Mersey Forest

Their work integrates with primary and secondary healthcare networks to deliver nature-based interventions tailored to local populations, such as mindfulness and outdoor counselling programmes. This integration ensures that their work aligns with local health system priorities (where they source some of their funding), providing a replicable model that TfC could emulate to deepen health equity outcomes.

Ecosystem Services and Indirect Health Benefits

Forest Research

The difficulty of linking ecosystem services directly to health outcomes was a recurring theme. While benefits like urban cooling and biodiversity enhancement are well-documented, Forest Research noted that health impacts often rely on assumptions. This highlights the importance of ecological data such as species diversity, canopy cover, and carbon sequestration in complementing health evaluations to demonstrate broader environmental contributions to community health and wellbeing. They mentioned iTree as a potential tool to quantify the benefits of trees, focusing on their ecosystem services and linking this where appropriate to the monitoring and evaluation of health outcomes.

The Woodland Trust

Highlighted tools like BIO-WELL, which links ecological quality to wellbeing benefits as promising for bridging the gap between environmental improvements and health outcomes.

Building a Scalable Evaluation Framework

The Woodland Trust

The Woodland Trust emphasised the importance of developing standardised frameworks, such as a monitoring, evaluation, and learning (MEL) system, to track social and health outcomes consistently.

Forestry England

They recommended a "pick and mix" evaluation approach, where projects choose from a set of established metrics tailored to their specific goals. This would allow TfC to align their evaluations with

both public health standards and ecological benchmarks, creating a versatile and scalable evaluation framework.

Natural England

Advocated for using parts of their new standardised evaluation framework to guide practitioners in measuring health outcomes through outdoor interventions more effectively. This would allow comparability across projects and enhance the credibility of findings.

Communicating Health Impacts

Mersey Forest

Mersey Forest emphasised the value of consistent data collection over time, stating that their ability to present a comprehensive dataset since 2015 has strengthened their credibility.

Natural England

They highlighted the need to align reporting with health system priorities, such as integrating metrics like WEMWBS or social return on investment (SROI) calculations to communicate the economic and social value of urban greening projects. This alignment would help TfC engage funders and policymakers more effectively.

Confidence in Communicating Impact to Stakeholders

General Public

TfC has a strong platform to engage and inspire the general public through urban greening initiatives. Their measurable achievements in improving air quality and promoting physical activity are relatable and impactful, supported by compelling stories and visually engaging case studies, such as their retrofit green interventions in schools. These examples effectively demonstrate health benefits, such as reduced pollution exposure and increased opportunities for physical activity, which resonate with community audiences. However, a lack of longitudinal evidence, a challenge common in the sector, limits the depth and strength of their messaging. To build greater confidence and credibility, TfC could collaborate with research institutions to integrate follow-up studies that track sustained health outcomes over time. This would provide a more compelling narrative, reinforcing the public's trust in the long-term value of urban forests.

Key Stakeholders in Health and Environment

TfC's work supports key public health objectives, including reducing childhood obesity, addressing respiratory health risks, and prevention. Additionally, it contributes to environmental priorities such as climate adaptation, urban cooling, and biodiversity enhancement. Policymakers and health practitioners increasingly demand evidence-based interventions, making TfC's existing datasets on air quality improvements and physical activity valuable assets. Strengthening these data with specific health outcomes would further enhance their credibility. Highlighting alignment with broader successful programmes, such as Sport England's *Active Environments*, can reinforce the scalability and effectiveness of their interventions. Partnerships with local health services and public health bodies could provide additional support, integrating their work into larger health and environmental strategies.

Funders

Funders value organisations that deliver measurable results, and TfC is well positioned to highlight meaningful impacts across their projects. Demonstrating alignment with health equity goals, such as prioritising under-served communities with limited green space access highlights a strategic approach that resonates with funders. Additionally, showcasing a commitment to investing in environmental and health outcomes reinforces the long-term value of their initiatives, further enhancing their appeal. Independent evaluations, such as those conducted by The Social Innovation Partnership for the *Childhood Obesity in Southwark* project, offer impartial validation and strengthen the credibility of their work.

Phase Two - Literature Review

1.1 Introduction

There is a myriad of evidence pointing to the health and wellbeing benefits of green space. We have scanned the literature and the health outcomes of tree planting projects and green space. This literature review is divided into 3 parts: physical health, mental health and green space design and health. For this literature review we refer to mental health as a positive state of mind and body, feeling safe and able to cope, with a sense of connection with people, communities, and the wider environment as defined by NHS England. Physical health refers to the state of the body, and includes whether you have an illness, injury, or a health condition. We recognise that health is not binary, and physical and mental health are interdependent aspects of human health.

Access to green space has incredible capacity to narrow health inequalities. A cross-sectional study of 66 European Cities found that more equal distribution of land cover / land use is associated with lower levels of socio-economic inequality, supporting the idea that city environments could be equigenic – that is, could create more equality (Olsen *et al.* 2019).

"If societies cannot, or will not, narrow socioeconomic inequality, research should explore the equigenic environments—those that can disrupt the usual conversion of socioeconomic inequality to health inequality" (Mitchell *et al.* 2015).

The equigenic value of green space is even more apparent as climate change begins to exacerbate extreme weather events, effecting our natural systems considerably. Green spaces and trees can help mediate extreme weather events and could be a tool for community resilience in the face of future shocks. Extreme weather will impact health in direct and indirect ways:

- Direct impact will be felt though extreme heat waves, rising sea level, changes in precipitation resulting in flooding and droughts, and intense hurricanes can directly cause injury, illness, and death. (National Institute of Environmental Health Sciences. 2022).
- The indirect ways in which health will be affected and through factors such as worsening air pollution levels, changes in temperature and rainfall (which can alter the survival, distribution of insects and other species that can lead to changes in infectious diseases). Increases in precipitation, storm surge, and sea temperature can lead to more water-related illnesses. Climate change can also affect food safety, exposing people to contaminated foods that can result in foodborne illnesses. In addition, climate change can affect mental health and wellbeing (National Institute of Environmental Health Sciences. 2022). Food security will also be impacted as we experience extreme weather events globally.

In a changing climate, urban areas are particularly vulnerable to extreme weather. Those already vulnerable such as the very young or old, those physically or mentally ill and others will be more at risk to ill health caused by these shocks. Urban green spaces will provide ecosystem services which support human health against the immediate shocks (i.e. cooling zones) as well as ecosystem services which support the wider landscape and make it more resilient (i.e. through slowing down storm water

flow which could create flash flooding). Resilience to these future shocks must be at the forefront of urban green design.

1.2 The State of Health Today

Within this literature review we have sought to define the current state of health in the UK and its burden on the NHS. This is to provide TfC with the most up to date health information to help influence and contextualise future projects to do with green space and health.

The Darzi Report found that at the start of 2024, 2.8m people were economically inactive due to long-term sickness. That is an 800,000 increase on pre-pandemic levels with most of the rise accounted for by mental health conditions. To remedy the nation's health, (amongst other recommendations), the Darzi report strongly states importance prevention and upstream intervention and emphasises care that is delivered in the community (Darzi, 2024).

1.3 Categorising the Literature

Type of Source	Description
Primary	Studies, Journal articles
Secondary	Reviews
Tertiary evidence	Policy and guidance

We have attempted to categorise research within the Literature review into the type of research it is primary (individual studies), secondary (reviews) or tertiary evidence (policy and guidance).

This is to communicate the reliability of the evidence base, (not that there is a lot of primary research). Our literature review also indicates areas where further research is necessary and where there are potential research fields. This can steer TfC towards research fields where research partners and universities may be needed.

2.1 Physical Health

Reference	Title	Type of Research
Alcock *et al.* 2017	Land Cover and Air Pollution Are Associated with Asthma Hospitalisations: A Cross-Sectional Study	Secondary
Andersen *et al.* 2021	Nature Exposure and Its Effects on Immune System Functioning: A Systematic Review	Secondary
Bonell *et al.* 2024	Effect of Heat Stress in the First 1000 Days of Life on Fetal and Infant Growth: A Secondary Analysis of the ENID Randomised Controlled Trial	Secondary
García de Jalón *et al.* 2021	The Influence of Urban Greenspaces on People's Physical Activity: A Population-Based Study in Spain.	Secondary
Hartig *et al.* 2003	Tracking Restoration in Natural and Urban Field Settings	Primary
Hunter *et al.* 2015	The Impact of Interventions to Promote Physical Activity in Urban Green Space: A Systematic Review and Recommendations for Future Research	Secondary
Juul and Nordbø. 2023	Examining Activity-Friendly Neighbourhoods in the Norwegian Context: Green Space and Walkability in Relation to Physical Activity and the Moderating Role of Perceived Safety	Secondary
Stanhope *et al.* 2020	Exposure to Greenspaces Could Reduce the High Global Burden of Pain	Primary
Taylor *et al.* 2015	Research Note: Urban Street Tree Density and Antidepressant Prescription Rates—a Cross-Sectional Study in London, UK	Secondary
Amion Consulting. 2022	Mersey Forest Report: Valuing the Natural Health Service	Primary
NEF Consulting and TCV. 2015	TCV's Impact: Organisational Social Return on Investment summary findings. Report online	Primary

2.2 Current Healthcare Burden on the NHS

The NHS is increasingly burdened by the prevalence of physical diseases such as cardiovascular disease (CVD), obesity, and respiratory conditions. CVD remains the leading cause of premature mortality, accounting for approximately 25% of deaths annually in the UK, with its associated costs creating significant economic strain (NHS Confederation, 2024). Obesity now affects nearly 30% of the adult population, contributing to a rise in related conditions, including diabetes and heart disease, and significantly impacting NHS resources (Darzi Review, 2024). Respiratory diseases, such as chronic obstructive pulmonary disease (COPD) and asthma, cost the NHS over £11 billion annually, highlighting their substantial health and economic burden (BMJ, 2024). Approximately 30% of preventable deaths in England are due to non-communicable diseases specifically connected to air pollution (NHS England, 2024).

The 2024 Darzi Report emphasises systemic challenges, including underfunded preventative measures and insufficient community care investment. For instance, hospital expenditure has risen from 47% to 58% of the NHS budget since 2006, with limited funds allocated for upstream interventions such as obesity management and smoking cessation. This imbalance exacerbates limits efforts to reduce chronic disease prevalence (Darzi, 2024). Moreover, 2.8 million working age adults are now economically inactive due to long-term illnesses, reflecting broader societal and economic consequences (Darzi 2024; BMJ, 2024). Addressing these challenges requires strategic reform to prioritise prevention.

Of course, beyond the primary impact of ill-health on the individual, we are not just concerned with the financial resource use but also with the social and environmental effects of this high burden of disease. We can think of these multiple impacts in terms of what is sometimes called the “triple bottom line” as part of the Sustainable Value Equation (Mortimer *et al.* 2018). This helps us to see the value that health benefits from green space can bring in the complex interaction of people and their environments.

$$\text{Value} = \frac{\text{Outcomes for patients and populations}}{\text{Environmental + social + financial impacts (the 'triple bottom line')}}$$

So, for example, a mental health inpatient who reduces their medication because of their work outdoors to plant trees and look after a garden at their hospital not only improves their health directly but also contributes to a healthier environment for all by increasing biodiversity and by reducing the carbon emissions that would have been used in producing their medicines. In addition, they have less of a social burden on their family and more of a positive social impact on staff and visitors at the hospital who also benefit from the green space project.

2.3 Research on Physical Health and Green Space

Physical inactivity is a major public health concern, with implications for health, society and economy. Green space can support physical health by providing a space in which people can participate in physical activity. There are links between greater availability of green space and decreased sedentary time and increased walking (García de Jalón *et al.* 2021). The public health dividend of increasing physical health in the population is substantial. Urban green space has the potential to contribute significantly to public health as a setting that encourages participation in physical activity (Hunter *et al.* 2015).

However, multiple sources emphasise that green spaces in themselves are necessary but not sufficient and other and interventions need to be made to make sure that the greenspace is welcoming, accessible, and safe. For example, perceived neighbourhood safety was significantly related to increased levels of physical activity (Juul and Nordbø, 2023). Also, Stangierska *et al.* emphasises the need for information and promotion of outdoor activities as part of preventive health (2023). The Centre for Sustainable Healthcare's guide to Green Walking in Mental Health Recovery sets out clearly the theory and health benefits of green walks and how to set one up (Krzanowski *et al.* 2020). They also have a plethora of case studies of green health routes on their website (NHS Forest, 2020). Another example of organised walking groups is the Mersey Forest's Natural Health Service proposes Healthy Walks, a programme of expert led walking activities in nature tailored to individual needs and designed to help meet target exercise and physical activity levels. Organised group walking activities stimulate increased physical activity, enhance interactions, reduce social isolation, and increase motivation levels (Amion Consulting, 2022). TfC would be well placed to organise similar events in urban green environments, supporting people to feel confident, improving physical and mental health and creating opportunities for people to meet others from their neighbourhood and combat loneliness too.

Although installing walking routes, green gyms, cycling paths / groups and nature trails are important, for impact on physical inactivity, (i.e having targeted benefits to obesity and type 2 diabetes levels), efforts need to be made which are more than simply developing green infrastructure, but support people in using the space. TfC's work should explore the various programmes and strategies which encourage the use of urban green space and promotes physical activity, these programmes should work with specific patient groups who have high levels of physical inactivity or demographics who feel less safe / comfortable using green space for activities. One way Mersey Forest are supporting people to use urban green spaces is through Green Gym, a programme which TfC could draw inspiration from. They include conservation work in an outdoor setting which also encourages engaged use of the body and muscles and therefore provides a workout session. These sessions promote participation in practical tasks to improve the environment (Amion Consulting, 2022). Green Gyms are trademarked by The Conservation Volunteers and they run over 50 across the UK, they claim Green Gyms enable people to improve their health and fitness by taking part in practical conservation activities. They are sited in areas of urban and rural deprivation where there are open or green spaces that need to be improved, including parks, school grounds, woodland, allotments

and derelict land. TCV's 2016 report suggests that Green Gyms had significant financial benefits, where between 2013-2014 they found a 1:4 return on investment. The report also finds that increasing the physical health of volunteers by an average of 33% was worth £2.6 million and reducing social isolation was worth more than £700,000 and increasing wellbeing amounted to £400,000 (Nef Consulting and TCV, 2015). For more information on the cost saving benefits on social prescription see the National Academy for Social Prescribing's cost savings reports (2024).

Apart from increase in physical activity, there are physical health benefits to green space which are made through the restorative benefits green space and trees provide. These include a reduction of inflammation, pain and stress. Exposure to green spaces could reduce the high global burden of pain. Stanhope describes established or potential links between exposure to environmental microbiomes, phytoncides, negative air ions, natural sights and sounds etc. and pain outcomes. There is research that green spaces improve pain outcomes, but more research needs to be understood around which elements of green space have the most influence on pain outcomes (e.g phytoncides, microbiome) (Stanhope *et al.* 2020). The reduction of pain may in part be connected to inhaling certain volatile natural compounds that can have a beneficial effect on the elicited immune response for both healthy participants and those with acute or chronic inflammatory conditions. The synthesis of reviewed studies points to positive effects of nature exposure on immunological health parameters, such as anti-inflammatory, anti-allergic, anti-asthmatic effects or increased NK (natural killer) cell activity. (Andersen *et al.* 2021).

Further research needs to be done to understand the effect size, duration of exposure and contributions of specific vegetation or ecosystem types. But we can infer that creating recovery places i.e., locations that are sensorily calming and produce volatile organic chemicals and support physical health benefits. More will be covered on green space design in section 4.2. These zones are important for resilience, recovery, and prevention.

TfC could consider working in care homes / rehabilitation centres, improving their green space and supporting nature-based interventions in these locations. Elderly people often have more pain, prescriptions, inflammation related illnesses, and reduced mobility may improve their symptoms and reduce medications in a green space context. One study in Australia found that increasing urban tree canopy cover may help to reduce the risk of dementia, though more research is needed (Astell-Burt *et al*. 2020).

A cross-sectional study Alcock *et al.* looked at how asthma hospitalisations varied dependent on green space. Their results pointed to the fact that green space and gardens were associated with reductions in asthma hospitalisation when pollutant exposures were lower but had no significant association when pollutant exposures were higher. In contrast, tree density was associated with reduced asthma hospitalisation when pollutant exposures were higher but had no significant association when pollutant exposures were lower. (Alcock *et al*. 2017). These findings point to the fact that green space

in itself does not necessarily reduce asthma hospitalisation, but the green space coupled with densely planted of trees and hedges do contribute to less asthma hospitalisation.

Heat stress and pregnancy can impact children's development. At least one study suggests that increasing heat stress is associated with both intrauterine growth restriction and growth faltering postnatally up to 2 years of age. (Bonell *et al.* 2024). Prolonged heat stress, which is likely to become more of a problem going forward, means that green space may become increasingly important in order to create cool zones in public spaces for pregnant people. Creating cool zones in public spaces is important for many intersections of society, but particularly for those who take medications (such as antipsychotics) which have contraindications in hot weather.

2.4 Where Further Research is Needed

Given the Darzi report and the current emphasis from the NHS on prevention, there is huge capacity for TfC work to support health upstream.

- Chose sites with most potential for impact
- Measure biomarkers of specific patient groups when doing nature-based interventions
- Working with specific patient groups

3.1 Mental Health

Reference	Title	Type of Research
Astell-Burt *et al.* 2022	Green space and loneliness: A systematic review with theoretical and methodological guidance for future research	Secondary
Blaschke, S. 2017	The role of nature in cancer patients' lives: a systematic review and qualitative meta-synthesis.	Secondary
Frumkin *et al.* 2017	Nature Contact and Human Health: A Research Agenda. Environmental Health Perspectives	Secondary
Gascon *et al.* 2015	Mental Health Benefits of Long-Term Exposure to Residential Green and Blue Spaces.	Secondary
Houlden *et al.* 2018	The relationship between greenspace and the mental wellbeing of adults	Secondary
Li and Sullivan. 2016	Impact of views to school landscapes on recovery from stress and mental fatigue.	Primary
Maa *et al.* 2009	Morbidity is related to a green living environment	Primary
McCormick. 2017	Does Access to Green Space Impact the Mental Well-being of Children	Primary
McEachan *et al.* 2015	The association between green space and depressive symptoms in pregnant women: moderating roles of socioeconomic status and physical activity	Primary
Park *et al.* 2009	The physiological effects of Shinrin-yoku (taking in the forest atmosphere or forest bathing): evidence from field experiments in 24 forests across Japan	Primary
Pihkala P, 2020	Eco-Anxiety and Environmental Education	Primary
Pocock *et al.* 2023	The benefits of citizen science and nature-noticing activities for well-being, nature connectedness and pro-nature conservation behaviours.	Primary
Sarkar *et al.* 2018	Residential greenness and prevalence of major depressive disorders: a cross-sectional, observational, associational study of 94 879 adult UK Biobank participants	Secondary
Schutte *et al.* 2016	Impact of Urban Nature on Executive Functioning in Early and Middle Childhood.	Primary

Vanaken and Danckaerts. 2018	Impact of Green Space Exposure on Children's and Adolescents' Mental Health	Secondary
White *et al.* 2020	Nature contact, Nature Connectedness and Associations with health, Wellbeing and pro-environmental Behaviours	Primary

3.2 Adult Mental Health - Current Burden on the NHS

By April 2024, about 1 million people were waiting for mental health services (Darzi 2024). The burden that is facing the mental health system is well evidenced and services all over the country are struggling. Despite this, there is an unequal distribution of resources between mental health and physical health. Mental health accounts for more than 20 per cent of the disease burden, but less than 10 per cent of NHS expenditure (Darzi 2024).

Cardoso and Mchayle estimate total cost of mental ill health in England in 2022 was £300 billion. This cost is broken down into human costs, economic costs, health and care costs.

- Economic costs of £110bn: Losses to the economy due to mental ill health. These include the business costs of sickness absence and 'presenteeism' at work, as well as staff turnover and unemployment among people with mental ill health (Cardoso and Mchayle 2024). The Darzi report argues that being in work is good for wellbeing and having more people in work grows the economy and creates more tax receipts to fund public services. There is therefore a virtuous circle if the NHS can help more people back into work. (Darzi 2024).

- Human costs of £130bn: The value, expressed in monetary terms, of reduced quality of life and premature mortality among people living with mental health difficulties (Cardoso and Mchayle 2024). The Dazi report found that people living with serious mental illnesses have significantly lower life expectancy than the rest of the population, typically dying 15 to 20 years earlier (Darzi 2024)

- Health and care costs of £60bn: This includes support provided by public services and informal care provided by family and friends (Cardoso and Mchayle 2024).

Despite the bleak state of mental health support across the board, there are intersections which are even more affected than others. In terms of age, mental health has been worse for two main age groups: 16 to 34 year olds and 50 to 64 year olds (Darzi 2024). Within the intersection of race there are also disparities, such as more white people receive treatment for mental health issues than people from Black, Asian and Minority Ethnic backgrounds (BAME) and they have better outcomes post treatment (Mental health UK, 2024). Rates of severe mental illness are higher among racialised communities in the UK. For those community's experiences of mental health treatment often add to

experiences of racism instead of mitigating them. (Mind, 2024). Other important statistics show that compared to white people:

- Black women are more likely to experience a common mental illness such as anxiety disorder or depression.
- Older South Asian women are part of an at-risk group for suicide.
- Black men are more likely to experience psychosis.
- Black people are 3.5 times more likely to be detained under the Mental Health Act. (Mental health UK, 2024)
- Refugees and asylum seekers are more likely to experience mental health problems than the general population, including higher rates of depression, anxiety, and PTSD. (Mental Health Foundation, 2021)

The Mental Health Foundation notes that despite the statistics, the true extent of mental health problems among BAME groups is not reflected, due to less data available, being less likely to report mental health problems as well as a lack of culturally sensitive treatment.

In summary, the pressure on mental health services is extraordinary and the health system is overwhelmed and the need for increased and adequate spending within the mental health sector is overdue. There are severe personal, familial, and economic disbenefits from mental ill health and certain age brackets, as well as BAME groups, have some of the severest health outcomes.

3.3 Adult Mental Health and Green Space

Two prominent theories about how nature produces positive responses for us are Ulrich's Stress Reduction Theory (1981) and the Kaplans' Attention Restoration Theory (1989). Attention Restoration Theory is about people being able to improve concentration and reduce mental fatigue by looking at natural scenes and spending time in nature. This is backed up by a myriad of studies such as the Berman *et al.* study which found that getting outside is good for your mind with simple and brief interactions in nature producing marked increases in cognitive control (2008). Evidently the natural environment is an important setting for humans to 'reset'.

Green space leads to stress recovery and directed attention restoration. Although stress does have some beneficial effects, the harmful effects of stress can play a role in various pathological conditions and diseases. Stress can negatively affect brain function, memory problems, cognition and learning, immune system functions, the endocrine system and the cardiovascular system. Based on the type, timing and severity of the applied stimulus, stress can exert various actions on the body ranging from alterations in homeostasis to life-threatening effects and death (Yaribeygi *et al.* 2017). Being unable to recover from stress can lead to the psychophysiological pathway linking stress and cardiovascular disease (Hartig *et al.* 2003). Hartig *et al. (2003)* compared psychophysiological stress recovery and directed attention restoration in urban and natural settings. They found that, on average, anger and aggressiveness declined in the natural environment but increased in the urban environment. They concluded that setting can either hinder or support restoration and for urban populations in

particular, easy pedestrian and visual access to natural settings can produce preventive and therapeutic benefits.

Forest bathing (Shinrin-Yoku) is a practice that is used to focus on mindful engagement with nature through slow walking, deep breathing, and sensory awareness, which has been shown to support physical and mental wellbeing. Salivary cortisol, blood pressure, pulse rate, and heart rate variability were used as indices. In a study by Park *et al.* (2009), the results show that forest environments promote lower concentrations of cortisol, lower pulse rate, lower blood pressure, greater parasympathetic nerve activity, and lower sympathetic nerve activity compared to urban environments. Therefore, forest bathing and, by extension and inference, other types of interaction with trees, have positive physical health outcomes by ameliorating several of the major factors that contribute to ill health including stress.

One particularly vulnerable population is that of mental health inpatients who are in a hospital setting because of the severity of their illness and would benefit hugely from being in nature but often have highly restricted access to outdoor space including green spaces. The Centre for Sustainable Healthcare has created a programme of walking in green space for these patients and has piloted this with very positive results. However, the intervention would benefit from more rigorous evaluation and wider spread (Green Walking in Mental Health Recovery, CSH, 2020).

Nature supports cancer patients with navigating the clinical and personal consequences of the disease. Nature provides patients with unburdened physical space invested with personal significance as found by a systematic review into the role of nature in cancer patient's lives. Based on this strong evidence base, it is worth considering working with this specific patient group and partnering with cancer charities.

Green space is good for all humans no matter their mental health (but a lower baseline of mental health is most impacted by positive green space interactions). Access to green space is fundamental of mental health, as shown by research whereby there was an analysis of the geographic variation in association with local green space and mental wellbeing. The model used revealed that an increase in 1 ha of greenspace within 300m of residents was associated with a statistically significant increase in life satisfaction, worth and happiness (Houlden *et al.* 2018). These findings provide some support for the inclusion of greenspace within 300m of homes for both hedonic and eudemonic wellbeing.

More equal distribution of land cover / land use will have significant equigenic value:

- Green space is even better for those with multiple indices of deprivation. Green space especially important for health outcomes for people of lower socio-economic groups, who had the poorest disease outcomes with less access to green space (Maas *et al.* 2009).
- Primary analysis of Dutch data found an association between greater amounts of green space in the living environment and reduced rates of suicide (Helbich *et al.* 2018).
- A systematic review found that contact with nature and provision of green space as potential person-focussed and place-based interventions for reducing loneliness (Astell-Burt *et al.* 2022).

- Access to green space has strong effects on pregnant women in the greener quintiles, who were 18-23% less likely to report depressive symptoms than those in the least green quintile (McEachan, 2015).

Access to green space is vital, but to have an even deeper value, access must be coupled with supporting people to engage with their natural environment. The evidence points to the intentional use of green space having even greater enhanced health benefits. For example, studies find that engaging in citizen science significantly benefits wellbeing and nature connectedness of participants, and pro-nature conservation behaviours (Pocock *et al.* 2023).

3.4 How Trees for Cities Could Engage with this Research

Considering Houlden *et al.* findings, spatial analysis should be done to consider relative access to green space, when choosing project locations. By collaborating with partners who have urban green space (i.e. churches, councils, the NHS), it will help make more green space publicly accessible.

There are also opportunities surrounding eco-anxiety and interaction with trees / green space. Although we know that, even without experiencing the direct or indirect effects of climate change, many feel distress simply by being aware of the global environmental crisis (Pihkala, 2018).

TfC should focus interventions which are intersectional, inclusive and provide targeted activities which are for particular demographics and culturally sensitive.

3.5 State of Mental Health in Children in the UK

The state of mental health in children is getting worse year on year. The Good Childhood report from 2024 shows that, since its records started, children's happiness with their life, friends, appearance, school, and schoolwork (rated in 2021/22) is at an all-time low. 11% of the children and young people who completed the 2024 survey said they had low wellbeing. (The Children's Society, 2024).

There is an increasing need for mental health support for children and young people with about 1 in 5 children and young people aged 8 to 25 years having a probable mental health disorder in 2023. (NHS England, 2023). The waiting lists for support are at record levels with 343,000 referrals for children and young people under the age of 18 waiting for mental health services, including around 109,000 referrals waiting for more than a year. For any person, a year wait is far too long, but for young people who are going through profound life changes, this is particularly concerning. (Darzi, 2024). 35% of children and young people referred to specialist NHS children's mental health teams had their referrals closed before they received treatment as their conditions were seen as not severe enough or inappropriate for treatment, (Pro Bono Economics 2020). This could indicate that many more children would benefit from support who are not meeting the 'severest' criteria.

There is a huge cost of untreated mental health issues. It is estimated that children and young people on mental health waiting lists are expected to cost public services an estimated £75m per year (Pro Bono Economics 2020).

All age groups are affected by mental health, but rates seem highest in 17 to 19 year olds. In 2023, 20.3% of 8 to 16 year olds, 23.3% of 17 to 19 year olds and 21.7% of 20 to 25 year olds were affected. Amongst 8 to 16 year olds, rates of probable mental disorder were similar for boys and girls, while for 17 to 25 year olds, rates were twice as high for young women than young men. (NHS England, 2023).

It is highly preferable to introduce early interventions which prevent conditions. The cost of these prevention programmes is also very low compared to the cost of treating problems once they develop. The Children's commissioner report in 2017 highlights the cost for delivering an emotional resilience programme in school was £5.08 per student compared to the average cost of admission to an in-patient CAMHS unit, for which the average cost is £61,000 (Children's Commissioner. 2017).

The immediate cost of treating poor childhood mental health is high, but the long-term impacts are considerable and shown to have economic knock-on effects. The long-term impact of this is estimated to be costing the UK a total of £550 billion in lost earnings based on comparable earnings of those who have not had poor childhood mental health (Bradshaw and Budge. 2015).

The cost of early intervention has been demonstrated to pay out in the long run with the Department of Health estimating that a targeted therapeutic intervention delivered in a school cost about £229, but derives an average lifetime benefit of £7,252. This is cost benefit ratio of 32-1 (Children's Commissioner. 2017).

Pertinent to TfC is research which shows just over half (54.8%) of young people aged 17 to 25 years reported being worried about the impact of climate change. (NHS England. 2023). In 2022, a survey found that 70% of participants are worried about the world they will inherit (Save the Children. 2022).

3.6 Mental Health in Children and Green Space

Given the current state of children and young people's mental health and the clear benefit early intervention plays in children's mental health, it is important to investigate the role of green space in these interventions. Tree planting has emerged as a practical and psychological approach to addressing eco-anxiety, the distress linked to environmental concerns such as climate change. Participation in tree planting provides individuals with a sense of empowerment, offering tangible and meaningful action in response to ecological issues. Frumkin *et al.* .2017) found that activities aimed at restoring the environment, including urban tree planting, can improve mental health outcomes by fostering a sense of accomplishment and reducing stress through direct engagement with nature. This field would benefit from further research between the direct connection between tree planting and mental health and ecoanxiety relief in both children and adults.

Two key systematic reviews looked at children ages 0-18 years and found that access to green space was associated with improved mental wellbeing and overall health and cognitive development of children. In one study, it is shown to promote attention restoration, memory, competence, supportive social groups, self-discipline, moderates stress, to improve behaviours and symptoms of ADHD and was associated with higher standardised test scores (McCormick 2017). Another study found significant evidence for an inverse relationship between green space exposure and emotional and

behavioural problems in children and adolescents such as hyperactivity and inattention problems (Vanaken, G.-J and Danckaerts, M. 2018).

There is strong evidence that having green space within 1km radius of residential areas is essential for some disease incidence (notably anxiety and depression in children). One study looked at morbidity data derived from electronic medical records of a cross generational population of 345,143 people. The researchers looked at the prevalence of a number of disease clusters and how it is related to the amount of green space in people's living environment. They found that the annual prevalence rates for 15 of the 24 investigated disease clusters is lower in living environments with more green space in a 1 km radius, showing that having green space within 1km radius of residential areas was highly correlated for these disease outcomes. This relation is apparent for diseases in all seven disease categories. It is strongest for anxiety disorders and depression. They found that for children (less than 12 years) the strongest relationship was found for depression. (Maas *et al.* 2009).

A view onto green space supports attention restoration, which supports an argument for better school design. In a study across 5 high schools in central Illinois, the high school students were assigned either a classroom with no window, a barren window and a green window. The results found that window views to green landscapes promote high school students' attention restoration as well as speed up their recovery from stress (Li and Sullivan. 2016).

Not only does a view of green space support attention restoration but interaction with green space through nature walks has been proved to support executive functioning. One study looked at 34 seven to eight year-olds and 33 four to five year-olds and studied the restorative effects of nature on these children's executive functioning. It found that both groups performed faster on attention tasks after nature walk compared to an urban walk. The school age children performed significantly better on attention tasks than preschoolers after a nature walk and preschoolers had more stable spatial working memory (Schutte *et al.* 2016). Integrating nature walks into the school day will support cognition and attention restoration.

3.7 Where Further Research is Needed

The Vanaken and Danckaerts 2018 systematic review looked across 21 studies at the impact of green space exposure on children's and adolescents' mental health and found significantly less research is available for emotional and behavioural difficulties in adolescents. (Vanaken and Danckaerts. 2018). Given that NHS England found mental health rates highest in 17-19 year olds (23.3%), more research is needed on adolescents and TfC should design work which engages with this age bracket.

There is a research gap around the amount of time spent in green space for children in relation to their attention restoration. Vanaken and Danchaerts suggest determining an optimal amount of time for children to be spending in green spaces (2018) and it may be worth TfC partnering with academic institutions to explore this. Examining specific biomarkers in children in relation to time spent in green space (McCormick, R. 2017) could also be an area for future research. Ideally, studies would be stratified by social class, education, age, and gender, as they possibly could modify the beneficial

health effects of green spaces (Gascon et al. 2015), but resources often preclude this and we need to work with researchers to find practical ways to do this.

A 2022 scoping review highlighted the presence of eco-anxiety in children and youth. However, none of the included articles had child-specific measures of this concept, suggesting that future research should further investigate the eco-anxiety phenomenon from a child-specific perspective (Léger-Goodes *et al.* 2022). The extent to which engaging with positive activities in green space can support children and their anxieties about the climate is under researched and TfC would be well placed to do this.

Interventions which improve cognition and attention restoration at schools could include landscape design around schools which optimises views of trees from the classrooms, along with training teachers to integrate nature walks into the school day to support cognition and attention restoration.

4.1 Design Recommendations for Green Spaces Based on Literature

This section covers some of the literature surrounding the design of green space and how that can be optimal for supporting human health. The main resources cited are as follows:

Reference	Title
Antonelli *et al.* 2020	Forest Volatile Organic Compounds and Their Effects on Human Health: A State-of-The-Art Review
Barwise and Kumar. 2020	Designing Vegetation Barriers for Urban Air Pollution Abatement: A Practical Review for Appropriate Plant Species Selection
Hagerhall *et al.* 2004	Fractal Dimension of Landscape Silhouette Outlines as a Predictor of Landscape Preference
Nazish *et al*. 2024	Health Impact of Urban Green Spaces: A Systematic Review of Heat-Related Morbidity and Mortality
Wang *et al.* 2019	Efficient Removal of Ultrafine Particles from Diesel Exhaust by Selected Tree Species: Implications for Roadside Planting for Improving the Quality of Urban Air
White *et al.* 2019	Spending at Least 120 Minutes a Week in Nature Is Associated with Good Health and Wellbeing

These resources can support design decisions for TfC informing changes to the way future urban green space is designed so that they have the best benefit to health and wellbeing. Design considerations should be made using the most recent scientific studies in order to make these urban green spaces most suitable for prevention, treatment, recovery and rehab, and could be coined “health spaces” or “recovery spaces”.

4.2 Design Considerations

Inhaling forest VOCs like limonene and pinene can result in useful antioxidant and anti-inflammatory effects on the airways, and the pharmacological activity of some terpenes absorbed through inhalation may be also beneficial to promote brain function by decreasing mental fatigue, inducing relaxation, and improving cognitive performance and mood (Antonelli *et al.* 2020). The use of evergreen trees such as Cedars, Spruces, Conifers and Pine, based on their ability to produce Volatile Organic Compounds and on strong evidence that these support antioxidant and antibacterial effects and reduce stress. These trees should be included in TfC planting plans to give the health benefits mentioned, these tree varieties frequently overlap with tree varieties which are particularly good at filtering air pollutants all year due to being evergreen (Barwise & Kumar 2020), so planting scented hedges could bring multifunctional way forward.

Lancaster University tested the ability of 9 different tree species to capture particulate matter: Silver birch, Yew and Elder trees were the most effective at capturing particulate matter due to the hairs on their leaves (Wang *et al.* 2019). There are many considerations about plant selection; pollen production, vegetation traits, foliage longevity and complexity, density and porosity of vegetation and

leaf surface features which all contribute to reducing air pollution. These are covered in Barwise and Kumar's 2020 study.

A note should be made around pollen-induced allergies which can also be solved by 'Right Tree, Right Place'. TfC should avoid use of trees high in pollen or with light / powdery or easily scattered and blown pollen (such as Lime and Birch). There are many other alternatives, such as female trees which are not pollen-producing and contribute to food production in urban settings.

There is potential for biodiversity to promote good human health and wellbeing, but more research needs to go into identifying the specific ecosystem services, goods and processes through which biodiversity may generate good health and wellbeing. (Lovell *et al.* 2014). Exposure to biodiverse aerial microbial communities can provide an under-recognised ecosystem service for human health. Urbanisation appears to be reducing the diversity of airborne microbes in cities with potentially important impacts on asthma, allergies, and urban-associated diseases. This research suggests specific efforts to cultivate diverse soil microbiota in both public and private urban green spaces that could provide further benefits (Flies *et al.* 2020). Although it is very difficult to measure the human benefits from soil improvements, a baseline soil test could indicate diversity before and after a TfC green space intervention as an indicator of aerial microbial communities, inferring potential human health. Stanhope's research supports this by showing that green space exposure potentially provides opportunities to benefit from known or proposed health-enhancing components of nature, such as environmental microbiomes, phytoncides, negative air ions, sunlight, and the sights and sounds of nature itself (Stanhope *et al.* 2020).

One of the Mersey Forest's 5 green space interventions includes mindful contact with nature. This applies the principles of mindfulness to the outdoors and is delivered in local woodlands and parks, mindfulness-based interventions aim to focus an individual on their moment-by-moment experience of nature (Amion Consulting. 2022). Using all the senses is a large part of mindfulness and doing this in a natural environment has many additional benefits. Whether that be through running mindfulness sessions with specific patient groups or designing the environment to encourage people to engage with trees in a multisensory way, this could be an area to explore. In Kathy Willis' book Good Nature (2024), she proposes that smell is the most underused and potentially most impactful sense when it comes to interacting with nature. She also suggests creating soundscape maps of urban environments in order to help people engage with their sense of sound. Various studies suggest birds and birdsongs positively affect mental health. According to one analysis, living in an area with 10% higher avian diversity rates increases life satisfaction 1.53 times more than a higher salary (White *et al.* 2019). TfC could design their green spaces where man-made noises are blocked out with thick hedge planting (see reference Barwise and Kumar, 2020 for species recommendations) and habitats are created which are best for nesting birds (i.e. scrub and installing birdboxes).

Planting spacing should be considered such that when trees mature, they create a landscape silhouette that has an optimum fractal dimension. This silhouette should be neither too overcrowded nor to sparse. Landscape outlines are a predictor of landscape preference and landscapes dotted with trees, i.e. savannas, or parkland landscapes such as those designed by Capability Brown, are preferred

to densely planted woodland. There is a preference to this fractal dimension, for relaxation. A growing body of research supports the benefits of intermittently planted, sequentially experienced and multi-dimensional landscapes (like those by Capability Brown and Humphry Repton in the 18th Century) for our relaxation (Haggerhall *et al.* 2004).

Climate change mitigation should be built into all of TfC's projects, for example planting should be designed strategically to help with stormwater management. Increased intensity of weather events will lead to downpours which threaten life, cause injury and mental health strain. Working on stem flow of water through strategic planting. i.e. riparian buffers upstream will slow this flow. And could be argued to be health-enhancing. Urban trees can reduce stormwater runoff by absorbing 15 to 27% of annual rainfall (US Environmental Protection Agency).

Extreme heat events will have an increasingly significant impact on urban areas due to the urban heat island effect exacerbated by climate change. Urban green spaces have a vital role in cutting heat-related deaths. Regions abundant in green spaces report lower rates of heat-related morbidity and mortality in contrast to those with sparse greenery (Nazish 2024). Another way in which climate change adaptation could be built into TfC projects is through planting trees in formations which create shaded areas to create cool zones.

5.1 Potential Recommendations

These are some ideas for directions TfC could take based on this literature review. Phase three will cover a selection of these ideas in more detail.

Programme Design Ideas:

1. **Work with specific demographics**: Focus on patient groups with high levels of physical inactivity (e.g., elderly).
2. **Collaborate with care homes and rehabilitation centres**: Improve green spaces at care facilities to support elderly residents (or other patient group) by reducing inflammation, pain, and medication reliance.
3. **Partner with specific charities which work with targeted patient groups i.e cancer charities**: Design nature-based interventions that address the physical and psychological burdens of cancer patients.
4. **Encourage active use of green spaces**: Implement infrastructure such as walking routes, cycling paths, green gyms, and nature trails to increase active use.
5. **Organise walking activities**: Implement expert-led walking activities in urban green spaces tailored to individual needs (e.g., healthy walks) to increase exercise levels, reduce social isolation, and enhance community motivation.
6. **Promote Green Gym initiatives**: Develop outdoor conservation programmes that combine physical activity with environmental improvement, like Green Gym. These could target urban or rural areas needing revitalisation.
7. **Measure intervention impact**: Collaborate with research institutions to measure health biomarkers and economic impacts of green interventions.
8. **Choose strategic locations**: Prioritise projects in health-impacted areas for maximum socio-economic impact. Work closely with the community that the green space project aligns with the community's needs.
9. **Address research gaps**: Investigate eco-anxiety mitigation and the relationship between green spaces and child and adolescent mental health.
10. **Partner with schools and youth organisations:** Organise nature walks or outdoor classroom activities to improve cognitive and emotional outcomes for children and young people.
11. **Study child-specific green interventions:** Research optimal exposure times, frequency, and activities in green spaces that enhance attention restoration, reduce ADHD symptoms, and improve cognitive development.
12. **Develop targeted outreach programmes**: Focus on populations with health disparities, such as racialised communities, economically disadvantaged groups, and those with limited access to green spaces. Design culturally sensitive activities to improve inclusivity.
13. **Address intersectional vulnerabilities**: Create interventions that address specific vulnerabilities, such as for individuals on medications with contraindications in heat, or tailored activities for women during pregnancy.

14. **Combine green spaces with social programmes**: Integrate social connection projects, such as group gardening, to combat loneliness and enhance mental wellbeing in adults, particularly for groups identified as struggling with mental health (as identified in section 3.2).
15. **Facilitate tree planting programmes:** measure the benefits of these events in relation to mental health and eco-anxiety.

Green Space Designs:

1. **Create recovery places**: Create sensory-calming zones in urban green spaces that produce volatile organic chemicals for physical and mental health benefits.
2. **Integrate health messaging into these recovery spaces**: Pair green space projects with public health campaigns (e.g., promoting exercise, reducing air pollution exposure) to maximise impact. Make people aware of why tree planting is being done in specific ways i.e "we are planting this dense yew hedge as a boundary of this park because it is exceptional at filtering particulate matter from the neighbouring road!".
3. **Climate-resilient spaces**: Create densely shaded cool zones to combat urban heat stress and mitigate poor health outcomes adverse heat events will have on vulnerable populations.
4. **Enhance accessibility and safety**: Ensure green spaces are welcoming, accessible, and safe to encourage broader community participation. Conduct studies to assess physical and psychological barriers to green space use, especially in under-served communities, and adjust interventions accordingly.
5. **Incorporate multisensory interactions**, i.e. develop interventions like mindfulness sessions in nature, emphasising smell, soundscapes, and tactile engagement with trees.
6. **Implement air pollution barriers**: Plant densely packed trees and hedges to reduce pollution, focusing on areas with high pollutant exposure to alleviate respiratory issues like asthma.
7. **Incorporate evergreen species**: Use trees like pines and cedars that produce year-round volatile organic compounds for stress reduction and antioxidant benefits.
8. **Consider fractal landscape preferences**: Design landscapes with optimal fractal dimensions (e.g., parkland-style plantings) for relaxation and visual preference.
9. **Mitigate urban flood risks**: work with urban planners to employ strategic planting for stormwater management, such as riparian buffers.
10. **Incorporate digital solutions**: Use apps or digital tools to guide users through sensory-based activities in green spaces, such as mindfulness exercises, tree identification, or soundscape exploration.
11. **Integrate nature in education through design**: Partner with schools to design nature walks or green spaces visible from classrooms to improve attention restoration.
12. **Track soil health**: partner with an academic institution to measure soil biodiversity to correlate improvements in microbial diversity with health outcomes. Although this research is in its early stages, the science around the microbiome is rapidly expanding as its importance is realised. Projects should aim to cultivate biodiverse aerial microbial communities to reduce urban-associated diseases and allergies.

Phase 3 – Trees for Cities Pilot Projects

The recommended projects outlined in Phase 3 represent opportunities for TfC to pilot targeted programmes that leverage urban forests and green infrastructure to deliver health outcomes, address health inequalities, and contribute to public health priorities. These projects aim to enable TfC to tell a consistent and compelling narrative about the societal benefits of urban forests through advocacy and targeted interventions. Operationally, these initiatives are designed to reduce health inequalities and improve outcomes for communities by integrating urban trees into health-focused programmes.

The recommendations are informed by identified gaps in research and practice, highlighting areas where TfC can help advance understanding and delivery of health benefits through nature-based interventions. However, these projects require further exploration, planning, and consideration to ensure effective implementation and the delivery of meaningful health outcomes. Each project includes a proposed monitoring and evaluation framework to provide a snapshot of what TfC could capture, some of the tools available to achieve this, and potential partnerships needed to drive them forward. Collaboration with academic institutions and other health and environmental experts is strongly recommended to refine design recommendations and ensure that health outcomes are assessed rigorously. Academic involvement is particularly important given the inherent complexities and confounding factors in outdoor health interventions, helping to ensure robust analysis and better assessments of causation.

A central goal of these recommended projects is to address and reduce health inequalities by ensuring that interventions are accessible and beneficial to under-served populations. Individuals experiencing adverse life conditions, such as living in poverty or facing social exclusion, often participate less in health programmes. This poses the risk that interventions could unintentionally exacerbate inequalities if they disproportionately attract participants with lower health needs, such as those who are wealthier or more mobile. To mitigate this risk, monitoring and evaluation frameworks must prioritise the collection and analysis of data that measures equitable access and outcomes. Participation rates should be analysed across socio-economic groups, ethnicities, and age demographics to identify any disparities in engagement. This data can be compared against local population demographics using sources like the UK Census to ensure that the projects TfC pilot are serving those that need it most.

In addition, health outcomes before and after participation should be analysed by characteristics such as socio-economic status and age to assess whether the benefits are equitably distributed across different groups. Geographic mapping of intervention sites against area level socio-economic and health data could help identify whether TfC projects are supporting the communities with the greatest need. Such analyses would provide valuable insights into the project design, enabling TfC to deliver more targeted interventions to engage and support under-served populations. However, conducting these evaluations requires specialist expertise, highlighting the need for partnerships with academic institutions and public health teams to ensure robust and meaningful assessments.

Children and Young People: Eco-anxiety and Resilience

The *Children and Young People Eco-anxiety and Resilience* project aims to address the growing issue of eco-anxiety among young people while promoting emotional resilience, nature-connectedness, and pro-environmental behaviours.

Connection to TfC's Strategy

This project aligns closely with TfC's strategy by building on its existing work in schools, including the *Planting Healthy Air* and *Growing Among Trees* projects, which emphasise the importance of green spaces in urban environments. It extends TfC's focus on creating accessible and inclusive urban forests by introducing targeted interventions for children and young people, addressing the pressing issue of eco-anxiety and its impact on mental health. Additionally, the project promotes stewardship and advocacy among young participants, fostering long-term community engagement and encouraging a new generation to connect with and care for urban forests.

Addressing Gaps in Evidence and Impact

This project directly addresses gaps in research and operational practices related to trees, green infrastructure, and health outcomes for young people. Research highlights the importance of tackling eco-anxiety as a collective and systemic issue, particularly as mental health challenges are most prevalent among young people, especially regarding climate concerns. Evidence also demonstrates the cost-effectiveness of early mental health interventions in school settings, emphasising the significant roles educators, practitioners, and policymakers play in influencing meaningful change. The project specifically targets children and young people, a group often under-represented in decision-making and collaboration on green infrastructure projects, despite being disproportionately affected by eco-anxiety. By prioritising their engagement, this initiative seeks to empower young voices and address their needs within the context of green urban spaces and mental health.

Public Health

This project addresses current public health priorities while also anticipating future areas of focus towards sustainability, equity, and preventive care. This project positions TfC to deliver nature-based interventions and emotional resilience programmes as part of a holistic care model, emphasising early mental health support to reduce the burden on healthcare systems. By encouraging local engagement and participatory design, the project fosters community resilience and social cohesion, addressing the mental health challenges young people face in the context of climate change.

Implementation

TfC's track record of delivering school-based greening projects highlights their capacity to engage young people, educators, and communities effectively. Leveraging their existing partnerships with schools and local authorities, TfC is well-positioned to implement the *Children and Young People Eco-Anxiety and Resilience* Project.

A mixed-methods approach is recommended for this project, incorporating tools that measure resilience, eco-anxiety, nature connection, and pro-nature behaviours. The Connor-Davidson Resilience Scale (shortened version) is well-suited for capturing changes in emotional resilience,

providing a validated and practical method for use in youth settings. The Hogg Eco-Anxiety Scale is ideal for measuring the specific mental health impacts of climate concerns, ensuring the project directly addresses eco-anxiety. The Nature Connection Index (NCI) can track participants' evolving connection to nature, a key outcome of the project. Finally, the Pro-Nature Conservation Behaviour Scale (ProCoBS) assesses behavioural changes, demonstrating how the project fosters environmental stewardship. These tools provide a comprehensive framework for evaluating the project's impact; however, we recommend working with an academic institution to identify practical approaches for monitoring, as the proposed framework may involve more data collection than is appropriate for children and young people. TfC should collaborate with a university and project partners to determine the most critical measures, ensuring the evaluation process is both efficient and effective.

To maximise the project's impact and sustainability, TfC should consider collaborating with a diverse range of partners. Engaging schools as key delivery partners will allow the project to embed activities into existing educational settings. Partnerships with youth organisations such as The Prince's Trust, Youth4Nature, and the Youth Environmental Service will expand the project's reach, ensuring inclusivity and diversity in participant engagement. Local youth groups and community organisations can further strengthen the project's connection to project. Collaborating with local health services will enhance the project's integration with public health initiatives, providing referral pathways for young people experiencing eco-anxiety.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Children and Young People: Eco-anxiety and Resilience *For underpinning research see section 3.5 and 3.6 in literature review*	Citizen science programme Emotional resilience workshops Youth advocacy programme Nature connection and conservation activities.	Number of people registering, attending and completing activities and workshops. Number of activities delivered. Number of youth advocacy initiatives and policy contributions made by participants. Time spent outdoors and spent engaged with nature per participant. Number of urban trees planted and biodiversity improvements recorded.	Increased awareness of eco-anxiety and pro-environmental behaviours and reduction in reported difficulties among participants. Improved emotional regulation and resilience. Enhanced nature connectedness and greater stewardship of urban green space. Increased self-efficacy and leadership skills in young people. Greater engagement in community and environmental activities.	Stronger community and policy support for urban greening initiatives driven by youth advocacy. Improved mental health outcomes for children and young people. Development of a generation equipped to address climate challenges with resilience and agency. Reduced reliance on healthcare services. Health and social care cost savings.	Connor-Davidson Resilience Scale (shortened version) 10 statements, 5 point scale Hogg Eco-Anxiety Scale 13 statements, 3 point scale Nature Connection Index (NCI) 6 statements, 7 point scale Pro-Nature Conservation Behaviour Scale (ProCoBS) 18 or 8 items, 7 point scale Interviews, focus groups and participant observations to gain qualitative insights into the benefits of urban forests on children and young people.

Urban Forests for Reducing Social Isolation and Loneliness

The project is designed to reduce social isolation and loneliness in under-served communities by creating safe, inclusive, and community orientated accessible green spaces. It focuses on urban populations that lack access to high-quality urban forests and green infrastructure or are traditionally disengaged from nature due to barriers like safety concerns, cultural irrelevance, or limited proximity to green spaces. Through activities such as creating, enhancing, and using urban forests and structured events and co-designed programmes with the local population, the project aims to use these spaces as community hubs fostering social connections, helping to reduce feelings of isolation and improving mental health outcomes.

Connection to TfC's Strategy

The project aligns closely with TfC's mission to connect people with nature and create healthier urban environments for everyone. By addressing social isolation and mental health disparities, the project broadens their focus from environmental impacts to social and health outcomes, promoting equitable access to green spaces and enhancing people's sense of ownership and connection to urban forests. This area of focus also supports TfC's goal of fostering sustainable, resilient communities by encouraging the development of long-term, self-sustaining community groups that care for and utilise these spaces as their own space to enjoy and connect with urban nature.

Addressing Gaps in Evidence and Impact

There is a growing body of evidence linking green spaces to reduced loneliness and indicating that people with more green space within a mile of their home report lower levels of loneliness, with pronounced benefits for those living alone. However, gaps remain in understanding the mechanisms and long-term impacts of nature-based interventions in this area. The project provides an opportunity to address some of these gaps by evaluating how the urban forests and community hubs offering a variety of interventions that are co-designed by the communities they serve, and having this work embedded in the green social prescribing system could influence loneliness in urban settings. It can also explore the cultural and contextual factors that affect how different communities engage with green spaces, ensuring that interventions are inclusive and relevant.

Public Health

The project aligns with current and emerging public health priorities by addressing loneliness and targeting vulnerable and under-served groups, including socially isolated people and those living alone; all who are identified as having a greater risk for depression, anxiety, and cardiovascular disease. The NHS' long-term priorities emphasise prevention and early intervention, and this project supports those goals by creating accessible opportunities for social connection and mental health improvement in community-based settings. It also aligns with the broader goals of integrating social prescribing further in the healthcare system.

Implementation

The development phase of the project should adopt a community organising approach, prioritising listening, learning, and co-design in the process. Engaging directly with community members to understand their needs, priorities, and experiences will ensure the interventions are relevant and

socially inclusive. This approach involves facilitating conversations to explore the current cultural and social landscape of the area, identifying barriers to engagement with nature, and together envisioning how the urban forests can best support the community's health and wellbeing.

TfC should co-design the community spaces alongside local residents, ensuring that their voices shape the design, activities, and maintenance plans for the project. This participatory approach fosters a sense of ownership and long-term commitment among community members. Learning from these interactions will also provide insights into how TfC can tailor its support to empower the community and address specific challenges. Community organisations and local councils could play a key role in expanding the local health and social context of the area, whilst aligning the public health priorities with the most vulnerable and under-served communities.

Also collaborating with the National Academy for Social Prescribing (NASP) could be a way to ensure the project is driving the social prescribing agenda forward and take an advisory role. Link workers, GPs, and other local healthcare providers can serve as referral partners, directing patients who could benefit from the programme. Lastly, academic institutions could support evaluation efforts by conducting longitudinal studies and contributing to the evidence base.

Alongside collecting community voices at every stage of the project, it is important to measure the project's impact on loneliness and social connection. The UCLA Loneliness Scale provides a validated tool for assessing changes in loneliness levels, capturing both emotional and social dimensions of isolation. The Personal Wellbeing ONS4 measure can be used alongside this to monitor wellbeing and mental health, which aligns closely with loneliness and social connection. Pre- and post-intervention surveys will track participants' progress, while qualitative methods will provide deeper insights into the lived experiences and barriers faced by participants.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Urban Forests for Reducing Social Isolation and Loneliness *For underpinning research, see 2.3 and 3.3 in literature review*	Design inviting, accessible hubs in urban forests, incorporating features like pagodas, seating areas, and shaded zones to ensure comfort and usability. Deliver, facilitate and co-design a variety of regular wellbeing activities e.g. guided walks, green gym events, mindfulness sessions for / with the community. Urban tree planting and maintenance activities. Provide training on basic tree care and community leadership to ensure ongoing stewardship. Collaborate with NASP and local healthcare providers to establish referral pathways for patients to access the project. Promote the project as a part of broader social prescribing efforts to address mental health and loneliness.	Number of community hubs created, including physical structures like pagodas and seating areas. Number of participants engaged in courses, activities, and events. Number of community groups established and actively maintaining the spaces. Educational materials and signage installed in the hubs. Number of urban trees planted. Time spent outdoors and spent engaged with nature per participant.	Participants feel safer and more welcomed in green spaces. Increased attendance at structured activities, with participants beginning to build social connections. Participants return independently to use the spaces beyond structured sessions. Improved social connectedness, reduced loneliness, and enhanced sense of belonging among participants.	Sustained reduction in loneliness and social isolation within underserved communities. Improved mental health outcomes, including reduced anxiety and depression rates. Strengthened community resilience through the formation of independent groups maintaining the spaces. Enhanced perception of urban forests as inclusive, safe, and relevant for diverse communities. Reduced reliance on healthcare services. Health and social care cost savings.	The UCLA Loneliness Scale 20 or 8 statements, 4 point scale Personal wellbeing ONS4 Survey 4 questions, 10 point scale Short Warwick Edinburgh Mental Wellbeing Scale (SWEMWBS) 7 statements, 5 point scale Nature Connection Index (NCI) 6 statements, 7 point scale Interviews, focus groups and participant observations to gain qualitative insights into the benefits and impact of the hubs on participants' health and wellbeing, including their sense of safety, enjoyment, and connection to the spaces.

Dementia and Urban Forests

The *Dementia and Urban Forests* project is designed to enhance the quality of life for people living with dementia and their caregivers by leveraging the therapeutic benefits of urban forests and green spaces. Through mindfulness activities, nature-based engagement, and inclusive community-based care, the project creates dementia-friendly environments that support cognitive, emotional, and social wellbeing.

Connection to TfC's Strategy

This initiative aligns with TfC's mission to create urban forests that support specific needs of a vulnerable population. It builds on TfC's strengths and commitment in creating accessible and sustainable green spaces, while expanding their scope and capacity to include targeted health project to address complex health and social challenges through nature-based interventions.

Addressing Gaps in Evidence and Impact

The project addresses significant gaps in research and practice related to dementia and green infrastructure, which will provide actionable steps for integrating urban greening into dementia care practices. Current evidence highlights the benefits of nature for reducing stress, agitation, and anxiety in people living with dementia, yet there is limited UK-specific data demonstrating the long-term impacts of urban forests on cognitive function and quality of life. Areas for exploration could include the impact of green spaces on memory recall, attention, and emotional regulation as well as identifying design elements that enhance usability, safety, and inclusivity in urban spaces. Also there is limited evidence on how nature-based interventions can alleviate carer's stress and improve their caregiving experience.

Public Health

Dementia affects around 900,000 people in the UK, with numbers projected to reach over 1.6 million by 2040 (Alzheimer's Society). The total cost of dementia in the UK is 42 billion, which accounts for significant healthcare expenditure and financial implications for those living with dementia and their families. This project offers an opportunity to reduce some of this burden by focusing on delaying symptom progression, which aligns with the NHS' long-term plan on early intervention and prevention to reduce the burden on healthcare services and improve people's quality of life. Also integrating the local needs into the design and use of these spaces, the project contributes to the broader public health goal of shifting care from institutional settings to community-focused environments.

Implementation

Implementing the *Dementia and Urban Forests* project requires thoughtful planning and a clear understanding of the complexities involved. Dementia is a multifaceted health challenge, and interventions must be designed to accommodate diverse needs, cognitive abilities, and social contexts. Working with individuals living with dementia requires specialised knowledge and skills so training staff and volunteers to understand dementia care and tailoring interventions that are adaptable to the varied needs of this group will be essential.

A robust monitoring and evaluation framework is essential for understanding the project's impact on participants' quality of life, nature connection, and overall wellbeing. The Dementia Statements - a rights-based tool outlining factors influencing quality of life - can provide qualitative insights into how participants perceive the project's benefits, though it is not a validated scale. For more structured evaluation, the Dementia Quality of Life Instrument (DEMQOL) offers a validated approach to assessing quality of life, though its implementation may be more challenging in some settings. The Nature Connection Index (NCI) can measure changes in participants' engagement with and connection to nature, providing an additional dimension to understanding the intervention's impact. Qualitative methods, such as interviews, focus groups, and participant observations will be important to capturing the nuanced experiences of those living with dementia and their caregivers, allowing a deeper exploration into how the project addresses accessibility, safety, and emotional wellbeing.

Partnering with organisations like Dementia UK, the Alzheimer's Society, and Dementia Adventure will help TfC provide with understanding dementia care whilst ensuring the interventions are aligned with best practices. Local authorities and healthcare providers can support the identification of participants and integrate the project into community and healthcare services. Also engaging directly with individuals living with dementia and their caregivers through a person-centred approach will help tailor interventions to meet their specific needs and preferences.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Urban Forests for Dementia *For underpinning research, see section 2.3 in literature review*	Co-design interventions with dementia groups and those experiencing dementia. Mindfulness activities Multi-Sensory walks Practical conservation activities (e.g. tree planting and green gym sessions) Conduct / facilitate workshops to educate patients and caregivers about the benefits of green spaces for dementia.	Number of participants engaged in mindfulness and nature-based activities. Improved accessibility of urban forests to support people with dementia and their carers. Time spent outdoors and spent engaged with nature per participant. Number of urban trees planted. Educational materials distributed and workshops conducted.	Reduced stress, agitation, and anxiety levels in participants. Enhanced mood and emotional regulation through sensory stimulation and social engagement. Increased caregiver confidence and reduced feelings of isolation. Improved cognitive function and memory recall in dementia patients. Greater utilisation of urban forests by individuals with dementia and their caregivers. Strengthened community awareness and inclusivity in green space design.	Improved quality of life for people living with dementia and their caregivers. Reduced reliance on intensive dementia care services through preventive and community-based interventions. Increased public recognition of urban forests as vital spaces for health and wellbeing. Reduced reliance on healthcare services. Health and social care cost savings.	'The Dementia Statements' They set out things that influence their perceptions of quality of life, in rights-based ways. Not a validated scale Dementia Quality of Life Instrument (DEMQOL) 28 or 31 item measure Nature Connection Index (NCI) 6 statements, 7 point scale Pre- and Post-Intervention Surveys Interviews, focus groups and participant observations to gain qualitative insights into the benefits of urban forests for experience and health outcomes.

Urban Forests for Cardiovascular Health and Stress Reduction

The *Urban Forest for Cardiovascular Health and Stress Reduction* project aims to address hypertension and cardiovascular health by integrating therapeutic activities in urban forests. Activities such as forest bathing, mindfulness exercises, and light physical activity are designed to reduce stress, lower blood pressure, and improve overall cardiovascular outcomes. Targeting individuals at risk, particularly those with pre-existing hypertension or living in underserved urban areas, this project seeks to demonstrate how nature-based interventions can provide measurable health benefits while promoting the role of green infrastructure in public health.

Connection to TfC's Strategy

This area of focus aligns with TfC's commitment to connecting people to urban forests and expanding the organisation's impact by addressing health disparities. By creating accessible, inclusive green spaces designed for health-focused interventions, the project fosters stronger connections between communities and urban nature.

Addressing Gaps in Evidence and Impact

The project addresses gaps in evidence surrounding the role of green spaces in improving cardiovascular health. While research demonstrates the potential of forest bathing to reduce blood pressure, there is limited data on the sustained impacts of such interventions in urban environments. This project provides an opportunity to contribute to the evidence base by examining the direct and sustained effects of these interventions.

Public Health

The project supports the NHS' long-term strategy on preventive care by targeting hypertension and stress, both leading risk factors for cardiovascular diseases. It creates community-based care by providing accessible, local green spaces for health interventions, reducing reliance on institutional care. Also if new urban forests are planted, it aligns with climate adaptation strategies by addressing urban heat and improving air quality, key factors that impact cardiovascular health. Moreover, it integrates nature-based solutions into healthcare pathways, aligning with public health goals for holistic and sustainable health strategies.

Implementation

Delivering this potential pilot project will require a detailed approach to monitoring and evaluation, alongside strategic partnerships to ensure effective implementation and measurable impact. Monitoring should incorporate clinically validated tools to capture both immediate and long-term health outcomes. Blood pressure measurements must follow clinical standards, including the use of automatic sphygmomanometers in controlled settings to ensure accuracy and consistency. Complementary tools, such as the Perceived Stress Scale (PSS), can assess reductions in stress levels, which are closely linked to cardiovascular health. Additionally, running qualitative surveys and focus groups can further enrich the evaluation by capturing participant experiences.

Collaboration with healthcare providers, such as general practitioners and cardiologists, will ensure the interventions are tailored to clinical needs and integrated into patient care pathways. Public

health teams can provide valuable support in aligning the project with local health priorities and identifying urban areas with higher rates of hypertension, while academic institutions can contribute expertise in designing evaluation frameworks and conducting longitudinal studies to assess sustained impacts. Partnering with community organisations will help ensure the project is inclusive and accessible, particularly for under-served populations with limited green space access.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Urban Forests for Cardiovascular Health and Stress Reduction *For underpinning research, see 2.3 and 3.3 in literature review*	Forest bathing (Shinrin-Yoku): Guided sessions in urban forests focusing on mindful engagement with nature through slow walking, deep breathing, and sensory awareness. Facilitate creative sessions such as nature photography to encourage relaxation. Train facilitators to measure participants' blood pressure before and after activities. Deliver a healthy walks programme. Practical conservation activities (e.g. tree planting and green gym sessions) Host workshops / develop education materials on cardiovascular health and nature exposure.	Number of forest bathing and physical activity sessions delivered. Number of participants engaged, with demographic data to identify high-risk populations. Blood pressure readings collected pre- and post-intervention. Educational materials distributed on cardiovascular health and the benefits of urban forests. Number of urban trees planted.	Immediate reductions in systolic and diastolic blood pressure following forest bathing and other activities. Increased awareness of the relationship between nature exposure and cardiovascular health. Enhanced stress management and relaxation among participants. Sustained improvements in blood pressure and cardiovascular risk markers for regular participants. Increased adoption of active lifestyles and engagement with green spaces. Improved community awareness and support for urban greening initiatives.	Reduction in the prevalence of hypertension and associated cardiovascular diseases in target populations. Enhanced public recognition of urban forests as vital health resources. Reduced reliance on healthcare services. Health and social care cost savings.	Blood pressure: Measuring systolic and diastolic blood pressure (mmHg) before and after interventions. Pre- and Post-Intervention Surveys e.g. Perceived Stress Scale (PSS). 10 statements, 4-point scale Longitudinal Tracking: Conduct follow-ups with participants to assess sustained changes in blood pressure and lifestyle behaviours. Possible reduction in prescriptions. Nature Connection Index (NCI) 6 statements, 7 point scale Interviews, focus groups and participant observations to gain qualitative insights into the benefits of urban forests for cardiovascular health.

Establishing Urban Forests as Recovery Spaces

The project focuses on integrating physiotherapy programmes with nature-based activities in urban green spaces, creating accessible, tree-based recovery areas that promote physical, mental, and social wellbeing. The target audience would be those in rehabilitation centres, clinics and / or community hubs for older adults, individuals with mobility challenges, and those recovering from illness or injury.

Connection to TfC's Strategy

The project aligns closely with TfC's mission to deliver a healthy, resilient urban forest while addressing pressing public health needs. It builds on their expertise in creating green spaces that enhance urban environments and fosters partnerships with healthcare providers to expand the role of urban greening in health outcomes. The initiative also reinforces TfC's commitment to equity by targeting underserved communities where access to high-quality green spaces for health-focused activities is limited.

By focusing on rehabilitation and recovery, the project broadens their impact, demonstrating how urban forests can address complex health challenges in addition to providing ecosystem services like biodiversity enhancement and air quality improvement.

Addressing Gaps in Evidence and Impact

The project addresses critical gaps in research and practice related to the integration of green spaces and rehabilitation. While the physical and mental health benefits of nature are well documented, there is limited evidence on how urban forests can explicitly enhance physiotherapy outcomes for individuals recovering from illness or injury. This presents an opportunity to explore the interaction between physical activity in natural environments and improved recovery outcomes, including reduced pain and better adherence to rehabilitation programmes. Furthermore, the accessibility and usability of green spaces for individuals with mobility challenges remain underexplored and little is known about the long-term impacts of nature-based physiotherapy on recovery rates. By investigating these areas, the project can contribute meaningful insights to the evidence base, demonstrating how urban forests can play a pivotal role in public health.

Public Health

This programme aligns with the NHS's priority to transition toward integrated, community-based care. By establishing accessible green recovery spaces, it moves rehabilitation from institutional settings to local environments, empowering individuals to manage their recovery within their communities. These spaces foster social connections, reduce isolation, and address broader health inequities. Additionally, the program integrates green spaces into holistic treatment pathways, showcasing how urban forests can enhance person-centred care. Aligned with the NHS Long-Term Plan, it positions nature-based rehabilitation as an innovative and sustainable solution within modern healthcare systems.

Implementation

Delivering this project requires strategic planning, meaningful collaboration with key stakeholders and robust monitoring to demonstrate the project's impact and inform future scalability. The project

could employ standardised health measurement tools such as EQ-5D and SF-6D to capture a comprehensive picture of participants' physical health, pain management, and quality of life. These tools allow for the consistent tracking of mobility, self-care, usual activities, pain/discomfort, and anxiety/depression over time. Active visits could also be measured at recovery sites to assess engagement, using site logs and digital check-ins.

To ensure the best outcomes of this potential pilot project, working in partnership is vital. TfC should consider working with physiotherapists and rehabilitation specialists, who can co-design programmes to align with clinical best practices. Local healthcare providers and public health teams should be engaged to ensure the project meets community health priorities and integrates with existing care pathways. Academic institutions can play a pivotal role in conducting longitudinal studies and contributing to the evidence base, strengthening the project's credibility. The University of Essex's School of Sport, Rehabilitation and Exercise could be a potential partner.

Health organisations can provide valuable insights into designing programmes that address complex health conditions, such as post-stroke rehabilitation, by incorporating exercises that improve balance, mobility, and cardiovascular health. Working with these partners also facilitates the integration of nature-based recovery interventions into broader healthcare policy, such as social prescribing pathways. Organisations such as Stroke Association, Arthritis UK and local rehabilitation charities could be a way to reach more people in using urban forests for therapeutic exercises tailored to meet the specific recovery needs of patient groups.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Establishing Urban Forests as Recovery Spaces *For underpinning research, see section 2.3*	Establish shaded, accessible green spaces with trees, benches, and sensory elements designed to facilitate physiotherapy exercises, recovery activities and relaxation. Position recovery spaces near rehabilitation centres, clinics and / or community hubs to ensure convenience for participants and healthcare providers. Collaborate with physiotherapists and occupational therapists to deliver targeted and tailored programmes, including balance, strength, walking and flexibility exercises that utilise the urban forest. Practical conservation activities (e.g. tree planting or Green Gym) Develop self-guided exercise plans with illustrated guides or signage throughout the recovery space, encouraging continued use of urban forests outside of scheduled sessions and throughout the seasons. Conduct workshops to educate patients and caregivers about the benefits of green spaces for recovery.	Number of recovery spaces created and improved. Improved accessibility of urban forests to support people with mobility challenges. Time spent outdoors and spent engaged with nature per participant. Number of urban trees planted. Number of physiotherapy sessions conducted in the recovery spaces. Educational materials distributed and workshops conducted.	Increased use of recovery spaces by target populations (older people, stroke patients, those with mobility challenges) Enhanced physical activity and mobility levels among patients. Improved emotional well-being and reduced pain perception through exposure to nature. Improved recovery rates and rehabilitation outcomes. Greater community awareness of the role of green spaces in health and recovery.	Long-term improvement in mobility and physical health among target populations. Strengthened recognition of urban forests as critical assets for public health and wellbeing. Reduced reliance on healthcare services. Health and social care cost savings.	Collect baseline and follow-up data on mobility, pain levels, and emotional wellbeing. Some quantitative tests / surveys could be used: Short Form Health Survey (SF-12) Standardised health measurement scales (EQ-5D) Create usage logs of 'Active Visits' to track the type of activity performed, duration of activity, intensity and frequency of visits. Nature Connection Index (NCI) 6 statements, 7 point scale Interviews, focus groups and participant observations to gain qualitative insights into the benefits of urban forests for recovery, mobility and pain management.

Urban Forest Cool Zones

The *Urban Forest Cool Zones* project aims to mitigate the health impacts of prolonged heat stress by creating shaded, climate-resilient spaces in urban areas for physical activity, rest, and social engagement. These zones serve as multifunctional spaces offering ecosystem services like cooling, while addressing health needs, particularly in vulnerable populations (e.g. pregnant individuals, people on antipsychotics, older adults).

Connection to TfC's Strategy

This project aligns closely with TfC's strategy by supporting their mission of creating healthy, resilient urban forests through enhanced tree cover in areas where it is most needed. It reinforces TfC's commitment to equity by prioritising urban areas disproportionately affected by climate change, addressing environmental and social disparities in access to cooling and green spaces.

Addressing Gaps in Evidence and Impact

As shown in the literature review, there is limited evidence that directly links urban cooling interventions to health outcomes like reduced heat-related illnesses. While the cooling benefits of trees are known, their integration into behavioural and health interventions is underexplored as well as insufficient tracking of how vulnerable populations use and benefit from shaded green spaces.

Public Health

The project aligns strongly with current and emerging public health priorities by addressing prevention, community-based care and climate adaptation. In the context of prevention, the project proactively targets heat stress, a growing public health concern exacerbated by climate change. By creating shaded spaces that mitigate heat exposure and encouraging physical activity, the project aligns with the NHS's long-term focus on reducing the burden of preventable conditions, such as heat-related illnesses. It also directly contributes to the reduction of health disparities and ensures that vulnerable populations benefit from urban greening initiatives. These efforts are in line with public health goals to foster community resilience and improve access to health-promoting environments.

Looking ahead, it also supports future public health priorities related to climate adaptation. As extreme heat events become more frequent, the project positions urban forests as critical infrastructure for climate resilience.

Implementation

The *Urban Forest Cool Zones* project utilises TfC's existing expertise in urban greening and partnership working, aligning with 'Cool Trees,' an emerging TfC pilot focused on climate adaptation, to deliver impactful solutions for urban resilience and public health.

To evaluate the cool zones' impact, TfC could employ a mixed-methods approach. Satellite imagery or GIS mapping can measure changes in tree canopy coverage, while temperature monitoring in intervention areas will quantify urban heat reduction. Collaboration with healthcare providers could facilitate tracking heat-related health metrics, such as emergency visits or hospital admissions, to assess public health impacts. In addition, qualitative surveys with local residents can gather insights on useability and experience of the zones, offering feedback on the social aspects of the project.

Collaboration with experts will be critical to the project's impact and scalability. TfC should partner with organisations like Forest Research and Kew Gardens to access expertise in urban forestry and climate adaption as well as supporting the design of monitoring frameworks and conduct longitudinal studies to assess health and climate resilience outcomes. Local authorities and healthcare providers will be key partners in identifying high-priority areas and integrating the project into broader public health and climate adaptation strategies.

One of the challenges of this project is the delayed delivery of certain ecosystem services, particularly shading benefits, due to the time needed for the trees to mature. Managing public and stakeholder expectations requires clear communication on the project's long-term vision and its dual role in addressing public health and climate resilience. Highlighting interim benefits, such as improved aesthetics and community engagement, can help maintain support and enthusiasm during the early stages.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Urban Forest Cool Zones: *For underpinning research, see section 4.2*	Plant urban forests that provide shade in in areas with populations at high risk (e.g. care homes / mental health hospitals) for exercise, rest, and social interaction. Tree Equity Score can be used to identify areas which have vulnerable populations (children and elderly), and low canopy cover. Deliver workshops on heat stress prevention and the benefits of urban forests for health and climate resilience. Provide interpretation at each cool zone explaining their purpose and health benefits.	Number of cool zones established and improved. Number of people using the cool zones in periods of high temperatures. Number of educational workshops and participants engaged. Reduction in temperatures within cool zones, measured regularly. Number of urban trees planted.	Increased use of shaded spaces for physical activity and rest, particularly by vulnerable populations. Improved awareness of heat stress risks and the role of urban forests play in mitigation. Reduced incidents of heat-related illnesses in target areas.	Increased resilience of urban populations to climate change impacts. Strengthened recognition of urban forests as essential for health and environmental sustainability. Cool zones increasing the social value of urban green spaces. Improved public health outcomes through reduced heat stress and associated complications. Reduced reliance on healthcare services. Health and social care cost savings.	Track the increase in tree canopy coverage in the intervention areas using satellite imagery or GIS mapping. Number of heat-related emergency visits or hospital admissions in the communities served by the cool zones. User experience surveys showing the number of users, average time spent, their activity and peak usage times. Gather feedback from participants in educational workshops on heat stress and the role of urban forests. Measure atmospheric temperature differences within and outside the cool zones to quantify the cooling effects.

Biophilic Design

The *Biophilic Design* project seeks to create a blueprint for designing urban forest spaces that prioritise health and environmental benefits. By integrating biophilic principles, the project aims to enhance cognitive function, reduce stress, improve air quality, and foster nature connection through multisensory design. Key features include planting trees that capture particulate matter, incorporating species that emit health-promoting volatile organic compounds (VOCs), and creating zones with diverse sensory elements such as vibrant colours, natural sounds, and appealing scents. This blueprint will guide TfC and other organisations in developing urban forest spaces that are accessible, inclusive, and aligned with community and ecological needs, providing a replicable model for integrating health outcomes into urban greening programmes.

Connection to TfC's Strategy

By emphasising health-focused and biophilic design, the project extends TfC's impact beyond environmental benefits to include human wellbeing and social outcomes. It also further reinforces TfC's commitment and role as a leader in designing urban environments that foster environmental stewardship and improve public health.

Addressing Gaps in Evidence and Impact

The project addresses gaps in understanding how biophilic urban forest design influences health and wellbeing. While existing research demonstrates the benefits of green spaces for stress reduction, mood improvement, and cognitive function, there is limited evidence on how specific design elements, such as tree spacing, colour preferences, and sensory diversity impact these outcomes. For example, studies show that densely planted areas with hedges and trees can reduce asthma-related hospitalisations, but more research is needed to demonstrate these benefits. Additionally, there is opportunity to further contribute to the role of multisensory experiences, such as soundscapes and scents in enhancing nature connection and stress relief. By exploring these gaps, the project will contribute valuable insights into how urban forests can be enhanced for health and environmental outcomes.

Public Health

The project aligns with public health priorities by addressing prevention and climate adaptation. By incorporating features that reduce stress, improve air quality, and foster nature connection, the project supports preventive strategies to mitigate chronic conditions like asthma, anxiety, and cardiovascular disease. Its focus on inclusive design also aligns with goals to reduce health inequities by ensuring all communities, especially under-served ones, have access to high-quality green spaces. Furthermore, the project addresses climate adaptation by emphasising tree species and planting strategies that enhance urban cooling, improve biodiversity, and mitigate air pollution. This integrated approach reflects the growing emphasis on connecting health and environmental strategies within public health policy.

Implementation

Initial implementation of the project should focus on piloting the blueprint in urban areas with high air pollution and limited access to green spaces. Co-design workshops with community members,

experts, and stakeholders will guide the development of multisensory zones and other features. Data collected during the pilot phase will inform scalability and refinement of the blueprint. Monitoring tools could include the Perceived Stress Scale to measure reductions in stress, the Nature Connection Index to evaluate participants' connection to nature, and the Office for National Statistics (ONS4) measure to assess wellbeing. It will be important to also measure air quality, using sensors to track particulate matter (PM2.5) and other pollutants, which will provide critical data on environmental improvements. Participant surveys and focus groups could complement the data, providing qualitative insights into how users engage with the sensory elements of the spaces.

Alongside community consultation and engagement, it will be important to work closely with local landscapers, architects, and designers to ensure the spaces incorporate culturally and ecologically relevant and appropriate biophilic elements. Engaging local councils and public health teams will also help align the blueprint with community needs and policy priorities. Academic institutions can support research efforts to evaluate the project's impact and refine design recommendations.

Project	Interventions / Activities	Outputs	Outcomes	Impact	Indicators / Survey Methods
Biophilic Design *For research underpinning these interventions see section 4.2*	Prioritise planting tree species known to capture particulate matter (PM2.5) e.g. birches, oaks and cedars, which emit volatile organic compounds (VOCs). Integrate hedges and shrubs to create natural barriers that improve local air quality. Add features to engage all senses, e.g. trees and shrubs with appealing scents, fractal patterns, water elements to enhance auditory and visual appeal, and bird-friendly habitats to encourage songbirds. Host workshops with local artists, landscapers, and environmental experts to design and activate sensory zones. Install signage encouraging visitors to engage their senses through walking trails and mindfulness exercises. Measure particulate matter and air quality improvements before and after interventions. Map soundscapes of the parks in collaboration with experts to assess the auditory benefits of bird populations and water features. Deliver mindful activities and guided sensory walks.	Number of trees, hedges and shrubs planted. Number of multisensory zones and walking trails created. Number of structured mindful activities delivered and participants engaged. Number of educational signs and materials installed. Time spent outdoors and spent engaged with nature per participant.	Lower particulate matter. Participants feel safer and more welcomed in green spaces. Increased engagement with sensory-focused urban forests Enhanced mood, reduced stress, and improved attention among participants. Participants return independently to use green spaces beyond structured sessions.	Improved air quality in urban areas with reduced particulate matter. Reduced asthma-related hospitalisations in areas with urban forests using biophilic design. Greater public awareness of the health and environmental benefits of engaging with the senses of urban forests. Increased community wellbeing and appreciation of green spaces. Reduced reliance on healthcare services. Health and social care cost savings.	Use sensors to measure air quality before and after interventions. Personal wellbeing ONS4 Survey 4 questions, 10 point scale Nature Connection Index (NCI) 6 statements, 7 point scale Pre- and Post-Intervention Surveys e.g. Perceived Stress Scale (PSS). 10 statements, 4-point scale User experience surveys showing the number of users, average time spent, their activity and peak usage times. Interviews, focus groups and participant observations to gain qualitative insights into the benefits and impact of the hubs on participants' health and wellbeing and connection to the spaces.

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