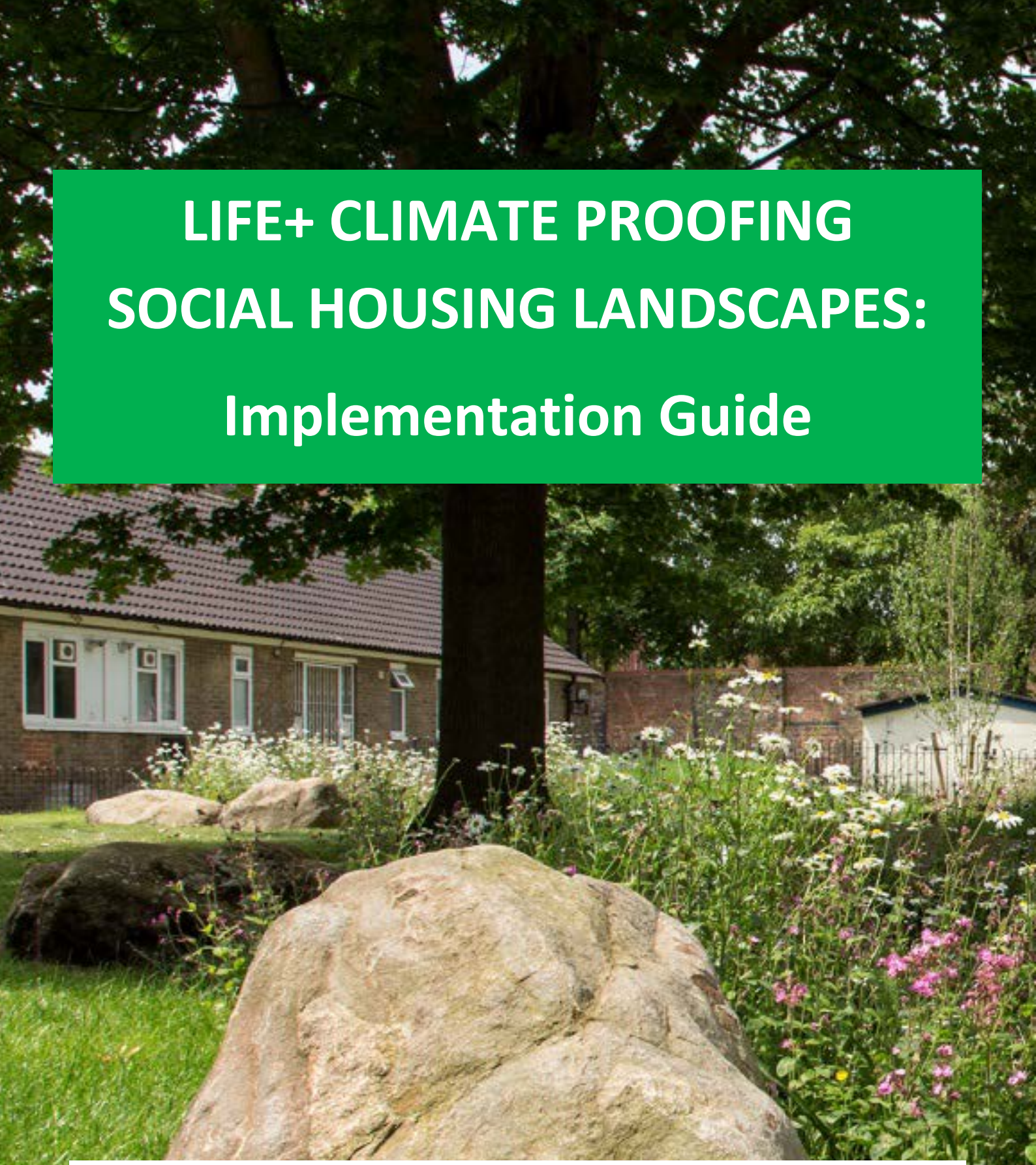
LIFE+ CLIMATE PROOFING SOCIAL HOUSING LANDSCAPES:

Implementation Guide



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INTRODUCTION

1. Introduction

1.1 Brief overview of the project

Climate-Proofing Social Housing Landscapes was a project run by Groundwork London in partnership with Hammersmith & Fulham Council. Co-financed by the European Commission's LIFE+ Programme, it was delivered from July 2013 to September 2016.

The project centred on three social housing estates in the Borough of Hammersmith and Fulham in West London. Through this, Groundwork London worked with the local authority, residents and other key stakeholders to design and implement climate change adaptation measures to ensure that these estates are better placed to withstand the impact of extreme weather events and other effects of a changing climate.

The programme aimed to demonstrate that through water-sensitive urban design measures and other climate adaptation actions, urban housing estates can play an important part in adapting our cities to cope better with climate change.

Key activities included:

- Retrofitting cost-effective, light-engineering solutions in green spaces to help ease environmental impacts such as flooding and heat waves, adopting a model that is replicable in and transferable to cities across Europe.
- Creating training and employment opportunities for apprentices to carry out some of the adaptation work, and for local authority and social housing staff and grounds maintenance contractors to learn how to maintain these measures and replicate them elsewhere.
- Working alongside residents to give them the opportunity to shape the open space improvements on their estates, and to raise their awareness about the implications of climate change for London and Londoners and the actions residents can take themselves to contribute to adaptation.

1.2 Purpose of this Guide and how to use it

This practical Implementation Guide outlines the opportunities and mechanisms for adaptation available to housing providers across Europe. It aims to support and enable housing providers to replicate the climate adaptation approaches adopted in this project across their own housing stock and surrounding green spaces by providing tools, resources and advice based on the activities and outcomes from the project, and using the three project sites as best practice examples. The Guide sets out the main impacts of, and lessons learned from, the project, and offers practical guidance and recommendations as well as signposting to other relevant resources and case studies from across Europe and beyond.

The Guide focuses on implementing climate adaptation measures for housing estates, in particular in the context of retrofitting solutions to existing open spaces in social housing environments. It considers a number of aspects of such projects, from the planning stage through to implementation, maintenance and monitoring, reflecting on key components such as identifying opportunities, engaging stakeholders, managing risks and securing funding.

What do we mean by 'climate adaptation measures'?

Adaptation aims to manage climate risk to an acceptable level, taking advantage of any positive opportunities that may arise. In the context of open spaces on housing estates, climate adaptation measures include a range of sustainable methods of dealing with surface water run-off from new and existing developments. They aim to attenuate rainfall and run-off and infiltrate as much water as possible back into the ground in order manage flood risk, improve water quality, protect against drought and maintain healthy aquifers.

There are a number of different ways of referring to such measures, including green and blue infrastructure, nature-based solutions, natural water retention measures, green features and water-sensitive urban design – these are used in different sections of this Guide, and can be found in other resources relating to urban climate-proofing, depending on the context.

Whilst the focus of the project, and this Guide, is on social housing landscapes, it is worth noting that many of the opportunities available, and the advice in this Guide, are also applicable to the implementation of climate adaptation measures at the wider neighbourhood level, for example involving businesses, schools, community buildings and faith centres. Although such contexts will have their own unique opportunities and challenges, there is significant potential to learn from and build on the approaches documented here.

The Guide is not a step-by-step manual and therefore does not need to be followed from cover to cover. Instead, different sections are relevant for those interested in different aspects – such as community engagement, policy or implementation. It does not intend to go into technical detail on all available solutions, instead using signposting to highlight where more information is available elsewhere.

1.3 Who is this Guide for?

This Guide is primarily for housing practitioners across Europe who are interested in climate adaptation measures and how these can be applied to their own housing stock and surrounding green spaces. It is also relevant to all professionals working in a similar field outside of the housing context, for example in green space, the public realm, urban development and planning. It may also be of interest to social housing residents and private homeowners or renters interested in learning more about these measures and the benefits they bring. Whilst the project described in this Guide is UK-focused, the Guide demonstrates how the approaches used are highly replicable in, and offer considerable benefits to, urban areas across Europe.

BACKGROUND

2. Background and Environmental Problem

2.1 The challenge

Climate scientists predict that climate change is likely to mean more extreme weather events across Europe, including winter flooding and summer heat waves. Climate change will significantly increase the threat of surface water flooding in urban areas with high soil sealing, drainage systems already at or near capacity, and an increasing number of intensive rainfall events. According to the European Environment Agency, this is likely to be a particular problem for cities in north-west and northern Europe.[1]

Social housing residents are typically more vulnerable to the impacts of climate change, often living in urban environments that are subject to an increased risk of surface water flooding and the urban heat island effect. This is because when land is developed, soil sealing reduces the amount of water that is absorbed into the ground through natural drainage. Surface water flooding can cause substantial damage, disruption and costs to these communities. In the UK, for example flood damage costs an estimated £1.1 billion per year, and over 5.2 million (one in six) properties in England are at risk of flooding from rivers, the sea, or surface water.[2] Furthermore, in urban areas the capacity for heat storage is increased by the mass of construction material, and the reduction in vegetated surfaces compared to rural areas means that the potential for evaporative cooling is reduced.

At the same time, vulnerable communities are also the least likely to be able to afford measures which could help them tackle this risk. Whilst most new developments are now designed with the flexibility to adapt to future climates, with the rate of renewal of the EU's urban environment at less than 1% per annum, there is a huge gap in terms of existing housing that was not designed to withstand such changes. Therefore, European countries, and the cities in which many of their citizens live, need to prepare and adapt in order to future-proof existing buildings and infrastructure, minimising the impact extreme weather events will have on both the environment and on people's lives.

2.2 Social housing in Europe

Despite marked differences between populations, fiscal and political environments and methods of provision, there are a number of challenges relating to social housing which are shared across Europe – not least the need to maintain and improve the quality of the building stock and its surrounding environments.

[1] See www.eea.europa.eu/publications/urban-adaptation-to-climate-change

[2] See Zurich Municipal Risk insight guide: Floods, available at: http://newsandviews.zurich.co.uk/wp-content/uploads/2014/12/Risk-Insight-Floods.pdf

The market share of social housing varies across Europe – from the Netherlands where it is as high as 33% of all housing, to countries such as Greece and Latvia where there is no or very little social housing.[3] Across Europe, considerable investment is being made by social landlords in housing repairs and maintenance; the retrofitting of housing stock has become part of landlords' responsibility for improving their tenants' quality of life and the energy efficiency of their stock. However, a 2011 survey by Housing Europe (formerly CECODHAS) found that only 10% of social housing landlords were actively implementing adaptation measures in their outdoor spaces. Given the importance of both the building stock itself and the surrounding open spaces in ensuring that social housing is able to withstand the impacts of a changing climate, this demonstrates a clear missed opportunity.

2.3 The solution

Climate adaptation solutions minimise the impact that urban development has on the environment, and the impact that a changing climate change could have on the buildings, open spaces and people that live there. Housing estates often feature some open or green space, but there is considerable potential to use these spaces more effectively for the benefit of the local environment and residents.

The impacts of retrofitting climate adaptation measures extend far beyond making an estate fit for the future, delivering a range of environmental, social and economic benefits as described below. In addition, as most housing providers have local performance measures or key performance indicators (KPIs) to measure improvements in service delivery, the benefits offered by such measures can also help to ensure that relevant KPIs are met.

Environmental benefits

By putting climate adaptation measures in place, it is possible to:

- **Manage flood risk**, mimicking natural drainage by reducing the rate and quantity of surface water run-off entering the sewers (for example, through natural water retention measures such as rain gardens, conveyance channels, swales, basins or permeable surfaces);
- **Improve water quality** by reducing sediment and contaminants found in surface water run-off, either through settlement or biological breakdown of pollutants;
- **Provide carbon storage and sequestration** in vegetation through tree and other planting schemes;
- **Provide natural cooling** to reduce the urban heat island effect and improve biodiversity by installing green roofs and walls, which can create habitats for birds and wildlife;
- **Reduce the need for irrigation** by selecting drought-resilient plants; and
- **Minimise the use of fresh water for irrigation** or other functions that do not require treated water from the mains by harvesting rainwater.

[3] See www.housingeurope.eu/resource-468/the-state-of-housing-in-the-eu-2015

These measures help to reduce the vulnerability of local communities and their homes to the impacts of climate change. Furthermore, they are often designed with greater capacity than is required at the time of installation, so that if the changing climate results in greater rainfall than expected, the measures will be able to withstand this.

Social benefits

Green infrastructure is designed to not only be functional, but to look visually attractive as well. It can help to reduce incidences of crime or anti-social behaviour by providing a visually attractive and easily accessible space that residents want to look after and enjoy rather than damage. It can improve the health and well-being of residents, encouraging them to spend time outdoors (including through informal play features for young residents), interact with their neighbours, and potentially helping them to grow their own plants or food. In turn, this can help housing providers meet their targets for estate improvement.

Furthermore, by working with estate residents throughout the process, it is possible to involve them in shaping open space improvements, raise their awareness of climate change and its implications, help them to understand the importance and benefits of such measures, secure their buy-in and encourage them to take action themselves – not just for the benefit of the environment but for their own benefit, too. From the perspective of a social housing landlord, this kind of interaction can ensure that KPIs for resident engagement are also met.

At the same time, if apprenticeship or employment opportunities are made available as part of a project, this could benefit local residents, which in turn would help the social housing provider to meet any targets for supporting residents to find work. These opportunities can also benefit the wider community, as Groundwork London's Green Team has done through the *Climate-Proofing Social Housing Landscapes* project (see section 3.1 below), potentially supporting those who have been unemployed for a long period of time.

Economic benefits

In addition to the employment and apprenticeship opportunities that such initiatives can provide, the considerable positive impacts that they offer can ultimately save housing providers money by reducing flood risks and associated costs such as repairs, remediation and high insurance premiums. In the wider European context, it has been estimated that every £1 spent on adaptation represents four times its value in potential damages avoided.[4] The social benefits offered by such measures can also help to avoid spending that may have otherwise been necessary to tackle crime, anti-social behaviour and other challenges.[5]

[4] de Bruin, K.C., Dellink, R.B. and Agrawala, S. (2009) 'Economic Aspects of Adaptation to Climate Change: Integrated Assessment Modelling of Adaptation Costs and Benefits' OECD Environment Working Papers No.6, OECD Publishing; referenced in the UK Government's National Adaptation Programme, July 2013

[5] This has not been measured through the *Climate-Proofing Social Housing Landscapes* project, but evidence exists from many other green space initiatives. For example, see Kuo, F.E. and Sullivan, W.C. (2001) 'Environment and Crime in the Inner City: Does Vegetation Reduce Crime?', Environment and Behaviour 33, no. 3

Training grounds maintenance contractors and housing staff in order to raise their awareness of the benefits of climate adaptation measures for social housing environments and help relevant teams learn how to maintain these measures and replicate them elsewhere can also help to save money by ensuring that existing teams have sufficient skills and knowledge rather than requiring additional resourcing.

Green infrastructure measures are often highly cost effective; many of them are inexpensive to implement and do not require extensive maintenance. Where maintenance is required, this is often relatively cheap and straightforward, especially as the infrastructure is accessible (rather than being underground). At the same time, it is often possible to implement measures alongside planned maintenance works, offering economies of scale compared to the costs of installing green infrastructure measures on their own. In the *Climate-Proofing Social Housing Landscapes* project, this was the case for the green roof on the residential block Richard Knight House, which had already been identified as being in need of repair, presenting an opportunity for the green roof to be installed when work on this roof was already planned.

With many housing providers facing limited available resources, these multiple benefits help to demonstrate the business case for cross-cutting investment in green infrastructure, for example through neighbourhood services or community investment programmes, and help to justify the implementation of such measures amongst other competing priorities.

2.4 The policy context

Adaptation measures of this nature are to a certain extent covered by European policy under the Water Framework Directive[6], which sets out the importance of surface water quality and places an emphasis on controlling 'diffuse pollution', and the EU Floods Directive[7], which required Member States to develop Flood Risk Management Plans by 2015. These measures also demonstrate practical responses in line with the EU Strategy on Adaptation to Climate Change[8], published in 2013, which set out a framework and mechanisms for strengthening Europe's resilience to current and future climate impacts. Given the uncertainty over the long-term impacts of climate change, the EU Adaptation Strategy encourages all Member States to adopt comprehensive adaptation strategies and recognises that it makes sense to begin with measures that are low-cost, flexible and good for both the economy and the climate.

A key relevant policy document is the European Commission's Green Infrastructure Strategy[9], which recognises the important role these measures play in a number of areas, including the provision of ecosystem services, the protection and enhancement of natural capital, adaptation to climate change and disaster risk management, as well as offering health and social benefits too. It sets out the significant contribution that green infrastructure can make to the implementation of many of the EU's main policy objectives, and advocates the full integration of green infrastructure into these policies. The strategy also looks at the possibility of developing a trans-European green

[6] http://ec.europa.eu/environment/water/water-framework/
[7] http://ec.europa.eu/environment/water/flood_risk/
[8] http://ec.europa.eu/clima/publications/docs/eu_strategy_en.pdf
[9] http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructure_broc.pdf

infrastructure (TEN-G) initiative, similar to that already in place for large-scale EU transport (TEN-T) and energy (TEN-E) networks, considers how to improve access to finance for green infrastructure projects, and recognises the importance of improving information and promoting innovation.

There are also synergies with other EU policy areas, including: the Clean Air Programme for Europe[10], as green infrastructure and naturally vegetated spaces in cities can reduce air pollution; and the EU 2020 Biodiversity Strategy[11], given the role of green infrastructure in halting biodiversity loss, creating habitats and protecting ecosystem services.

Climate adaptation initiatives have the potential to demonstrate how EU environment policy can be implemented at the local level. However, for the most part these measures are more closely related to national and regional legislation, which means that the extent to which they are being implemented varies considerably across Europe.

It is important to link climate adaptation initiatives, such as those described in this Guide, with existing policies in order to make the case for such initiatives and embed them in the longer term thinking of policy makers and practitioners. For example, in the *Climate-Proofing Social Housing Landscapes* project, local policies including Hammersmith & Fulham Council's Local Plan, Housing Strategy and Biodiversity Strategy, and guidance including Transport for London's SuDS Design Guide, have all been strengthened by the outcomes of, and lessons learned from, the project. More information on policy influencing, as well as advice on how to do this effectively, can be found in section 6 below.

[10] http://ec.europa.eu/environment/air/clean_air_policy.htm
[11] http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm

APPROACH & SOLUTIONS

3. Approach and Technical Solutions

3.1 Overview of project methodology

The *Climate-Proofing Social Housing Landscapes* project sought to deliver a holistic package of climate change adaptation solutions in three social housing estates within the London Borough of Hammersmith and Fulham.

The London Borough of Hammersmith and Fulham is one of the 32 London Boroughs, situated to the western side of Central London. The River Thames forms the borough boundary to the South and South-West. It is the third smallest of the London Boroughs in terms of land area (1,640 hectares) and currently has a population of c.182,500. Population growth is expected to slow over the next decade, however, it is already one of the most densely populated local authorities in England, with around 114 persons per hectare (pph) compared to the London average of 52pph (Hammersmith & Fulham Council, 2010).

The three estates, owned by the Local Authority, were chosen because they reflect different social housing contexts (such as property types and estate sizes) that can be found across EU member states, demonstrate vulnerability to increasingly extreme weather conditions, and have high indices of multiple deprivation. In this way, the project was able to demonstrate how green infrastructure adaptation measures can be implemented in a wide range of urban housing settings. Broadly speaking, the approaches are highly replicable and could be implemented across Europe; however, they are likely to require climate appropriate and site specific adaptations depending on the location in question.

Through the project, various highly effective, affordable and socially acceptable green and blue infrastructure interventions have been implemented in all three estates. The aim has been to improve the overall quality of these urban environments, addressing climate threats such as flood risk, water scarcity and overheating, and wider contributors to local environmental quality such as biodiversity, air quality and water quality. The implemented measures are light-engineering solutions, including small basins, rain gardens, and green roofs and walls. Soft landscaping elements have been implemented through accredited apprenticeship and employment programmes for local people as part of Groundwork London's Green Teams, many of whom have been out of work for long periods of time, therefore creating local jobs (see box below). Hard landscaping elements have been delivered by externally appointed contractors. In this way, different mechanisms for resourcing the delivery of adaptation measures have been demonstrated.

"We've shown here with these three relatively small spaces that there's a lot that can be achieved… Every time we come down here when it does rain, it seems to be achieving what we expect. It's a great example of what can be achieved in a housing estate right in the heart of Hammersmith. You only have to see how the public are interacting with the space to see that there are benefits, and we need to be doing it more. The scheme not only delivers a major improvement to our residents' environment, but is also helping to reduce the impact of climate change, especially in terms of flood risk, through the type of interventions that can be rolled out across London. Groundwork London worked tirelessly to ensure that our residents were involved throughout the process and many residents have approached me since to tell me just how much they love the finished product".

George Warren, Flood Risk Manager, Hammersmith & Fulham Council

Green Teams

Groundwork's Green Teams create better and greener places while providing team members the opportunity to learn new skills, gain qualifications and improve their employment prospects. Through structured programmes, young people – often those who are unemployed – carry out real and valuable environmental improvements in neighbourhoods so that these neighbourhoods and those who live in them see tangible benefits on the ground.

The experience gives young people key skills for working life, with all training paid for. Most members are on six-month contracts, helping them to build their confidence and self-esteem, with support provided to help them find work on completion of their contract.

In the *Climate-Proofing Social Housing Landscapes* project, 22 Green Team members, of which over half are residents from the London Borough of Hammersmith and Fulham, have carried out landscaping and maintenance works. Through the project, team members have been learning new skills and building their confidence in the process. This has included building raised planting beds for food growing, laying topsoil and turf, planting and mulching. The trainees were also initially responsible for plant establishment and on-going maintenance work, before this was handed over to the local authority's contractors.

All members have been awarded a Level 1 horticulture qualification from City & Guilds (the leading skills development organisation in the UK) and, with support from Groundwork London's employment team, some have since taken on gardening or other relevant jobs as a result.

"A really satisfying part of gardening work is watching people enjoy something that you've made. I've learnt how to handle machinery, gained some turfing skills, and hopefully lost a few pounds thanks to all the physical activity!"
Louis MacDonald, Green Team Member

In order to raise awareness, promote the benefits of such measures, and ensure that they are properly managed, a series of training modules has been developed and delivered for housing professionals and grounds maintenance contractors, supporting them through the full process from planning through to procurement, implementation and maintenance (see section 5.7 below).

Residents on the three estates have also been closely engaged throughout the project (see section 7 below), raising their awareness of, and support for, the measures being implemented. As well as being informed of project progress through regular communications and events, they have also been actively involved in the design process and will continue to participate in the long-term maintenance of the installed measures. Residents on all three estates have been given the opportunity to become Sustainability Champions, with free training to equip them with the skills and understanding to manage their green space assets effectively. To support their ongoing involvement in the initiative, residents have also been given training on the maintenance of the measures that they are responsible for, such as food growing beds. Some residents have also attended maintenance handover sessions with contractors so that they are informed of the maintenance activities that contractors are responsible for.

The project has sought to provide an evidence base that makes the business case for cross-cutting investment in green and blue infrastructure for social housing, by demonstrating its cost effectiveness and value for money through the environmental, social and economic benefits it offers. With this aim in mind, an evaluation methodology has been established in order to monitor both the technical performance of the measures and their social and environmental value, as described in section 6.2 below.

Through all of the above, the project aimed to develop a methodology that would be applicable and transferable to other housing estates, not only within the UK but also across Europe. Various resources have been developed in order to share learning from the project, including this Implementation Guide, training materials, a Layman's Guide, project film and 360° virtual tour. These are available on the project's dedicated website, www.urbanclimateproofing.london. Other relevant learning materials are referred to throughout this Guide, with web links provided.

3.2 Key project stages

The key stages in the *Climate-Proofing Social Housing Landscapes* project were as follows. These would also be applicable to many other projects of a similar nature:

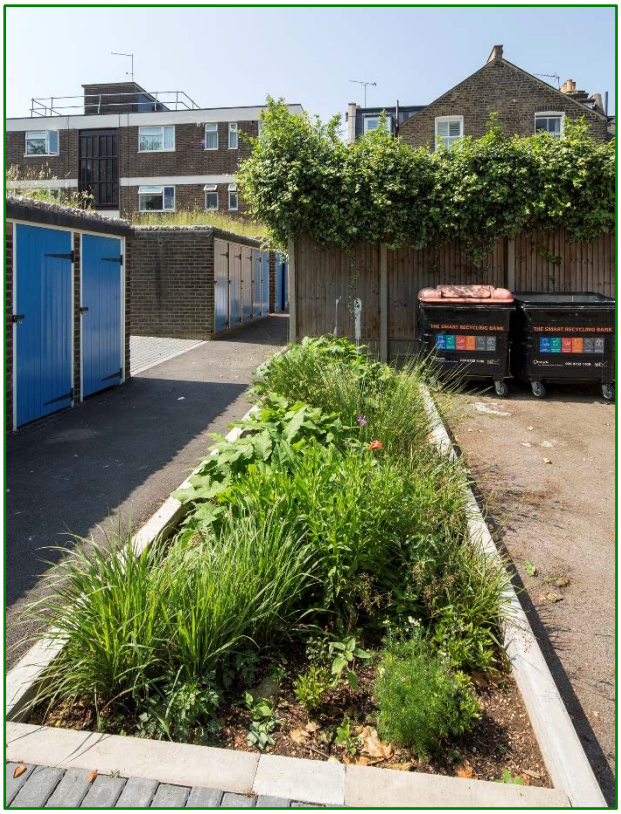
- Initial audit;
- Assessment of threats and opportunities;
- Feasibility assessment;
- Prioritisation of opportunities;
- Design;
- Preparation for implementation;
- Implementation;
- Maintenance;
- Monitoring and evaluation; and
- Dissemination and communication.

Resident engagement is not listed as an individual stage above as this has been a cross-cutting activity throughout the project, from design and implementation through to maintenance and evaluation. More detail on the above stages and on resident engagement activities, as well as guidance on how to go about completing each stage, is given in sections 5-7 below.

3.3 Technical solutions

A wide range of climate adaptation solutions are available within the context of retrofitting housing environments; many of which may be desirable at any one site. However, the suitability and feasibility of different measures will depend on a number of site-specific factors, such as the availability of space or light, soil characteristics, existing land use, pedestrian and vehicular access and movement patterns, and restrictions created by existing below ground services and/or tree roots. To be fully functional and deliver maximum benefits, the design of measures always needs to reflect their specific contexts.

Solutions, and the key benefits they offer, include:

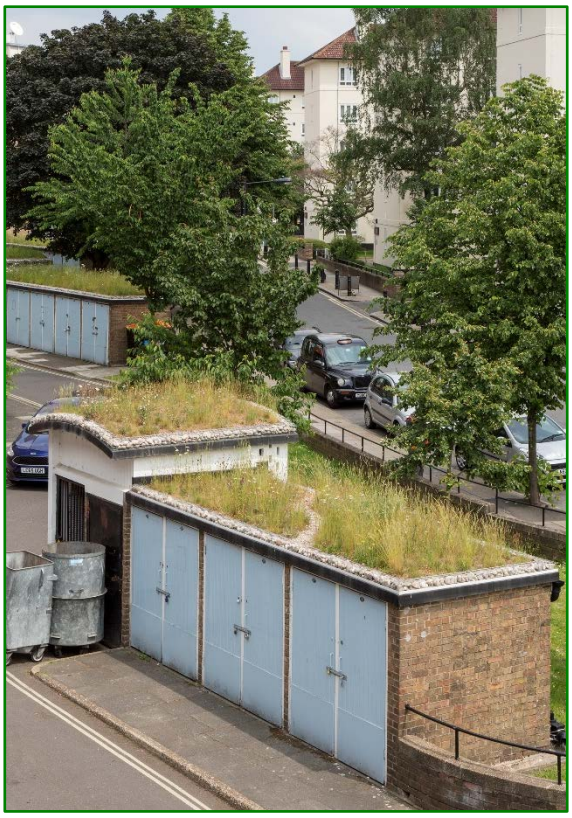


Rain gardens: a shallow depression, with absorbent yet free draining soil and planted with vegetation that can withstand occasional flooding. Rain gardens can be designed to accept run-off diverted from downpipes, paved areas or highways, thus reducing pressure on the piped drainage network. They can be planted with shrubs and perennials or wildflowers, and consequently provide visual interest and valuable wildlife habitat.

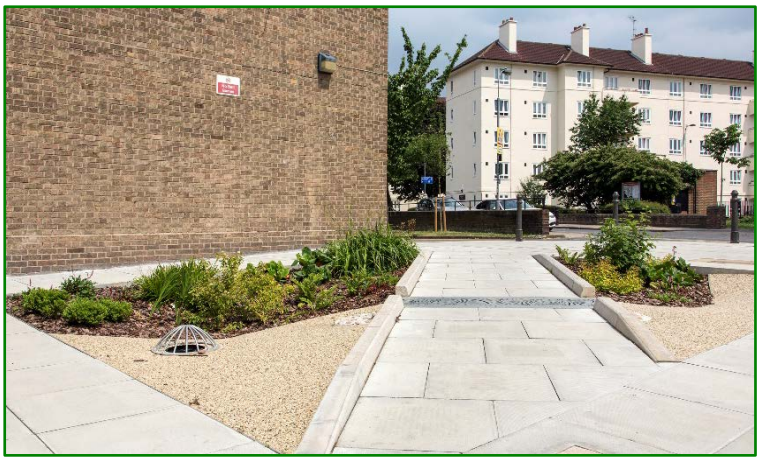
Retention and infiltration basins: these are shallow, open, depressions within the landscape that are normally dry, but in heavy rainfall provide capacity to store water for a short period. Infiltration basins are designed to maximise infiltration into the soil. Retention basins provide temporary storage of water, using a flow control structure at the discharge point to control the rate at which water drains out of the system. Because infiltration and retention basins are normally dry, they present good opportunities to incorporate informal play structures, and variations in substrate and planting can maximise benefits for wildlife.

Tree planting (generally): trees provide multiple adaptation benefits, for example intercepting and storing rainfall, providing shade and reducing local air temperature through evaporative cooling. Trees also provide valuable wildlife habitat, carbon storage, contribute to air quality improvements and provide visual interest.

Storm water tree pits: these combine below ground storage of surface water run-off with tree planting in paved areas. The area below and between the tree pits is excavated and filled with a structural soil, which combines soil with a structural component (such as rock or geocellular storage). Run-off is directed to the feature, irrigating the trees and providing an enhanced drainage function.



Green roofs: this is a roof of a building that is partially or completely covered with vegetation grown in a growing medium (soil), with waterproofing beneath. Green roofs reduce run-off by intercepting and storing rainwater on and in the plants and growing medium. The plants also release water back to the atmosphere through evapotranspiration. Green roofs provide other adaptation benefits, such as reducing the risk of overheating in the building beneath and reducing local air temperature through evaporative cooling. Green roofs can be planted to create diverse habitats that benefit biodiversity and provide visually interesting landscape features for residents.



Pervious surfaces: hard landscaping measures that store surface run-off before allowing it to infiltrate into the ground and/or to discharge to another drainage component. Pervious paving can reduce the rate and volumes of water entering piped drainage systems as well as helping to improve water quality by filtering out pollutants.

Schotterrasen (Austrian gravel lawn): a gravel material, with small quantities of organic matter that can be seeded with grasses and wildflowers. It can be designed to provide a durable surface for pedestrians and/or vehicles, whilst also creating an attractive green space that lets water permeate into the ground and provides valuable wildlife habitat.

Swales: vegetated channels, which are used to slowly convey run-off, whilst promoting infiltration and the filtering out of pollutants. Diverse planting can be used to enhance biodiversity and visual interest.

Infiltration trenches: shallow excavations with rubble or stone that create temporary subsurface storage of storm water run-off, thereby enhancing the natural capacity of the ground to store and drain water.

Green walls or vertical rain gardens: a wall partially or completely covered with vegetation, either planted in pockets of growing medium held vertically on the wall or grown up or down the wall (climbing or trailing plants). Green walls help to regulate local air temperature through evaporative cooling, combat air pollution by trapping particles on plant leaves and stems, and enhance local biodiversity. Vertical rain gardens are green walls that are irrigated by rainfall collected by diverting run-off from roof or balcony surfaces above into irrigation tanks. In this way the vertical rain garden helps to reduce pressure on the piped drainage system, whilst also avoiding the use of potable water for irrigation.

Downpipe fed raised planters: small planters irrigated by surface water draining from roofs or balconies above. They provide the same benefits as rain gardens but on a smaller scale, and can be installed in areas where open space is limited.

Other features, such as food growing beds and informal play features can be introduced into the landscape in conjunction with the above features, to further enhance the multi-functional character of housing landscapes. These features will encourage use of the green spaces, providing opportunities for locally grown fruit and vegetables, acting as a learning and behaviour change opportunity for local residents, and also offering health-related benefits such as access to healthy food, outdoor exercise and combating social isolation.

This Guide does not go into technical detail on the various solutions listed above as there is already an extensive range of published material on the options available, the benefits they offer, requirements for installation, costs and other practical information. For more information on this, please see external resources such as:

- Natural Water Retention Measures (NWRM) website (www.nwrm.eu): a platform that collates information on NWRM at the EU level, featuring an online catalogue of measures;
- CIRIA (www.ciria.org): the construction industry research and information association in the UK, which has expertise in sustainable drainage. See:
    - SuDS Manual, latest update published November 2015;
    - BeST (Benefits of SuDS Tool) – a tool which helps to assess the benefits of SuDS;
    - Susdrain (www.susdrain.org): an online community created by CIRIA that provides a range of resources for those involved in delivering sustainable drainage systems in the UK;
- Green Infrastructure information and guidance on the European Commission's website (http://ec.europa.eu/environment/nature/ecosystems/)

3.4 Project locations and measures installed

The project aimed to showcase a number of measures that support climate adaptation in urban housing estates, while also providing additional benefits such as biodiversity, play, visual amenity and air quality improvements. The measures installed at each site took into account a range of site-specific factors, as described below. These features can be explored in a 360° virtual tour, developed by Groundwork London, which can be viewed here: www.groundwork.org.uk/Sites/urbanclimateproofing/Pages/ucp-estates

Whilst all the features - from green roofs to basins, rain gardens and swales - have been used elsewhere before, there are only limited examples of such features being integrated and retrofitted in a housing estate landscape in this way.

Queen Caroline Estate

Queen Caroline Estate is a large, open estate with 14 residential blocks of between 3 and 10 storeys and two single-storey bungalows. The buildings are separated by large areas of grass, with scattered mature trees, and paving. Many of the residential blocks have pitched roofs that drain to external guttering and downpipes. Around half the downpipes run through properties with private gardens. There are also a number of ancillary buildings across the estate, including a community centre, training room, garages, pram sheds and bin stores. Before the project started, the existing open space had limited amenity or aesthetic value, with large areas virtually unused.

Figure 1. Queen Caroline Estate open spaces – before and after

Through discussions with residents about how to bring these spaces back into active use, it became clear that the estate had an active Tenants and Residents Association, with an enthusiasm to expand food growing on the estate and a desire for there to be more colour and interest in the landscape.

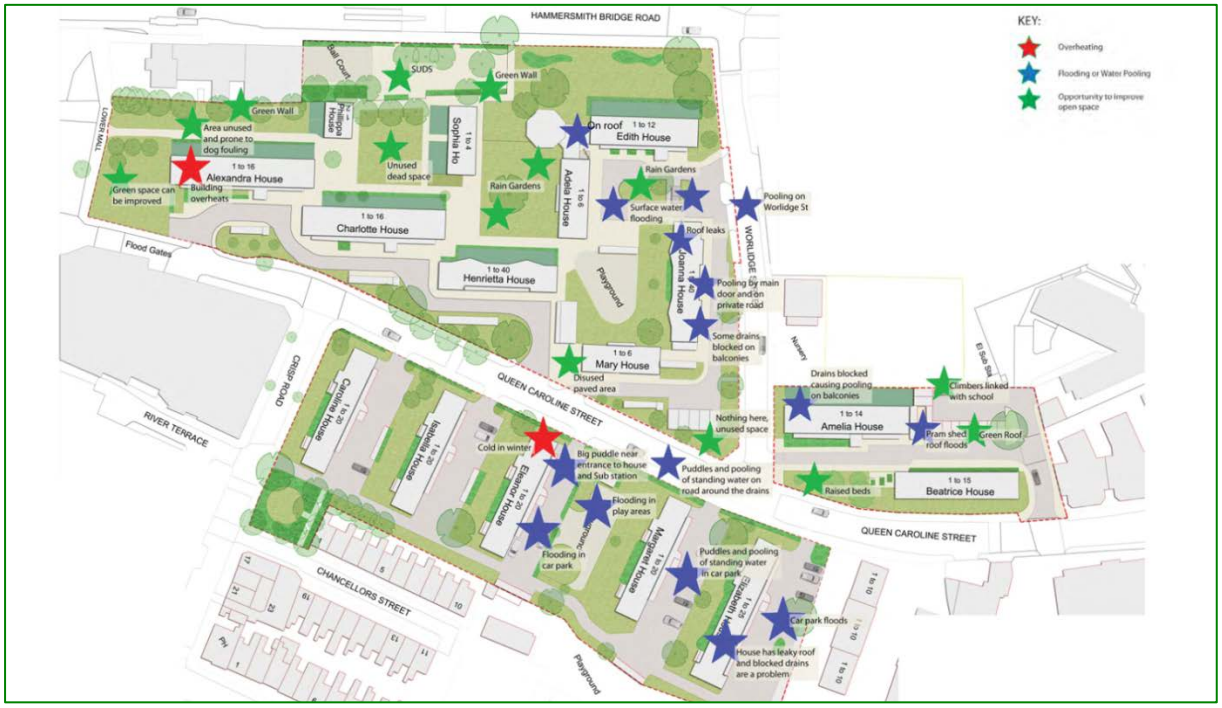


Figure 2. Queen Caroline Estate consultation comments, May 2014

Initial site survey work and discussions with Council staff and residents highlighted a number of weaknesses/threats and strengths/opportunities:

Weaknesses & threats

- Incidents of surface water flooding in the local area;
- Extensive water pooling on estate roads, play areas and paths during heavy rain;
- Some overheating of flats on the upper floors of some of the more exposed blocks;
- The Borough is served by a combined sewer system with combined sewer overflows (CSOs) draining directly to the Thames. The Environment Agency assessment of Thames Tideway CSOs (EA, July 2011) identifies the Hammersmith Pumping Station CSO as a Category 1 CSO, meaning that it operates frequently and has adverse environmental impacts;
- High levels of air pollution (particulates and NO_2) and noise from adjacent roads;
- Large areas of unused impermeable hard landscape; and
- Large areas of mown amenity grassland with little or no biodiversity interest.

Strengths & opportunities

- Large unused areas of open space (hard and soft);
- Easily accessible external downpipes;
- Unused corners of the estate roads and parking areas, which could relatively easily be converted to small pocket rain gardens;
- A large number of ancillary buildings with flat roofs with the potential for greening;
- Scope for additional tree planting;
- Interest from the residents in expanding food growing and opening up some of the green spaces for play and recreation; and
- A desire from residents for more diverse and colourful planting.

The combination of large unused areas of open space and easily accessible externally located downpipes on most of the buildings provided scope for relatively large-scale ground-level features to manage surface water run-off from the adjacent building roofs and paved areas and to bring open spaces back into active use. Measures installed through the project include grass swales, stony and grassy basins, green roofs on bin stores and pram sheds, tree planting, de-paving to form rain gardens, food-growing beds and pervious surfacing, including Austrian gravel lawn (Schotterasen). As a result, areas that were previously under-used are now gardens with colour and interest.

Figure 3. Queen Caroline Estate stony basin – before and after

The grassy basins and swales across the estate have been planted with three different kinds of turf: a wildflower turf designed for use in sustainable drainage systems, a standard wildflower turf, and standard amenity turf. This has been done to examine how each type of vegetation responds to different conditions. Most of the time the basins are dry, but after heavy rainfall there may be standing water, so the plants growing there need to tolerate both wet and dry conditions. Around the basins, natural play features have been incorporated, such as boulders and stepping logs, to make the space more inviting and to encourage recreation. A trial with one resident to divert water through their garden and through an open channel across a public path to a swale has been successful and similar approaches are set to be rolled out further.

Schotterrasen is commonly used in Germany and Austria but is relatively new to the UK. The Queen Caroline estate is only the third location in the UK where it has been used, creating an opportunity to transfer lessons learned here to other areas across the country.

The food-growing beds have quickly become well used. A food-growing club has been looking after the beds, and has successfully grown strawberries, blueberries, squashes, tomatoes and potatoes. Gardening has been proven to offer many benefits beyond providing tasty fruit and vegetables to eat, such as lowering stress levels, improving mental health and wellbeing, and improving physical fitness through low impact exercise.

Figure 4. Queen Caroline Estate rain garden – before and after

"This project has made a lot of improvements to the look of the estate, as well as helping to gel our community together." ***Ros O'Connell, Treasurer, Queen Caroline Tenant and Resident Association***

Cyril Thatcher, Eric MacDonald and Richard Knight Houses

These three and four storey blocks are situated on a compact and organised site in the centre of a Conservation Area, with relatively small-scale, well-defined open spaces that are accessible to all residents. Before the project started, these open spaces were used by some residents in the summer months, but given their small size they provided limited recreational opportunity. There are also a number of ancillary buildings across the estate, including pram sheds, bin stores and an electricity substation.

Figure 5. Cyril Thatcher, Eric MacDonald and Richard Knight Houses open space – before and after

Through discussions with residents, it became clear that, like the Queen Caroline Estate, residents were interested in food growing and were keen for there to be more colour and interest in the landscape. Large flat roofs on the residential buildings and on storage units meant that there were also potential spaces for green roofs.

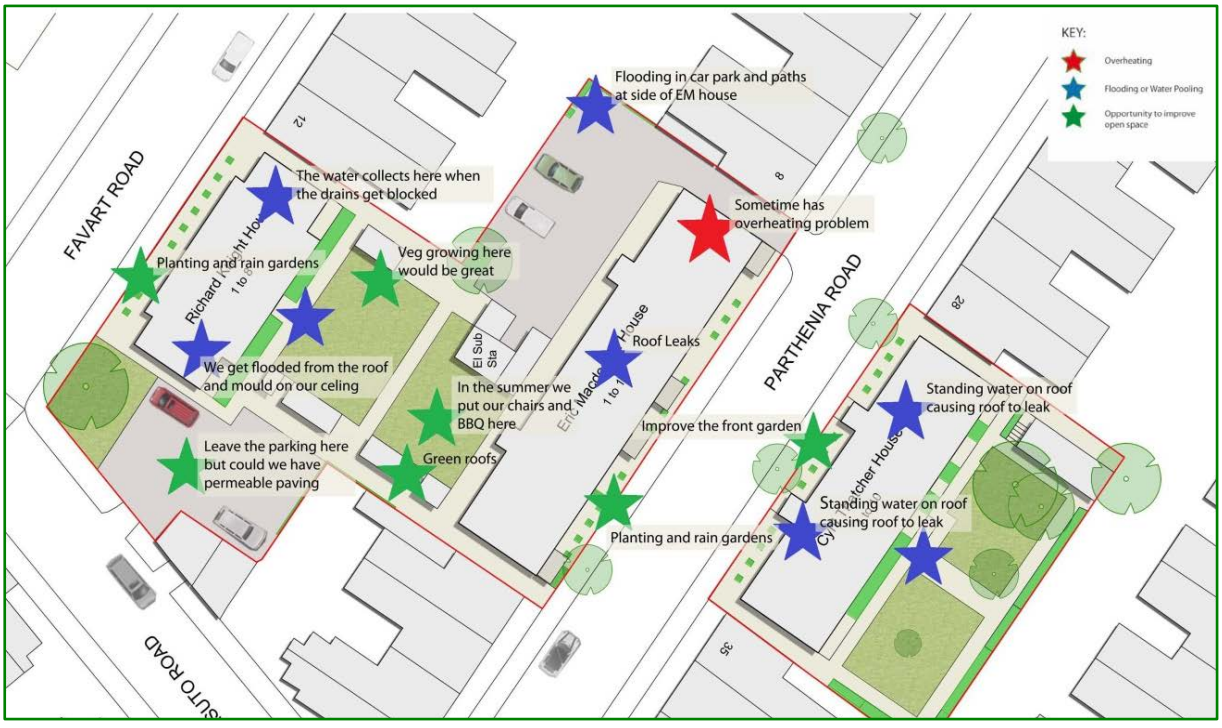


Figure 6. Cyril Thatcher, Eric MacDonald and Richard Knight Houses consultation comments, June 2014

Initial site survey work and discussions with Council staff and residents highlighted a number of weaknesses/threats and strengths/opportunities:

Weaknesses & threats

- Incidents of surface water flooding in the local area;
- Water pooling on the flat roofed buildings and reports of leaks in the top floor flats;
- Water pooling on the estate paths, particularly at the entrance to Richard Knight House, and in the car-parking areas;
- Some overheating of flats on the upper floors of the three blocks;
- The Borough is served by a combined sewer system with CSOs draining directly to the Thames. The Environment Agency assessment of Thames Tideway CSOs (EA, July 2011) identifies the Hammersmith Pumping Station CSO as a Category 1 CSO, meaning that it operates frequently and has adverse environmental impacts;
- Large areas of mown amenity grassland with little or no biodiversity interest; and
- Downpipes located internally, so not easily accessible.

Strengths & opportunities

- Large underused areas of open space (soft);
- Unused corners of the estate roads and parking areas, which could relatively easily be converted to small pocket rain gardens;
- Large flat roofed residential blocks with the potential for greening;
- A large number of ancillary buildings with flat roofs with the potential for greening;
- Scope for additional tree planting;
- Interest from the residents in expanding food growing; and
- A desire from residents for more diverse and colourful planting.

The prevalence of flat roofs on the estate in combination with the hard to access internal downpipes and the relatively small ground level open spaces, made the installation of green roofs a good option. Through discussions with Hammersmith & Fulham Council, it emerged that roof upgrades were being planned for Richard Knight House to improve waterproofing and insulation. This presented an opportunity for a green roof to be installed at the same time with limited additional disruption and the opportunity to keep the costs of greening to a minimum.

In addition to taking forward the green roof on Richard Knight House, green roofs have also been installed on the bin store and pram shed roofs, which unlike the roof of Richard Knight House are visible at ground level and from adjacent properties. The greening of these roofs has therefore contributed significantly to the attractiveness of the space and has been received very positively by residents.

Figure 7. Cyril Thatcher, Eric MacDonald and Richard Knight Houses green roofs, tree pit and rain garden

The extensive green roof installed on Richard Knight House is has been planted with a variety of wildflower species, providing diverse habitats for insects and birds. By intercepting and storing rainwater, it significantly reduces the quantities of water draining from the roof to the sewer and over the long-term also has the potential to help regulate the temperature of properties in the block. Experimental plots were used to enable an analysis of how the green roof performance varies according to planting type (seed or plug), substrate depth, and with or without the installation of a water retention fabric within the substrate.

Although there was limited space at ground level for interventions, it was also possible for the project to install food-growing beds within permeable paving, a combined rain garden and storm water tree pit and a small swale.

A small, unused section of the car park has been transformed into a combined rain garden and storm water tree pit. Rainwater falling on adjacent roofs and paving is directed to this feature via a surface channel. The water is then absorbed into the soil, providing water storage in times of heavy rainfall, and a source of water for the new tree and the plants in the rain garden. The rain garden and tree pit sit above a rock filled trench, which provides additional capacity for storing rainwater.

The swale outside Richard Knight House redirects water that previously pooled on the pathway. The water is now absorbed by the grass. The swale has been planted with a wildflower turf to make it look more attractive and to provide increased benefits to wildlife.

Figure 8. Cyril Thatcher, Eric MacDonald and Richard Knight Houses green roof and food growing beds – before and after

"The garden is much approved of by all of the residents, and we have seen a reduction in vandalism since it was built. As I am mostly at home due to my husband's dementia, having a garden gives me huge pleasure." ***Lyn Hally, Richard Knight House Resident***

Cheeseman's Terrace

Cheeseman's Terrace is a large but densely built housing estate with small pockets of green. The estate consists of 12 blocks of flats, predominantly positioned around three courtyard spaces. Before the project started, each courtyard consisted of paths, paved seating areas and amenity grass with scattered trees and play equipment, some of which was in a poor condition and not well used. The residential buildings, most of which are five-storey, are set close together, with a surrounding hard landscape dominated by roads, paths and car parks. There are also two three-storey rows of housing and a number of ancillary buildings across the estate, including a community hall, pram sheds and an electricity substation.

Through discussions with residents, it became clear that, like the other two study sites, residents were interested in food growing. Residents were also interested in improving the under-used open spaces, both for play and for quiet relaxation.

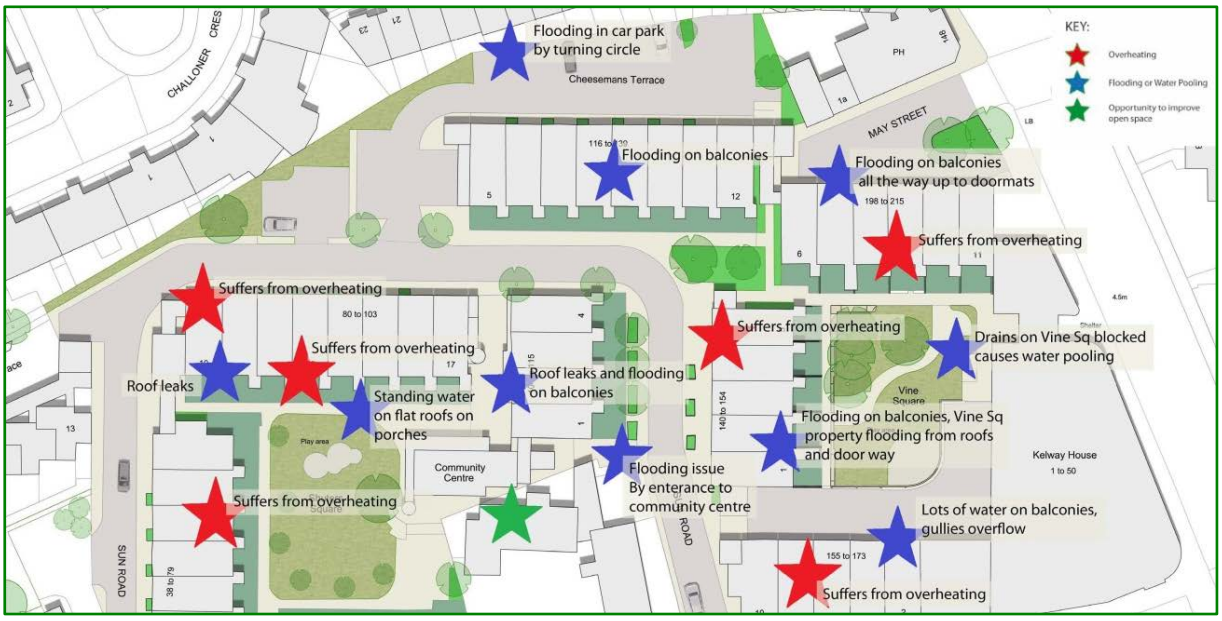


Figure 9. Cheeseman's Terrace consultation comments, May 2014

Initial site survey work and discussions with Council staff and residents highlighted a number of weaknesses/threats and strengths/opportunities:

Weaknesses & threats

- Incidents of surface water flooding in the local area;
- Water pooling on the flat roofed buildings and reports of some leaks into flats and/or damp;
- Water pooling on communal balcony areas;
- Water pooling on the estate paths and in the car-parking areas;
- Some overheating of flats on the upper floors of the blocks;
- The Borough is served by a combined sewer system with CSOs draining directly to the Thames. The Environment Agency assessment of Thames Tideway CSOs (EA, July 2011) identifies the Hammersmith Pumping Station CSO as a Category 1 CSO, meaning that it operates frequently and has adverse environmental impacts;
- Limited green space; and
- Downpipes draining the roofs of the blocks located internally, so not easily accessible.

Strengths & opportunities

- Unused corners of the estate paths, roads, and parking areas, which could relatively easily be converted to small pocket rain gardens;
- Existing small planting beds and grass areas, which had the potential to be relatively easily converted to accept surface run-off from adjacent roads and paths;
- Large flat roofed residential blocks with the potential for greening;
- Some ancillary buildings with flat roofs with the potential for greening;
- Interest from the residents in expanding food growing; and
- A desire from residents for more diverse and colourful planting.

Figure 10. Cheeseman's Terrace rain gardens on Sun Road – before and after

With the limited soft landscape on the estate, there was a need for more of a focus on a greater number of small interventions scattered between the buildings. These included green roofs on pram sheds, small grassy basins and rain gardens designed to drain adjacent parking areas, permeable paving on the vehicular access to one of the blocks and a series of small rain gardens set in paved areas and underlain by an infiltration trench. The resident gardening club was initiated through the project, and has become very active; the club has now taken over the management of several flowerbeds across the estate. Natural play features have also been incorporated in one of the courtyards in combination with a small rain garden, to encourage recreation.

Figure 11. Cheeseman's Terrace improvements to Orchard Square – before and after

REPLICATING THE APPROACH

4. Replicating the Climate-Proofing Social Housing Landscapes project approach

The need for climate adaptation measures in social housing landscapes across Europe continues to grow, with the ever-increasing risk of extreme weather events affecting those living in social housing, who are often particularly vulnerable to their impacts. In the context of limited available resources and competing priorities, housing providers are in need of adaptation solutions that can be implemented easily and at a relatively low cost, in order to ensure that their housing stock and open spaces are capable of withstanding future changes to the climate and that their residents will not suffer from the impacts of these changes.

The *Climate-Proofing Social Housing Landscapes* project demonstrates a holistic approach to making social housing landscapes climate ready and fit for the future, bringing together the implementation of climate adaptation measures with a comprehensive programme of resident engagement, training for housing professionals and maintenance staff, and apprenticeship and employment programmes for the long-term unemployed. Given the similarities between different housing landscapes across Europe, and the shared challenges that are being faced, all of these elements of the project could be adapted and transferred to social housing landscapes in other European cities. This gives the potential for widespread implementation of climate adaptation measures across Europe, building on the approaches and experiences of this project.

As set out in this Guide, the approaches adopted in the project show that there are cost effective, socially acceptable and highly replicable alternatives to heavy engineering, which can deliver positive environmental, social and economic impacts not just in the context of UK social housing but also in social housing environments across Europe.

The following sections offer guidance for those looking to implement similar initiatives to the *Climate-Proofing Social Housing Landscapes* project, based on the experiences and lessons learned from the project. They give an overview of each key stage, before setting out key recommendations for other projects of this nature as well as identifying some challenges or risks that may need to be mitigated or addressed. This guidance is from the perspective of both delivery partners in the project – Groundwork London and Hammersmith & Fulham Council – as well as other key stakeholders.

IMPLEMENTATION

5. Implementation of Green Infrastructure Interventions

5.1 Overall project planning, start-up and management

At an early stage, it is important to put in place a plan for the overall management of the project. This should cover the ongoing management of the project once implementation is underway, to ensure that the project is delivered as planned, within agreed budget and timeframes and with the engagement of appropriate stakeholders.

In the *Climate-Proofing Social Housing Landscapes* project, this process included the following key steps:

- The need: understanding the environmental problems to be targeted and how they could be addressed;
- Desired outcomes: agreeing the project's key aims and objectives;
- How to get there: agreeing the key actions and activities required to meet these targets;
- What will happen as a result: projecting expected results and impacts;
- Who to work with: identifying partners and other key stakeholders;
- How to finance this work: identifying and securing funding sources;
- What could go wrong: understanding potential risks and constraints; and
- Sharing information: planning for effective communication and dissemination.

Key recommendations

- Plan realistic timeframes – for example, build in sufficient time for the approval of works into the project plan;
- Ensure sufficient funding for the full project to avoid any funding gaps which may then delay works; look for opportunities such as linking to planned maintenance works (which can offer multiple benefits in addition to costs);
- When securing funding, demonstrate the necessity of the work so that it is not just seen to be something that is additional to requirements;
- Try to plan for a staggered approach to different project stages (such as design, engagement and implementation) if working across multiple sites, to avoid large gaps between activities;
- Prepare for unforeseen events by talking with the right people throughout different project stages and developing a risk register which is reviewed on a regular basis, in order to keep on top of potential issues and challenges;
- Have a flexible approach to financial management to allow for new information to be taken on board and unexpected expenses to be covered;
- To secure longevity, do not approach this kind of project in isolation but encourage cross-disciplinary working. For example, in the local authority context it will be much more effective to involve and influence different departments as much as possible (such as housing, planning, flood risk);
- Secure senior level buy-in within the housing organisation / local authority from the start;
- Develop a strong project management approach, with systems in place to ensure its successful delivery;

- Organise monthly meetings with relevant stakeholders in attendance in order to keep track of progress and give time for any issues to be discussed and addressed;
- If possible, work with an external advisory group to support the project's transferability and promotion across a range of relevant sectors, including housing, landscape, water management and environment;
- Put in place an internal project communications plan and protocols to ensure the project benefits from frequent and effective communication between delivery partners, across departments and within project teams.

Potential challenges to address

- The budget may be insufficient to meet project requirements; especially if expenditure is not tracked on a regular basis once the project is underway;
- Funding may not be received when expected – be prepared to re-plan project timescales as necessary as this could have a knock-on effect on key project activities;
- If funding is secured from multiple sources (for example, European and local), be aware that expectations and requirements from these different funders will need to be managed and addressed;
- Consider that the project may need to be delivered within the budget constraints of a housing association or local authority, which may mean plans have to be scaled back;
- Project teams may not have the necessary capacity and skills to deliver the project successfully, and therefore may need training in particular areas;
- Project management and delivery teams may change over time, which risks delaying the project – good handover notes and established handover processes are critical.

5.2 Spotlight on: establishing project partners and other key stakeholders

Relevant stakeholders

There is a wide range of relevant stakeholders that need to be engaged in a green infrastructure project. This will depend on the location and measures to be installed, as well as the organisation of social housing in the relevant country. Different stakeholders will also need to be engaged at different stages of the process – from those who need to be engaged early on to ensure a project can go ahead to those who need to be involved over the longer term, for example in the management or maintenance of measures.

However, broadly speaking the following groups of stakeholders should all be considered:

- Architects / urban designers
- Spatial planners
- Local authorities (including local planning authority and lead local flood authority)
- Water companies
- House builders (if new development)
- Ecologists
- Housing associations and other providers
- Landscape architects
- Water engineers
- Academics
- Local residents
- Wider local community

Climate-Proofing Social Housing Landscapes **project partners and stakeholders**

Building on the list above, the key partners and external stakeholders involved in the *Climate-Proofing Social Housing Landscapes* project are listed below. The project demonstrated a holistic approach, with multiple teams working together to ensure its successful delivery. Many of the stakeholders involved, or at least the categories they belong to, will be relevant for similar projects elsewhere in Europe.

Lead partner - Groundwork London:

- Project Director
- Project Manager
- Senior Community Project Officer
- Community Project Officer
- Landscape Architects
- Communications team
- Green Team managers
- Green Team apprentices
- Finance team

Local authority partner (social housing provider) - Hammersmith & Fulham Council:

- Housing and Regeneration –
    - Head of Estate Services
    - Housing Improvement Project Manager
    - Housing officers
    - Grounds Maintenance contractors
    - Property services officers
    - Repairs and Building Maintenance teams
    - Health and safety teams
- Finance –
    - Principal Accountant
- Environment –
    - Flood Risk Manager
    - Biodiversity Officer

External stakeholders:

- Residents and Tenant and Resident Associations (TRAs)
- Water company
- Environment Agency
- Consultancies – green infrastructure specialists
- Monitoring / evaluation experts (University of East London)

External advisers:

- Landscape Institute
- National Housing Federation
- Town and Country Planning Association (TCPA)
- London Climate Change Partnership
- Natural England
- Environment Agency
- Thames Water
- Greater London Authority (GLA)
- CIRIA

Guidance for effective partnership working

When engaging with external stakeholders on such initiatives, it is worth considering the following guidance:

- Understand each stakeholder's role, priorities and interests – different stakeholders will need to be involved in a project for different reasons, and are likely to have their own goals (which may or may not match the objectives of the project itself). The working relationship will be much more effective if these factors are understood and built into the engagement process from the start.
- Engage at the right level of the organisation – senior members of staff may be the decision-makers but may not have time to engage; whereas less senior members may be essential to work with on a day to day basis but may need to seek approval for big decisions.
- Engage each stakeholder at the right time – different stakeholders will be key to different stages in a project; some will be vital in the preparation phase, whereas others will need to be involved in dissemination. Consider each stakeholder's contribution to the project and ensure that clear plans for working with them are put in place in advance.
- Sell the benefits – as set out in this Guide, there are many potential benefits of these projects; however, housing providers are likely to have a number of competing priorities, which may mean that green infrastructure is not part of their plans. Highlighting the clear environmental, social and economic benefits of such a project will help to demonstrate why it should be given priority; this will also help to secure funding too.
- Draw up a partnership agreement at the start, setting out each partner's role and responsibilities, as well as timeframes for key activities. Plan regular progress meetings and reports as appropriate to the project, to ensure that progress towards objectives is tracked.

5.3 Spotlight on: securing project finance

With many housing providers facing budget cuts, securing sufficient funding to finance such projects can be difficult. The earlier sections of this Guide set out the need for climate adaptation measures, given the potential risks of a changing climate to social housing and its residents. When housing providers are developing their business plans and maintenance schedules, these arguments should help to ensure that such measures have their place among other competing priorities.

However, where there is a risk that implementing such measures could mean that other essential services can no longer be provided, it is worth considering the following potential opportunities:

- Review planned investment in open spaces, including green infrastructure, as it may be possible for additional measures to be added on as part of this;
- Consider if it would be possible to install measures as part of planned maintenance activities, as this is likely to reduce the costs compared to what they would be if the measures were installed on their own;
- Investigate any existing streams of money for groundworks on the site;
- Explore external sources of funding, either locally, nationally or at the EU level; for example, if the area is prone to flooding, funding may be available for flood risk management;

- Consider the scale, as it may be possible to deliver small-scale interventions at a low cost, involving residents in the design, implementation and maintenance;
- Review local, regional and national policy objectives and priorities to establish where funding might be available;
- Partner with organisations/institutions that are committed to delivering on related targets.

The *Climate-Proofing Social Housing Landscapes* project was co-funded by the EU's LIFE+ programme, the financial instrument supporting environmental, nature conservation and climate action projects throughout the EU.[12] This financial contribution made up 50% of the project costs, with the project partners meeting the other 50% through match funding from various sources, including the Greater London Authority's Drain London programme and other Hammersmith & Fulham Council funds. Due to the success of the project, it has also been possible to leverage additional finance to fund further measures on the estates after the completion of the European-funded project, as well as the ongoing monitoring of the environmental impacts of the interventions. This will help support the impact of the project over the longer-term and will continue to contribute to the evidence base for such initiatives.

Capital costs of the *Climate-Proofing Social Housing Landscapes* project

Relative costs per m^2 of land improved – project works and 15 housing estate improvement projects undertaken by Groundwork London in LBHF in the last 3 years:

Works	Relative costs per m^2
General landscape improvements (entrances, paving, soft landscape)	1.00
Traditional play areas and outdoor gyms (play surfacing and equipment)	1.40
Natural play and food growing areas (soft landscape works with timber furniture)	0.55
Ground-level SuDS (hard and soft-landscaped basins, channels and associated paving)	0.90
Green roofs, excluding waterproofing (residential block, pram sheds and bin stores) [excluding gabion edging]	1.68 1.22

[12] See http://ec.europa.eu/environment/life/index.htm

Available funding opportunities for green infrastructure projects will depend on the specific areas or even measures in question, and the timing of each project. However, at the European level there are currently a number of opportunities worth exploring when planning for green infrastructure interventions in urban housing contexts:

- Natural Capital Financing Facility: under the NCFF, the European Investment Bank (EIB) will provide loans and investments in funds to support projects that promote the preservation of natural capital, including adaptation to climate change (such as green infrastructure measures), in the Member States. The NCFF runs from 2014-2017 and has a total budget of €100-125 million.
- Green infrastructure projects can be supported through programmes integrated into Member States' development strategies and co-financed from the Structural Funds (the European Regional Development Fund and European Social Fund), the Cohesion Fund, LIFE+ (which the *Climate-Proofing Social Housing Landscapes* project has benefited from) or the Horizon 2020 funding programmes.
- EU funding for climate change mitigation and adaptation could also provide significant co-benefits for green infrastructure. The EU's multi-annual financial framework for the period 2014-2020 ensures that at least 20% of the European budget is climate-related expenditure and proposes greater financing opportunities for green infrastructure projects.
- The private sector can also play a role in financing green infrastructure projects, given the budget limitations of public funds and the benefits on offer. This could include public-private partnerships, or through tax incentives, loans and bonds.

5.4 Design and implementation

Once the project has been set up, key stakeholders established and finance secured, it is time to consider the detailed design and implementation of climate adaptation measures. The *Climate-Proofing Social Housing Landscapes* project took the following approach to these stages of the project:

- Initial audit:
    - Desk-based data collection and site surveys – site context and site analysis
    - Community consultation events to characterise the sites and identify their strengths and weaknesses
- Assessment:
    - Interpretation of the site surveys and community consultation results to identify environmental threats and opportunities
    - At this stage, opportunities were identified with an open mind in the knowledge that the feasibility and prioritisation stages could be used to screen and then prioritise options
- Feasibility assessment:
    - Screening opportunities based on an assessment of key factors such as green infrastructure functionality, technical feasibility, financial feasibility and maintenance requirements
    - Expert input to the process (e.g. structural engineer, drainage engineer, ecologist)

- Prioritisation:
    - Short-listing of opportunities using a simple multi-criteria assessment method to establish a prioritised list of interventions to take forward to sketch design
- Design:
    - Master plans for each estate
    - Outline and sketch proposals for sites within each estate
    - Further feasibility surveys – topographical, soil contamination, utilities, structural (roofs identified for green roofs)
    - More detailed design covering materials, aesthetics, spatial arrangements and maintenance requirements
    - Technical review (including drainage calculations)
    - Working with the local authority (housing, flood risk, hard & soft maintenance contractors) and with residents to get their input to the design proposals
    - Initial cost estimates
    - Securing planning permission
- Preparation for implementation:
    - Revised cost estimates for specific elements
    - Timelines for implementation
    - Drafting maintenance schedules
    - Tender actions - tender drawings, schedules of work, material specifications and bills of quantities, tender issue and analysis
    - Contract preparation and issue
- Implementation:
    - Pre-start meetings
    - Contractors delivering hard landscaping works on site
    - Soft landscaping by Green Team apprentices
    - Contract administration
    - Installation of noticeboards to keep residents informed
    - Ongoing resident engagement including food growing and gardening clubs

Key recommendations

- Get information on the local landscape from the housing provider or local authority – for example LIDAR data[13], flood risk assessments, flood modelling, flood records, historic land use;
- Ideally surveys (topographical, ground investigation, below ground services) would be undertaken for the entire area under consideration and before design work begins. However, this can be costly and it may be more cost effective to commission surveys slightly later in the design process (concept or sketch design) so that they can be better targeted. An on-site assessment of the existing drainage system combined with service information from utilities companies should be sufficient to support feasibility assessments and early design stages;
- Source information on the design and construction of adjacent buildings (for example, original architects drawings) from the housing provider or local authority (typically kept within archives);
- If monitoring/performance assessment will feature as part of the project, start planning for this at the design stage, including considering what needs to be monitored and the expertise required to do this;
- Look for opportunities to integrate proposals with other planned maintenance and refurbishment works, such as incorporating roof greening with planned roof upgrade works;
- Focus expert external assistance and advice at key project stages, for example feasibility/concept design, detailed design and post construction reviews (as required), and be clear on the scope of information required at each stage;
- Consider how existing features may need to be modified to support the functioning of the new measures (such as tree works, guttering repairs, re-location of services);
- Design in infrastructure such as taps, or preferably water butts, to support maintenance, particularly during establishment;
- Look at the success of existing planting types and be realistic with residents about the pros and cons of different types of planting. For example, wildflower meadow can look spectacular during the spring and summer, but may not be to everyone's taste in the autumn and winter. Planting schemes should balance benefits for wildlife and for residents;
- Use TRAs, housing officers and caretakers to help with access to information about the estate;
- Ensure that there is safe access for the construction works and for maintenance;
- Incorporate additional elements such as informal play features, access improvements and food growing in addition to the core climate change adaptation measures to ensure resident buy-in and encourage the use of spaces;
- Try to allow a long lead in time prior to construction, especially for elements where the current scale of the market may mean they have limited availability (such as SuDS wildflower turf). If materials are new to those delivering the project, consider visiting existing projects to see how the materials perform;

[13] Light detection and ranging (LIDAR) is an airborne mapping technique that provides digital elevation data and allows highly detailed terrain models to be generated. In England this data is collected and provided free of charge by the Environment Agency, which now has accurate elevation data for 72% of England.

- Work closely with contractors; ensure they are fully briefed on design specifications and the use of any non-standard materials; ensure they are clear on the resources and equipment needed and are available throughout the required period; provide them with a briefing on customer care at the project outset so that they can deal with resident enquiries effectively; and ensure measures installed by them are protected through agreements with the housing provider;
- Build in contingency and prepare for unknowns, such as those relating to services – even with good preparation, unexpected challenges can still arise;
- Ensure an appropriate level of site visits to inspect the quality of works;
- If creating new apprenticeship/employment opportunities, ensure the teams are well supported by a supervisor;
- Deliver post-implementation surveys to monitor and inspect works and be prepared to work with contractors to rectify any aspects that are not working as expected;
- Ensure noticeboards and information located on temporary construction fencing provides clear detail of plans and timelines for the work; on completion of works install permanent information boards to explain designs and features.

Potential challenges to address

- The design and implementation period may take longer than initially planned (for example, there may be delays in securing planning permission); this could have knock-on effects on other elements (for example, the installation of measures may have to take place at a different time of year than planned, when planting may be more difficult);
- Even with below ground services survey information, unmarked services may exist and services may be found at different depths or in slightly different locations. Contractors should always take the necessary precautions (for example, CAT scanning) and some elements may have to be re-designed during the construction stage to accommodate services;
- Feasibility assessments and surveys may generate results that require plans to be adapted – this means a flexible approach may be required;
- It may be difficult to get resident or other key stakeholder buy-in for the planned measures – see section 7 for guidance on how this can be done;
- Managing residents' interests and concerns whilst contractors are on site could prove difficult where there are delays or where residents are dissatisfied with the level of disruption during works.

5.5 Spotlight on: feasibility assessment and prioritisation

In the *Climate-Proofing Social Housing Landscapes* project the site survey work was undertaken during December 2013 and January 2014. This was followed in March and May 2014 by a series of consultation events held at each of the three estates to introduce residents to the project and to gather information on:

- How residents use the green spaces on their estate;
- Problems residents experience (flooding, water pooling, overheating, lack of provision of certain facilities); and
- Ideas residents had for green space improvements.

Each site was considered at two spatial scales, with the surveys considering both the site itself (for example, existing vegetation, drainage regime and so on) and the local context of each estate (such as open space provision and recreation opportunities, flood risk and so on).

A series of survey plans were prepared for each site, with the support of Groundwork London's GIS team. These survey plans overlaid the data collected with information retrieved from site visits into a spatial map of each estate. These include location plans, land use data, open space and recreation mapping, nature conservation designations, surface water flood modelling, air pollution (particulates & nitrogen dioxide) and traffic noise. In addition, site plans visually represented the arrangement of buildings, hard standing and green space across the three estates, a vegetation survey, drainage survey, access and movement survey, greening opportunities and drainage opportunities, consultation comments, photo survey and shade analysis.

In the **assessment** stage the spatial maps and site plans were analysed to consider the range of environmental threats and issues experienced by the three estates and review the extent of opportunities for retrofitting green infrastructure. Environmental threats were considered to include exposure to overheating, risk of flooding and water scarcity and drought. Opportunities were considered to include urban greening through green roofs, walls and increased tree planting, sustainable drainage systems including ground-level rain gardens, swales, basins and permeable paving and water storage through rainwater harvesting systems. Furthermore, green infrastructure opportunities were evaluated with regards to their effect on climate mitigation, improving surface water run-off and air quality, biodiversity, visual amenity, opportunities for play and increased social interaction through for example, food growing.

Groundwork London's landscape team worked with the housing provider and residents to develop a shortlist of interventions for each of the three estates, which would each be prioritised according to key criteria. In order to assist with the **feasibility assessment**, Groundwork London appointed a consortium led by The Ecology Consultancy (TEC) to provide technical support and specialist expertise throughout the design process. The TEC consultancy team included leaders in green infrastructure assessment and implementation, responsible for the design and build of many green roofs, living walls and rain gardens.

With the support of the TEC consultancy team, a methodology for the **prioritisation** and selection of measure on the three estates was developed. This involved applying a site-specific multi-criteria scoring and weighting system to the long list of adaptation measures for each estate identified through the feasibility assessment, with weighting based on the key objectives of the project (for example, effectiveness at climate change adaptation was given a greater weighting than other factors such as play and recreation). The criteria included:

- Effectiveness in reducing the risk of flooding, exposure to overheating and reducing water scarcity;
- Contribution towards wider green infrastructure benefits (biodiversity, amenity, water quality, air quality etc.);
- Technical and financial feasibility;
- Maintenance requirements; and
- Social acceptability and aesthetic quality.

The prioritisation process resulted in a shortlist of interventions for each of the three estates, which were then agreed with the housing provider. Based on these findings, the landscape team developed initial outline proposals for the retrofit of green infrastructure on the three estates. Early iterations set out how the estate open spaces could accommodate different types of retrofit green infrastructure. These were developed into master-plans for each estate and sketch designs and visualisations for sites within each estate. These were used to discuss the proposals with stakeholders.

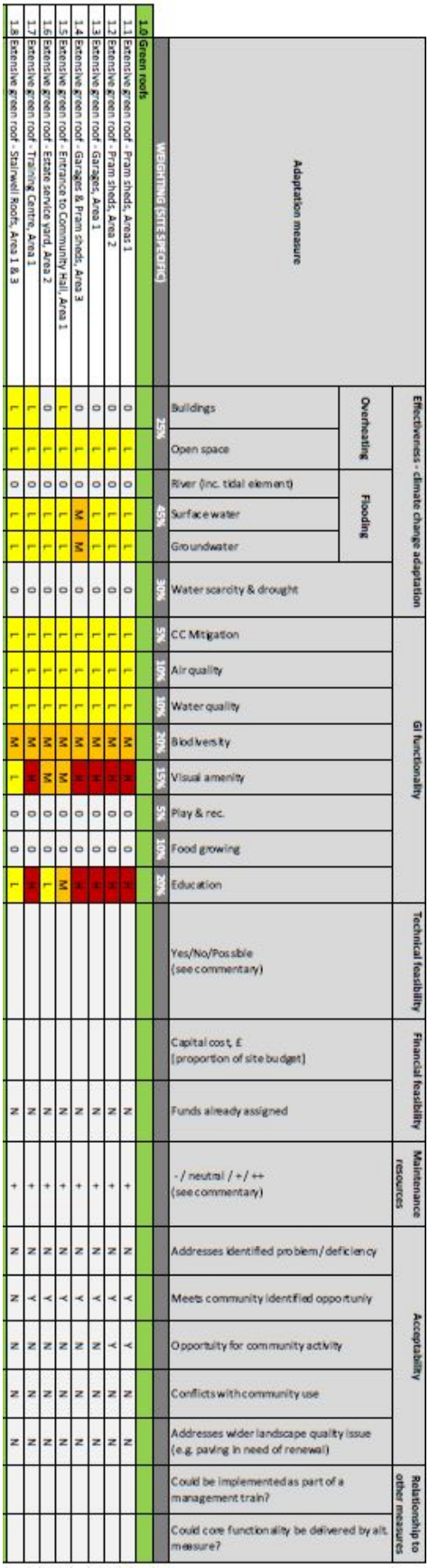


Figure 12. Example of screening and prioritisation process

5.6 Management and maintenance

As well as preparing for implementation, it is also equally important to plan for the ongoing management and maintenance of interventions, to ensure their ongoing effectiveness in the long term.

The key stages in the *Climate-Proofing Social Housing Landscapes* project were as follows:

- Finalising the maintenance schedule – this was drafted in the design stage but had to be finalised based on measures installed, and agreed with the housing provider;
- Green Team maintenance of soft landscaping works;
- Training courses for housing and grounds maintenance professionals to support ongoing maintenance and replication elsewhere (see below);
- Further engagement with residents to support their involvement in looking after the measures;
- Maintenance handover with housing provider's maintenance teams;
- Ongoing communication and dissemination of project information, results and lessons learned to a wide range of stakeholders across Europe.

Key recommendations

- Align with existing maintenance programmes where possible, for example existing estate renewal processes, which can help to lower costs;
- Review best practice and industry standards in green infrastructure and SuDS maintenance in order to develop a comprehensive maintenance schedule for all component measures;
- Consider offering training to maintenance contractors to support the maintenance of interventions in the long term (see section 5.7 below) – if residents are also to be involved in maintenance, they may also require basic training;
- Develop maintenance statements and create a manual with construction drawings so that stakeholders know what has been delivered;
- Ensure there is a plan and budget in place for continued maintenance beyond the project funding period to ensure the effectiveness of interventions throughout their design life;
- Consider dissemination and communication opportunities for the project, for example the potential for awards, case studies or other channels for project recognition to support project publicity.

Potential challenges to address

- Maintenance of climate adaptation features could be seen by maintenance contractors to be an additional cost or effort compared to existing maintenance plans, and they may therefore not be happy to include it in existing contracts;
- Maintenance contractors may not have the necessary skills to maintain interventions that require different treatment, highlighting the importance of clear maintenance schedules;
- If maintenance schedules are not clear, or not adhered to, the effectiveness of interventions may be significantly reduced;
- If residents are not aware, or supportive, of the interventions they may cause damage which would make the maintenance of interventions more challenging or costly;
- Protecting features could be challenging in the long-term where future estate maintenance or renewal plans may disrupt installed measures.

5.7 Spotlight on: training for housing staff and maintenance contractors

Over the course of the *Climate-Proofing Social Housing Landscapes* project, Groundwork London delivered eight workshops to develop the local institutional capacity of the local authority and its maintenance contractors to facilitate the replication of the project's approach across the Borough. This aimed to ensure that housing staff and contractors understand the impacts of climate change at a local level and are equipped to specify and maintain retrofit solutions going forward.

Two training programmes were developed. The operatives training programme sought to ensure that climate adaptation measures can be effectively planned for and maintained as part of the estates services provided by the housing provider to residents on the three estates. The workshops were designed to ensure that operatives understand how common green infrastructure measures can be integrated into routine maintenance so that they are confident in carrying out routine and special maintenance inspections. The senior management training programme aimed to support the wider implementation of climate adaptation measures within the borough through supporting the commissioning, financing and communication surrounding green infrastructure retrofit measures.

Although the training in this project was developed specifically for the London Borough of Hammersmith and Fulham, the detailed content could be easily adapted to reflect any other local authority or neighbourhood area. It is likely that the training needs identified and addressed through this project are similar in other areas, especially where housing providers are exploring such initiatives for the first time.

The methodology used in this project was as follows:

- Initial training needs analysis, stakeholder identification and review of the existing green infrastructure training market; this included a survey sent to individuals identified by Hammersmith & Fulham Council;
- Training workshops outline developed using findings from this initial research;
- September 2014: two introductory workshops to define training scope and content (operatives / senior management);
- Detailed content and format of delivery established using feedback from introductory workshops;
- July 2015: 1st masterclass for housing sector professionals, featuring a tour of project sites and Q&A with expert panel;
- December 2015: operatives training:
    - Introduction to green infrastructure and SuDS
    - Maintenance of green infrastructure and SuDS
- January 2016: senior management training:
    - Introduction to green infrastructure and SuDS
    - Stakeholder engagement and acceptance
    - Tackling environmental issues and delivering high quality retrofit solutions
    - The business case and financing
- January 2016: Effectiveness evaluated through feedback from participants and evaluation report completed;
- April 2016: Maintenance refresher and handover of project sites to maintenance contractors; including going through the maintenance schedule from Groundwork London, with specific guidance on green roof maintenance due to the particular treatment required;
- September 2016: 2nd masterclass for housing sector professionals, focused on transferability and replicability of project approaches.

Groundwork London is currently in the process of securing accreditation with Lantra, the UK sector skills council for land based and environmental industries, to support wider roll out of the programme across the housing sector. An update on this will be provided, when available, on the project website at www.urbanclimateproofing.london.

Benefits of training

Operatives training can help ensure that teams are aware of the benefits offered by climate adaptation measures and why these are important, as well as the maintenance requirements and how these differ or overlap with usual maintenance practices. It can also help to increase confidence in carrying out maintenance tasks and provide an opportunity for participatory learning through practical workshops.

Operatives training participants on how they will use the training:

'Immediately - I will use experience gained in sustainable drainage in carrying out planned maintenance works.'

'Within 3 months, I aim to liaise with my TRA, show them the benefits of SuDS and encourage them to make their own bids to improve their estates.'

Senior management training can help to ensure that there is a coordinated communications effort at senior level with consistent messaging around the green infrastructure and SuDS agendas, building a strong evidence base and using the evidence of the problem to inform investment decisions, as well as the need to consider the most effective ways of involving residents and the wider community. It can also help staff to recognise the need for an inter-departmental approach to climate adaptation, and in turn trained staff can help to educate other teams on this.

Senior management training participants on how they will use the training:

'Will be useful immediately when assessing flood risk assessments and SuDS proposals for major developments.'

'I would consider SuDS as part of any future project I might manage.'

Guidance and recommendations for delivering training

Some recommendations that have emerged from the experience of delivering training through this project are as follows:

- In many cases housing staff and maintenance contractors will not have much previous experience of climate adaptation measures; an initial survey can help to identify the existing awareness and any gaps that need to be addressed;
- Consider including practical workshops and site visits as part of the training so that participants can see the areas in question and also see examples of the measures first hand; for operatives this could also include a mock maintenance visit where participants can put the learning into practice;
- Where site visits are not possible, before and after photos can help participants to visualise the changes and illustrate the scale of transformation possible;
- Consider grouping together workshops in a single day or half day to make the most effective use of participants' time;
- Try to involve practitioners from across different disciplines – this is likely to make for interesting discussion and allow participants to consider improved ways of working to deliver shared objectives;
- Maintenance, stakeholder engagement and acceptance, and costs compared to traditional approaches are all key areas that are likely to be of interest to training participants – these topics should be built in to training materials where possible;
- Develop learning materials tailored to each group of participants that can be taken away at the end of the course and used as a reminder of key learning;
- Although not always practical, if delivering a project in multiple sites modifying learning materials so that they are place-specific could help to facilitate learning;
- Decide the appropriate timing for the training to take place – it may be best to hold workshops when implementation is underway to ensure that adequate learning from the project's delivery can be shared and that there are live examples of completed projects to illustrate the principles of the training; this may also reduce the need for a refresher course.

IMPACT MONITORING & EVALUATION

6. Impact Monitoring and Evaluation

6.1 Overview of project impacts

The *Climate-Proofing Social Housing Landscapes* project has resulted in a range of environmental, social and economic benefits for the three West London housing estates, their residents, the local authority, and the wider local area.

- Environmental results – a range of quantitative impacts leading to increased resilience to climate change
- Social results – quantitative and qualitative impacts, including jobs or apprenticeships created, health and well-being benefits, community cohesion, reduction in crime and anti-social behaviour, use of areas for play and relaxation, resident interest and awareness in climate change issues and impacts
- Economic – jobs or apprenticeships created, financial savings

6.2 Overview of project monitoring and evaluation approach

Technical performance

In this project, an academic partner, the University of East London (UEL), was appointed to monitor the climate adaptation impacts of the various interventions across the three sites. UEL has a wealth of experience in measuring the impact of adaptation measures, which has enabled the role of specific interventions to be effectively quantified. Using a range of tools, a number of qualitative and quantitative indicators have been assessed:

- Performance of measures during rain events (e.g. infiltration rates) and the development of vegetation captured using fixed-point time lapse cameras at key locations near to the interventions, which took a photo every 15 minutes during the monitoring period (day and night)
- Environmental conditions, including the timings and size of rain events, temperature, wind direction and speed, and humidity, monitored using weather stations; this enabled a comparative analyses to be made with the fixed-point photo monitoring and other monitoring data
- Aspects such as rain water inputs and infiltration times monitored using flowmeters at inlets (e.g. downpipes from roofs) and pressure sensors in basins, in order to understand the impact of selected rainfall events on surface water run-off and in turn measure the quantity of water diverted from reaching the sewer network
- Thermal monitoring using a thermal imaging camera to understand the impact on the urban heat island effect, with a focus on key aspects such as green roofs on particularly hot/cold days and comparisons made with untreated surrounding areas

- Biodiversity monitoring on the green roofs, using vegetation surveys to understand the floral species diversity (inventories to record every floral species and quadrats to monitor experimental plots on Richard Knight House); % vegetation cover was also monitored through this process, and residents were informed of the biodiversity monitoring through conversations with UEL whilst on site
- Photographic monitoring during site visits to create an archive of the development of biodiversity and to monitor elements as they develop and mature
- Simulated storm events to assess how selected interventions would perform in a 1 in 100 year storm event (as they were designed for), by pumping water into the intervention and monitoring data readings from the relevant monitoring equipment (e.g. pressure sensors), as well as undertaking photographic documentation and visual assessment.

On the residential green roof at Richard Knight House, experimental plots enabled an analysis of how the green roof performance varies according to planting type (seed or plug), substrate depth, and whether an Aquaten water retention membrane was installed or not.

In addition to monitoring the interventions across the sites, control sites were monitored where available, including control roofs on the estates, and a barologger was installed at UEL to enable the data compensation needed due to variation in day to day atmospheric pressure. This allows for a comparison between those areas with and without adaptation measures in place. As control sites are not easily available for ground level interventions such as basins and swales, simultaneous monitoring of site conditions and the performance of interventions helped to determine performance.

The above tools and methodology used to support the technical monitoring process in this project are widely transferrable to other similar initiatives elsewhere in the UK and Europe. The monitoring process has been documented in more detail in a separate monitoring report written by UEL, available at www.urbanclimateproofing.london.

Wider benefits

Given the range of environmental, social and economic benefits offered by these types of interventions, it is valuable to expand the monitoring scope of a project beyond its environmental benefits. In addition to the technical performance of measures, in the *Climate-Proofing Social Housing Landscapes* project a further evaluation of impacts was conducted using a combination of a Social Return on Investment (SROI) model and the CIRIA BeST tool.

SROI[14] is an outcomes based measuring tool that provides a framework for measuring and accounting for a broader concept of value and incorporates the social, economic and environmental costs and benefits of a project. This enables an understanding of how the project adds value in terms of the social impacts of its actions, and helps to maximise the value of these impacts for local people. This approach involves further resident and other key stakeholder engagement, and can also help effectively communicate impacts to funders, other stakeholders and target audiences. SROI results can also help fund other similar projects, by building the evidence base and making the case for why such projects are important.

[14] www.neweconomics.org/issues/entry/social-return-on-investment

SROI is conducted in six key stages:

1. Establishing scope and identifying stakeholders – including how to involve them
2. Mapping outcomes – identifying inputs, outputs and outcomes
3. Evidencing outcomes and giving them a value – developing indicators and collecting data
4. Establishing impact – including the ways outcomes might have been affected by different variables
5. Calculating the SROI – including a sensitivity analysis and projecting into the future
6. Reporting, using and embedding

These stages are described in further detail in the UK Cabinet Office's Guide to SROI, with guidance set out for each stage.[15] SROI has been widely used to evaluate the broad range of impacts of environmental projects, for example in the work of Greenspace Scotland.[16]

BeST is a new tool developed by CIRIA to make assessing the benefits of SuDS easier, without the need for full-scale economic inputs.[17] It can be used to estimate the monetary value of interventions, across a range of factors from reduced flooding to lower temperatures. The tool has been developed with a view to supporting the provision of better information on the benefits of these schemes, which could help fund such schemes in the future. It also acts as a decision support tool by enabling a comparison between different options in both new build and retrofit contexts. In this project we put BeST to the test alongside SROI to help quantify the wider impacts of the interventions.

Impact on policy

The *Climate-Proofing Social Housing Landscapes* project also sought to inform local, national and EU policy and strategy around green infrastructure for climate change adaptation in the social housing sector, introducing best practice that can be used to inform the evidence base for policy changes.

With this in mind, the monitoring phase of the project also focused on the interventions' impact on policy. This included conducting an initial policy review and developing a policy influencing action plan in order to understand the policies that could be influenced and the key timings for doing so. Consultation responses were submitted and case studies written, as well as contributions made to guidance and other documents through engagement with relevant stakeholders (including the Greater London Authority, Thames Water and others) and networks (including the London Climate Change Partnership, All London Green Grid and Neighbourhoods Green). Following this, we gathered and documented any evidence for the inclusion of climate adaptation measures as strategic investment priorities within Hammersmith & Fulham Council's plans, and any wider impacts on local or regional policy-making.

[15] Available at: http://socialvalueuk.org/what-is-sroi/the-sroi-guide
[16] See www.greenspacescotland.org
[17] Available at: www.ciria.org/News/CIRIA_news2/New-tool-assesses-the-benefits-of-SuDS.aspx

6.3 Key impacts of interventions

The results of the project monitoring and evaluation help to demonstrate the need for investment in green infrastructure and the benefits that schemes of this nature can deliver.

Technical performance

The results from UEL's monitoring of the interventions across all three estates demonstrate that the interventions are performing as designed, and as expected. In the period monitored the capacity of the ground level SuDS was never exceeded, which shows that they therefore diverted 100% of the rainfall away from the storm drain system. The results also show that green roofs absorbed an average of 89.02% of rainfall landing on them, again diverting rainfall away from the drainage system and supporting the growth of vegetation and increase in biodiversity in the process.

Some evidence of the success of these interventions from the monitoring results is presented below:

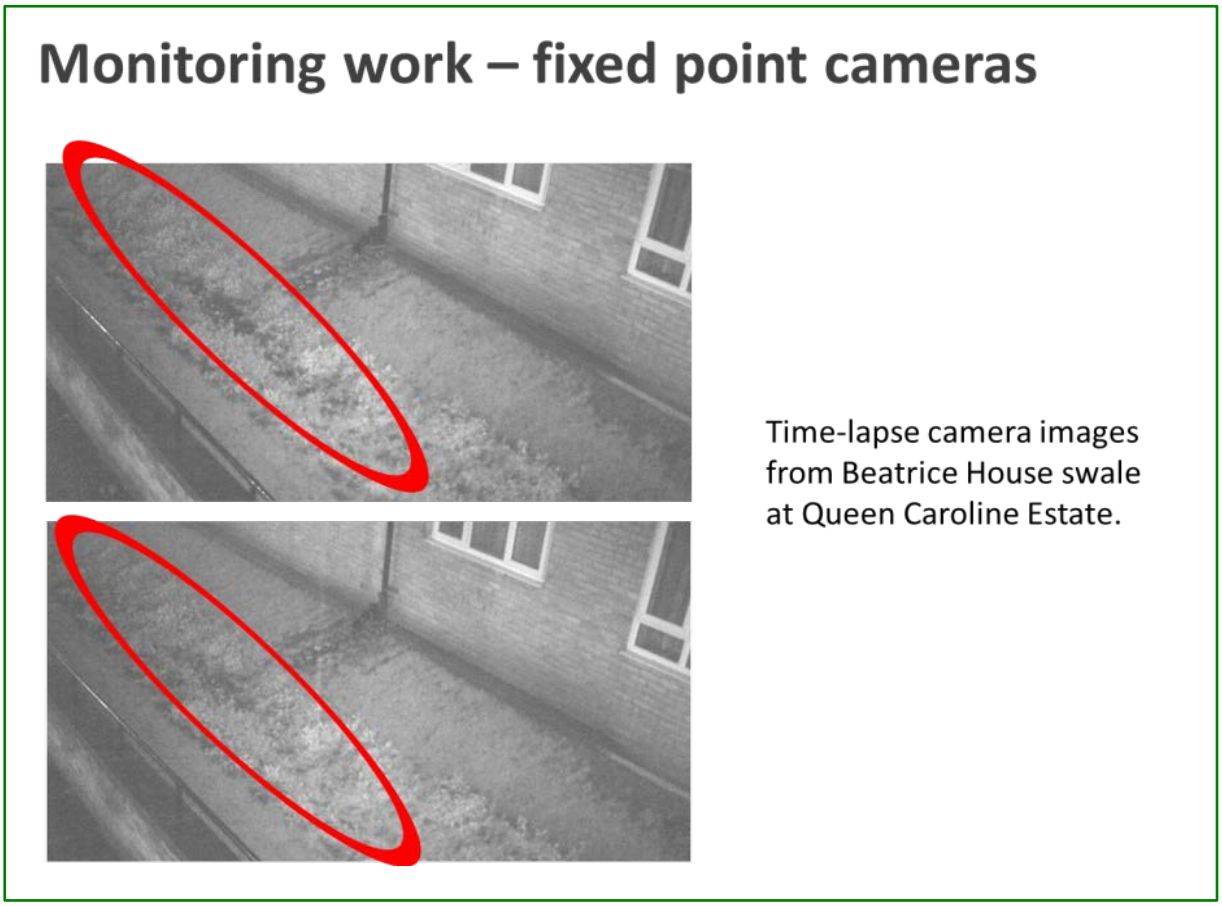


Figure 13. *Time lapse camera images from a swale at the Queen Caroline Estate during a heavy rain event (11th January 2016), with the top photo showing the basin filling during the heaviest rainfall period, and the bottom photo showing it empty again 15 minutes later. This demonstrates that the swale was able to retain and attenuate all of the rainfall that fell directly onto the area and that which was diverted from the roofs of the neighbouring block of flats.*

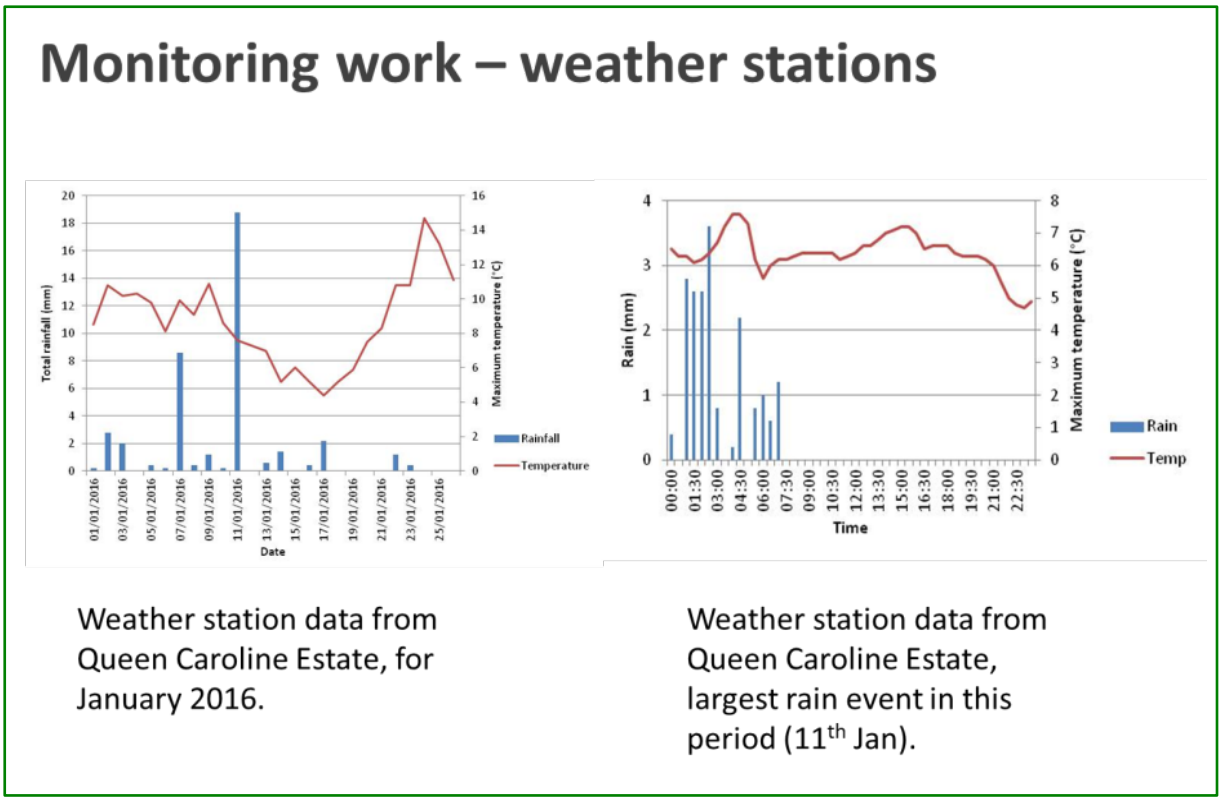


Figure 14. *An example of data generated by the Queen Caroline Estate weather station, showing rainfall and temperature during the same heavy rain event.*

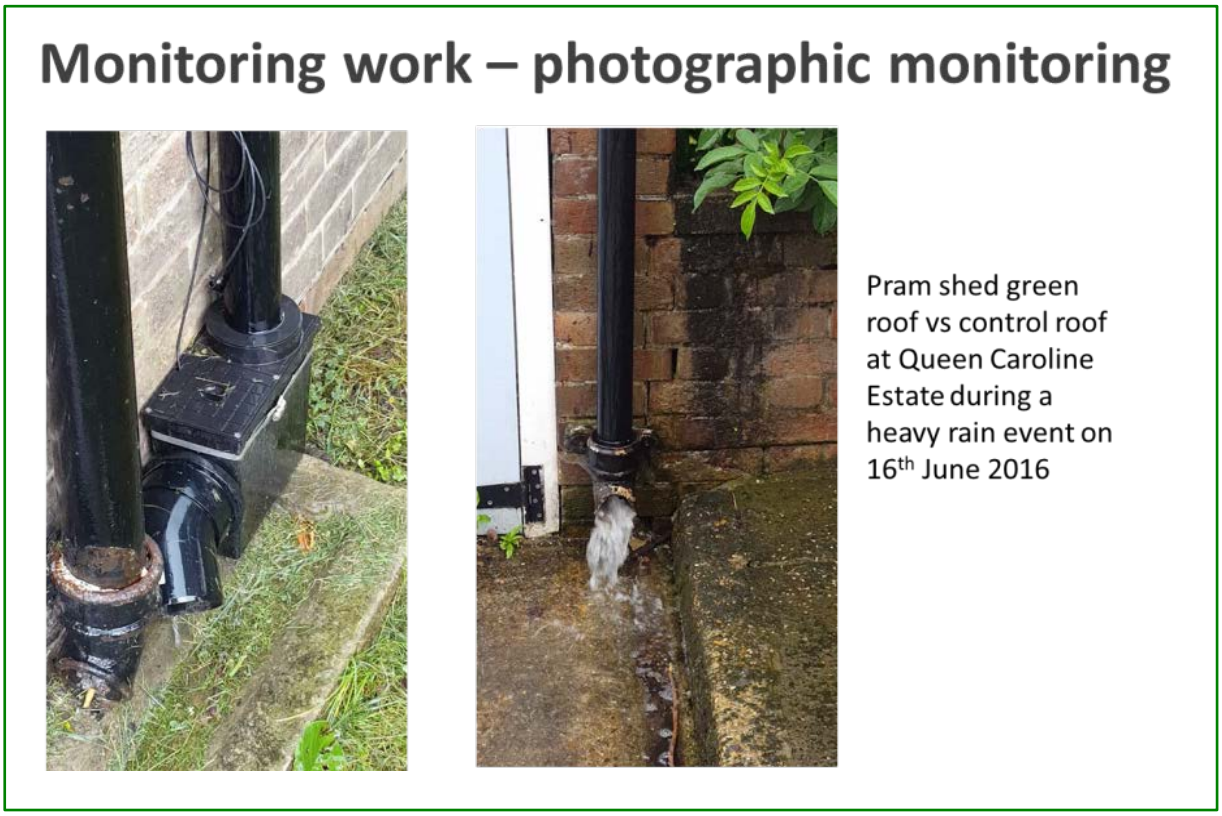


Figure 15. *Example of photographic monitoring simultaneously showing low run-off from a pram shed green roof downpipe to the ground level stormdrain system compared to a pram shed with no green roof installed (heavy rain event, 16th June 2016).*

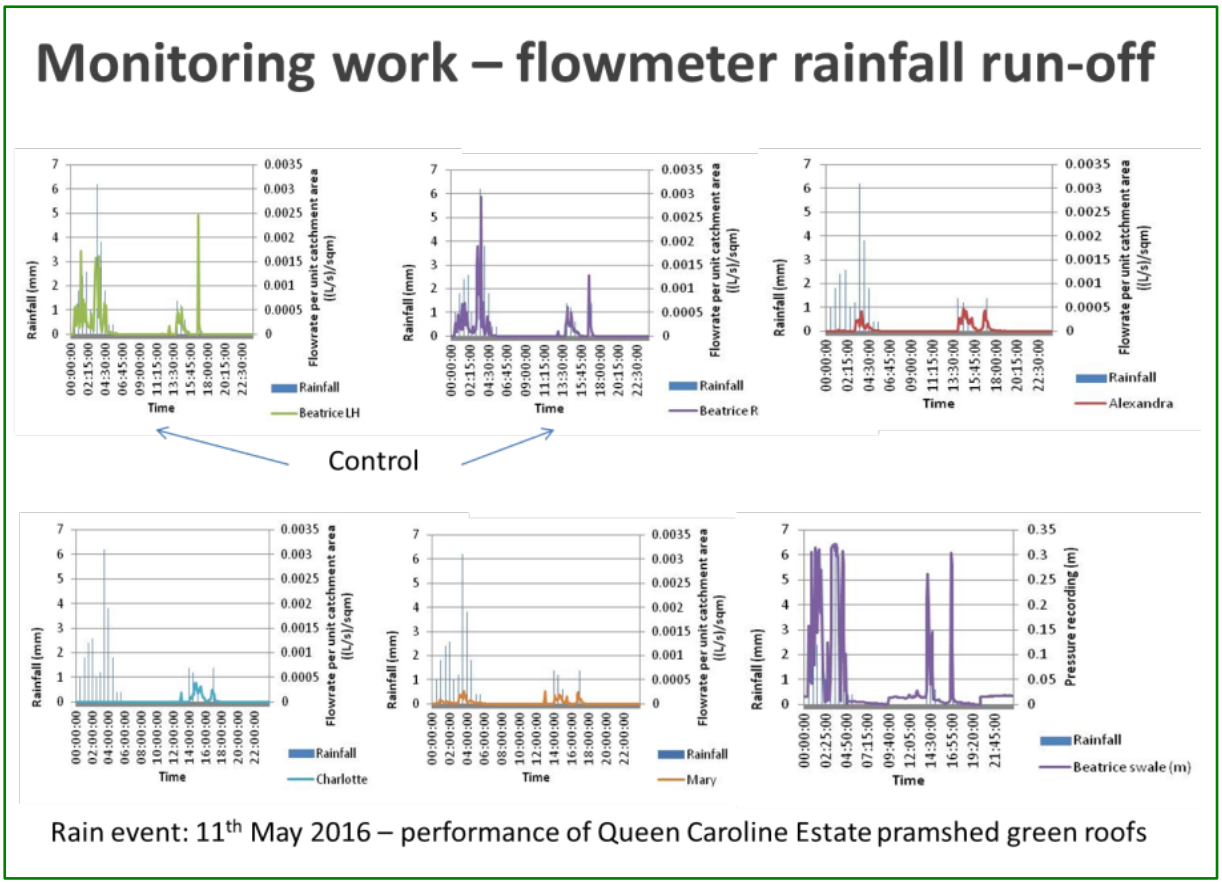


Figure 16. *Water attenuation patterns at Queen Caroline Estate for the green roofs vs. control roofs, and for one of the swales, during a selected heavy rain event.*

Evidence from the roof run-off monitoring showed substantial reductions in the peak flows from the green roofs compared to the control roofs (max. 100% - no flow from green roofs, whilst some flow from control roofs), as well as substantial evidence of delay, which helps avoid storm drain system overloading. Data from the pressure sensor in the swale also supported the evidence captured by the time-lapse cameras, indicating that the swale was effectively conveying and infiltrating the stormwater rather than the basin holding pooled water over long periods. This is important as it means that stormwater storage volumes are available for the next rain event.

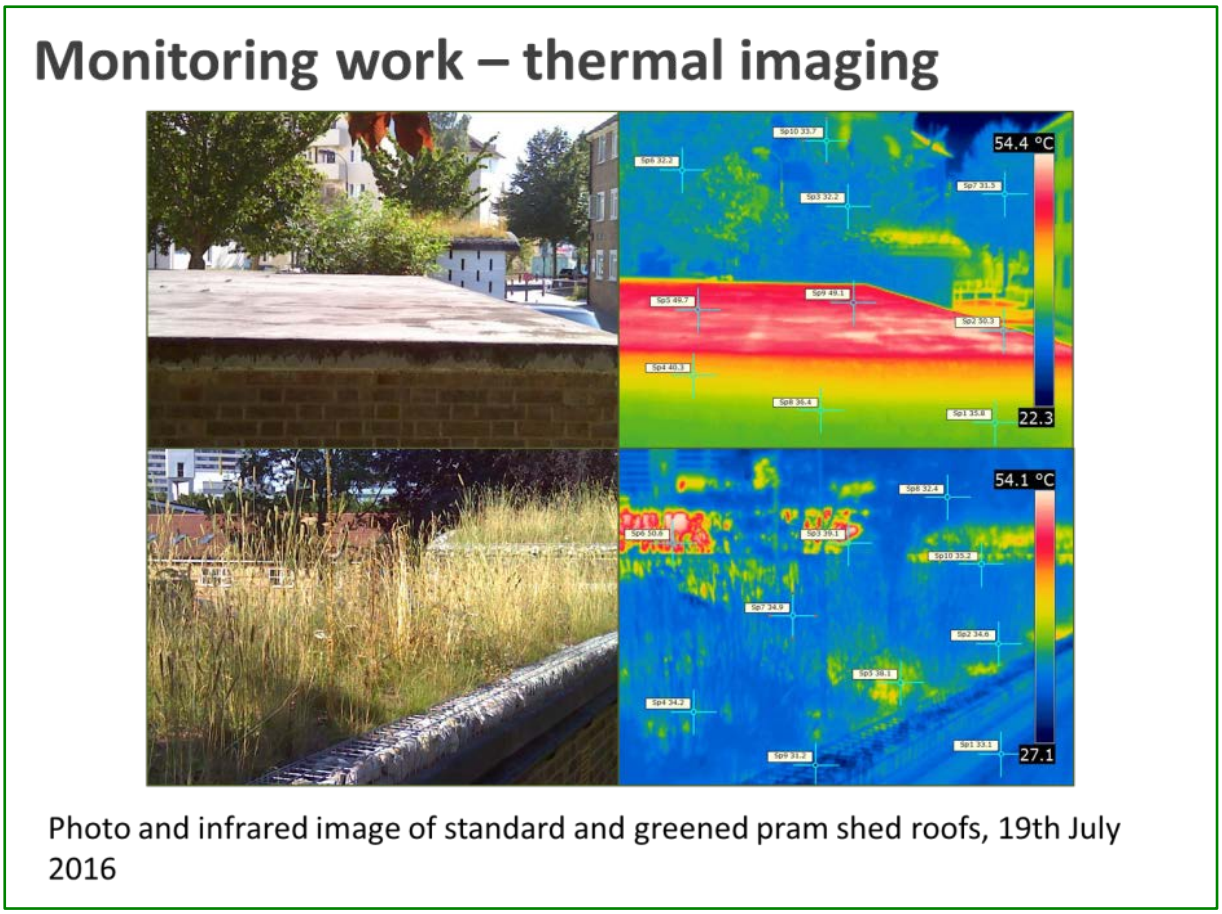


Figure 17. *Infrared image reveals a temperature difference of 32.1°C between the hottest and coolest areas within the fields of view. Hottest temperatures (>49 °C) were associated with the standard pram shed roof areas; substantially hotter than the maximum daily temperature recorded by the nearby weather station (32.6°C). Coolest temperatures were associated with the tall, vegetated areas of the greened pram shed roofs (with temperatures from 34.2°C to 34.9°C). This demonstrates the beneficial effect that green roofs could have on the urban heat island effect and thermal stress.*

Monitoring work – biodiversity monitoring

Species	Common name	10th July	12th August	25th September
Achillea millefolium	Yarrow	x	x	x
Agrostis stolonifera	Bentgrass	x	x	x
Centaurea nigra	Knapweed	x	x	x
Chenopodium album	Fat hen	x	x	x
Clinopodium vulgare	wild basil	x		x
Dianthus maritima	Thrift		x	x
Festuca sp.	Fescue grass	x	x	x
Galium verum	Lady's bedstraw		x	
Geranium spp	Geranium spp.			x
Leucanthemum vulgare	Oxeye daisy		x	x
Lotus corniculatus	Birdsfoot trefoil	x		x
Malva sylvestris	Common mallow		x	x
Oxybasis rubra	Red goosefoot	x	x	
Persicaria maculosa	Redshank	x	x	x
Plantago lanceolata	Narrowleaf plantain	x	x	x
Sanguisorba minor	Salad burnet			x
Scorzoneroides autumnalis	Autumn hawkbit	x	x	x
Senecio vulgaris	Groundsel	x	x	x
Silene dioica	Red campion		x	
Silene latifolia	White campion	x	x	x
Sonchus oleraceus	Smooth sowthistle		x	
Urtica dioica	Common nettle			
Viola tricolor	Wild pansy			x
Totals		13	17	18

Floral inventory surveys on the Cheeseman's Terrace green roof, summer 2015

Figure 18. *Floral diversity on the roofs increased with time following the creation of the roof. However, whilst the roofs had a diversity of wildflower species, these were all fairly typical London green roof species despite using a haying treatment (intended to encourage colonisation of the roof by different species associated with hay).*

Monitoring work – photographic monitoring

Figure 19. *Clockwise from top left: common carder bee on clover in a SuDS swale; hoverfly on yellow composite flower on Cheeseman Terrace green roof; honey bee in Richard Knight House rain garden; and campion flowers on pram shed roof.*

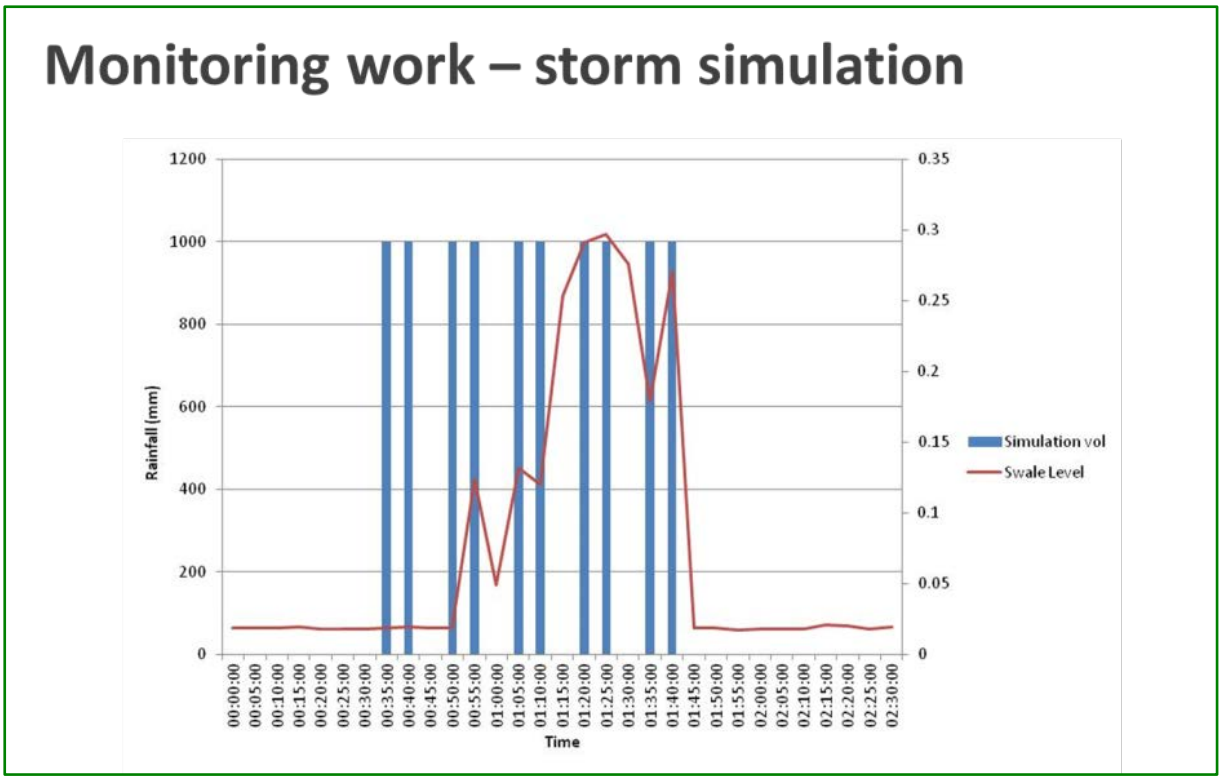


Figure 20. *This shows the impact of the storm simulation at a swale at Queen Caroline on 29th July 2016, in which 10,000L of water pumped into the swale. The pressure sensor in the basin captured the swale reacting to rainfall by recording an increase in pressure following the 'rain' (caused by water pooling above the sensor). This increase in pressure was short-lived however, with a reduction in pressure in a relatively short period following the cessation of the 'rain'. This supported an initial visual assessment of the swale, which noted that no standing water was visible within the swale 15 minutes after the storm event. These results indicated that the swale was effectively conveying and infiltrating the water, rather than the basin holding pooled water over long periods. Moreover, at no point during the storm simulation did water pooling in the swale reach the swale's stormwater overflow, which indicates the swale has additional storage capacity that could be used.*

Further detail on the technical monitoring results is available on the project website at www.urbanclimateproofing.london.

Wider benefits

The results from the SROI assessment demonstrate that climate change adaptation measures benefit local communities beyond their immediate role of alleviating localised flooding. The measures installed as part of the capital works programme in this project brought about outcomes that increased residents' pride in their local area, their sense of belonging and their social ties to their neighbours; all factors which contribute to community cohesion. The SROI also established that the community engagement and sustainability champions training programme delivered as part of the programme (see section 7) contributed to residents' knowledge of climate change and understanding of its potential impacts; it is hoped that this knowledge will enable residents to be more prepared for, and responsive to, the effects of a changing climate.

The SROI also demonstrated that several other stakeholders also experienced positive outcomes, including the local authority, Green Team apprentices, volunteers and the environment itself.

It was found that for every £1 invested in the *Climate-Proofing Social Housing Landscapes* project, the programme generated £4.39 of benefits. This ratio was calculated by using financial proxies to give a monetary value to various outcomes and by establishing the true impact of interventions through using deadweight, displacement, attribution, drop off and discounting measures common to the SROI process. When applying sensitivity analysis to test the assumptions used the ratio always remained positive, but varied in a range from £2.31 to £5.15 of benefits for every £1 invested.

Impact on policy

The project has served as a valuable best practice example, demonstrating the multiple benefits of retrofit green infrastructure schemes in housing environments and strengthening the evidence base to support more of this kind of work going forward. Groundwork London, Hammersmith & Fulham Council and members of the Advisory Group have mainstreamed and embedded project activities and results in both Borough and pan-London policy.

Through the project, the following policies and plans have been influenced directly:

- Defra/CLG SuDS consultation (2014) on an alternative approach to the one envisaged in the Flood and Water Management Act 2010, specifically to deliver sustainable drainage systems through changes to the current planning system;
- Hammersmith & Fulham Council Housing Strategy (2015) – specifically on the themes of regenerating places and increasing affordable housing supply, and excellent housing services for all. Due to the success of the project, Hammersmith & Fulham Council's Housing Department is now looking into how they can encompass certain aspects of the project within future works;
- Hammersmith & Fulham Council Local Plan (2015) on the promotion of adaptation measures in housing open spaces, both for new developments and retrofit of existing spaces – the project has helped to strengthen the planning policies associated with SuDS and climate change proofing of developments;
- London Sustainable Drainage Action Plan (2016) on the need for, and benefits of, sustainable drainage schemes in London, and the role that NGOs can play in this; case study featured in draft plan (final plan not yet published);
- Hammersmith & Fulham Council Biodiversity Strategy (2016) on the role of green infrastructure in helping increase local biodiversity;
- Transport for London (TfL) SuDS Design Guide – case study on Queen Caroline Estate featured as a best practice example, and Groundwork London listed as a suggested partner in projects of this kind;
- Hammersmith & Fulham Council's climate adaptation plans and the role of sustainable drainage in this;
- The London Plan on London's response to climate change.

6.4 Adapting project approaches: guidance for effective monitoring and evaluation

As can be seen from the information provided in this section, the monitoring and evaluation methodology used in the *Climate-Proofing Social Housing Landscapes* project could easily be transferred to other green infrastructure projects, not just within social housing contexts but also at the wider neighbourhood level. When doing so, it is advised to consider the following advice:

Technical performance

- Establish at the start what needs to be monitored and when this needs to take place – this may depend on the aims of the project and the priorities of any funding body that is supporting the work. This exercise needs to be done early on to ensure the monitoring is feasible and that interventions are designed appropriately.
- Identify and appoint a suitable partner to work with on the monitoring of impacts at an early stage. This doesn't have to be a costly exercise; for example, residents, students and the wider local community can be engaged in some of the less technical monitoring approaches if budgets are limited. It may also be possible to estimate the impact of a project using results from other similar projects where it is not possible to carry out a detailed monitoring exercise.
- If an external organisation is appointed to carry out the monitoring, ensure monitoring activities and timings are agreed from the start, as well as the timings of any impact reports. For example, some monitoring activities will need to take place in the summer (such as biodiversity monitoring on green roofs) whereas other monitoring activities may be as interesting in the winter (such as a storm simulation event, as soil will be more saturated at this time of year).

Wider benefits

- Build in the evaluation from the start – consider what information is needed and when and how to get it; understanding what needs to be evaluated will help to establish whether an SROI assessment is appropriate or necessary.
- Ensure there is sufficient time to complete the evaluation process – SROI can be a time consuming exercise if done thoroughly, and will need to be embedded in any stakeholder engagement activities of the project from the start.
- Think about how to frame the questions to be asked in the appropriate way – both to be understandable for different stakeholders and in order to produce useable data.
- Make use of available guidance for measuring wider benefits, including supporting documents for the SROI and BeST processes and reports from other organisations that have already used these tools – this should also help to establish suitable financial proxies. Training may help to ensure staff have the necessary skills to complete these exercises, and to develop confidence in making the necessary assumptions.

Impact on policy

- Plan ahead – understand the relevant policies and plans that will be subject to review and open for consultation in the timeframe of the project.
- Consider opportunities to influence policies and plans indirectly – for example by writing and disseminating case studies on the project, which could then feature in future guidance documents.
- Engage the right stakeholders who can help to identify opportunities and ensure the relevant information from the project reaches key decision makers.
- Be realistic – a small-scale project on its own may not be able to influence European or national policy, but will still serve as a replicable best practice example helping to make the case for adaption.

Potential challenges to address

- If there are delays in tendering the monitoring aspects of the project this may mean that monitoring timescales have to be re-planned;
- Technical monitoring results will be more accurate if gathered over the longer term – this may limit the value of shorter monitoring periods, however spot testing and storm simulations can get around this issue;
- If SROI is not embedded in the project from the start it may be difficult to add it in at a later date, potentially limiting the value of the results;
- The timing of the project will affect the scope for influencing policy – if no policies or plans are undergoing review at that time, or if the evidence from the project is not available when consultations are open, then this will be limited.

COMMUNITY ENGAGEMENT

7. Community Engagement

7.1 Importance of engaging communities in green infrastructure initiatives

Effective engagement with residents, and in some cases the wider local community, is vital for securing support for green infrastructure initiatives. If done well, it can result in site-specific community adaptation action plans, practical involvement in climate adaptation approaches and ongoing management and maintenance activities beyond the lifetime of the project itself.

Local community members often have important knowledge that may not be readily available to an outsider (such as the housing provider), but which may be extremely valuable in the development of new projects. By undertaking community engagement, it is possible to gain access to this information, whilst at the same time helping residents to understand the benefits of a project and involve them in plan-making at a local level. In addition, green infrastructure can be an abstract concept to communities; engagement using language that works for them helps to create understanding, and gets people thinking about the ways they use green spaces and how this could potentially change.

Community engagement is crucial not only in the early phases of a project, but throughout. Continued engagement beyond consultation can help to ensure ongoing resident support for the project and its legacy.

7.2 Overview of project community engagement approach

In the *Climate-Proofing Social Housing Landscapes* project, Groundwork London worked alongside residents throughout the life of the project, giving them the opportunity to shape the open space improvements on their estates. This engagement helped to promote greater awareness of the implications of climate change for London, and the actions that residents can take themselves to contribute to adaptation and resilience.

The key aims of resident engagement in the *Climate-Proofing Social Housing Landscapes* project were to:

- Increase the community's adaptive capacity to climate change and involve residents on the proposed works for their estate;
- Increase education and awareness about climate challenges, threats and opportunities at a local as well as a global scale;
- Develop a climate adaptation plan for each estate, which supports increased local resilience to the impacts of climate change, improved responsibility for resource efficiency and management of open spaces through involvement in the design and maintenance of green infrastructure features, and a stronger sense of community in the intervention areas;
- Better understand residents' perceptions of the current state of each estate and its use, ensure they understand the green infrastructure measures to be installed and the environmental and social functions of each;

- Support active resident participation in the implementation and ongoing use and management of individual measures such as rain gardens, rainwater harvesting, tree planting and their maintenance.

A diverse range of engagement activities has been delivered during the project, which has allowed residents and the wider community to become involved with the project in ways that suit them. The method used to engage residents was as follows:

- Develop a detailed community engagement plan at the start of the project, identifying who to engage, the key opportunities to do so, and the appropriate methods of engagement;
- Holding launch events to introduce the project to each estate;
- Engage the TRAs and other interested resident groups on the estates in meetings, including involving them in the development and delivery of engagement plans and regularly attending resident meetings in order to get feedback and provide updates on project progress;
- Initial consultation phase to understand how residents use the green spaces on their estate, problems they experience, and improvements they would like to see;
- Involve residents in mapping their estate's environmental issues and ideas for solutions, reviewing the resulting assessments and the designs put forward;
- Share concept designs with residents, bringing the project to life and helping residents to visualise the improvements that could take place;
- Use initial consultation on the designs to develop an ongoing plan of activities that are unique to each estate and look at adaptation to climate change more broadly;
- A range of workshops, events, leaflet dropping and surveys (through door knocking) to keep residents engaged throughout the project and understand their views on its impacts;
- Energy and water efficiency home visits through Groundwork's Green Doctor programme;
- Food growing and gardening clubs;
- Sustainability champions training sessions, to equip local residents with the skills and understanding to manage their green space assets effectively;
- Development of noticeboards for each estate informing residents of works implemented and their benefits;
- Events on each estate to celebrate the completion of capital works;
- Engagement in estate climate adaptation plans, including through estate walkabouts and photography competitions;
- Use researched SROI outcomes questions to baseline and assess the change in social outcomes perceived by residents as a result of the project and how that compares to the investment committed.

7.3 Key results of community engagement activities

As a result of the community engagement undertaken during the *Climate-Proofing Social Housing Landscapes* project, 8 residents have gone through sustainability training, and 85 have received home energy and water efficiency advice visits from Groundwork's Green Doctors.

The evaluation and feedback from the training demonstrated an increased awareness of climate change issues and their potential impacts, including increased practical skills and confidence to address climate change problems and communicate these to others.

As a result of the home advice visits, residents:

- Saved £1,590.90 a year on their energy bills through the use of energy saving measures
- Prevented 6,537 kg of CO_2 being emitted a year
- Avoided 605,916 litres of water being wasted a year
- Saved £2,742 per year through switching their energy provider

Community gardening and food growing clubs have been established, with around 40 growing sessions undertaken on the Queen Caroline Estate alone; these clubs have continued since Groundwork-led activities finished. Sessions helped to develop resident knowledge of food growing and how a changing climate would affect this.

Groundwork London has also worked with residents to produce three local climate adaptation plans, which set out assets that each community values, threats to those assets, key actions that they can take to protect their estate against the impacts of climate change, and those actions that will need support from their housing provider and others.

Climate-Proofing Social Housing Landscapes community engagement in numbers:

- 472 local people engaged in events/activities
- 1,236 households reached through marketing/promotion
- 55 community activities delivered, including 12 events
- 41 TRA meetings attended
- 8 sustainability champions recruited
- 85 households received Green Doctor visits
- 3 local adaptation plans developed
- 81% of residents agree or strongly agree that the quality of the green spaces has improved significantly
- 58% of residents report that they use the green spaces more often since the works were completed

Some key themes and lessons have emerged from this experience:

- Awareness of the environment – a focus on hyper-local impacts of climate change has helped to increase this over the course of the project, with 90% of residents asked reporting an increased understanding of climate change
- Use of open spaces – across the estates, open spaces were rarely used before the project – since the interventions have been installed and engagement activities carried out, this has changed so that residents not only use the spaces more but also report an increased sense of belonging and pride in the area they live
- Responsibility for the estate – before the project, residents felt they were not able or willing to personally make or contribute to improvements to their estate. Engaging residents in the design process, and enabling them to make small-scale improvements has helped to change this perception
- Importance of the estate's design – this can impact on the community and the way residents interact with each other, for example gated areas of an estate restrict free movement and access to certain green spaces. Retrofitting climate adaptation measures in the three estates has helped to improve the sense of community and access to open spaces.

7.4 Adapting project approaches: guidance for effective community engagement

The approaches to community engagement carried out in the *Climate-Proofing Social Housing Landscapes* project could easily be adapted or even replicated in other contexts. Many engagement activities can be built into existing programmes of resident engagement and therefore do not require additional staff resources.

Some key considerations for effective resident engagement are set out below:

- Develop an overall engagement strategy at the start, which sets out planned engagement and communication activities, key channels for engagement, and relevant stakeholders throughout the project; a wide range of activities will help residents to interact with the project in ways that suit them;
- As part of this, plan the schedule of engagement; schedule activities to coincide with milestones in project design and implementation so that stakeholder involvement is timely, relevant and impactful; it may be necessary to be flexible but setting this out from the start helps ensure the key opportunities for engagement have been considered;
- If working across multiple sites, carry out staged consultation in the same order as the physical works to reduce the time residents are waiting for the works to start;
- Ensure regular communication with residents at all stages of the project; including TRAs where applicable as a cost-effective and consistent way of keeping residents up to date with the progress of works on site;
- Support residents to inform the design process through estate mapping exercises and assisting with prioritisation activities; provide a specific range of options for features to residents, to ensure that proposals are realistic and achievable;

- Secure resident interest and buy-in by framing communications in the right way – for example, talk about the local effects of climate change that they would be able to see (such as overheating, flooding or drains overflowing), as this can be easier to relate to than the bigger picture;
- Involve Housing Officers in project engagement sessions/consultations;
- Offer residents training opportunities related to green infrastructure to help grow their understanding and involvement in the ongoing maintenance of measures;
- Install temporary noticeboards around the estate as works commence so that residents are well informed; replace these with permanent information boards on completion of works, to raise awareness of the installed measures and the benefits they offer;
- Activities that include home visits can help to access hard to reach residents and provides another avenue for dissemination;
- If implementing the project through apprenticeship/employment programmes, make sure the TRA are aware of this; this will help to increase understanding of the social benefits it offers;
- Look for opportunities to unlock potential by speaking to individuals about particular challenges or ideas (for example, in the project a resident at the Queen Caroline Estate allowed a downpipe diversion to take place through their private garden);
- Respond quickly to any queries or problems; try to pre-empt these by having a risk register in place with actions to address or mitigate these risks.

Potential challenges to address

- Not all estates will have a TRA, which can make it more difficult to establish contact and communicate with residents; in addition, where there is a TRA not all residents will attend the meetings - these residents may prove harder to reach (for example, if they are elderly or do not speak the national language);
- Different stakeholders may have conflicting priorities, for example planting that is good for biodiversity may not be visually appealing to residents;
- Working close to residents' properties can be disruptive, especially if works take longer than expected;
- Stakeholders may have limited initial understanding of climate change and the links between this and local issues such as flooding, poor drainage or over-heating;
- Stakeholders may have limited initial understanding of the terminology and descriptions of climate adaptation measures;
- There may be very limited use of estates' green spaces prior to the work being implemented; resident engagement should ensure that installed measures will bring the spaces back into use;
- If there is a large gap between consultation phase and implementation this may lead to queries and concerns from residents and other local stakeholders.

ADDITIONAL RESOURCES & LINKS

8. Additional Resources and Links

8.1 Project information

For more information on the *Climate-Proofing Social Housing Landscapes* project, see:

Website: www.urbanclimateproofing.london

The website features: a project overview; details of the three project sites; case studies, videos and other resources; news; project film; 360º virtual tour; testimonials; media coverage, awards and events; contact information; and links to Groundwork London's Twitter and Facebook accounts

Tumbler blog: http://urbanclimateproofing.tumblr.com/

Twitter: @GroundworkLON (#urbanclimateproofing)

Facebook: www.facebook.com/GroundworkLondon

EU LIFE projects database:
http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=4752

8.2 Where to find technical guidance on green infrastructure measures

- Natural Water Retention Measures (NWRM) website: www.nwrm.eu
- CIRIA (UK): www.ciria.org
    - SuDS Manual: www.ciria.org/Memberships/The_SuDs_Manual_C753_Chapters.aspx
    - Susdrain (UK): www.susdrain.org
- Green Infrastructure information and guidance on the European Commission's website: http://ec.europa.eu/environment/nature/ecosystems/

8.3 Where to find information on EU funding opportunities

Information on some of the current funding opportunities is provided in section 5.3 above. European funding opportunities change frequently so have not been listed here in detail. For more information see: http://europa.eu/european-union/about-eu/funding-grants_en

8.4 Other available tools and resources

Cabinet Office Guide to Social Return on Investment: www.bond.org.uk/data/files/Cabinet_office_A_guide_to_Social_Return_on_Investment.pdf

CIRIA's BeST resources: www.ciria.org/News/CIRIA_news2/New-tool-assesses-the-benefits-of-SuDS.aspx

Susdrain 'Going with the flow' infographic: www.susdrain.org/files/resources/ciria_guidance/susdrain_going_with_the_flow_infographic.pdf

Other project examples:

London and UK:

- Bridget Joyce Square, Australia Road, London: www.susdrain.org/case-studies/case_studies/bridget_joyce_square_london.html
- Olympic Park, London: www.susdrain.org/case-studies/case_studies/olympic_park_london.html
- Clapton Park Estate, London: http://howtomakeadifference.net/tag/clapton-park-estate/
- Derbyshire Street Pocket Park, London: www.susdrain.org/case-studies/case_studies/derbyshire_street_pocket_park_london_borough_tower_hamlets_1.html
- Peabody's IMPROVE Programme, London: www.peabody.org.uk/our-neighbourhoods/landscaping/improve
- Lamb Drove, Cambridge (new development example): www.susdrain.org/case-studies/case_studies/lamb_drove_residential_suds_scheme_cambourne.html

Europe and international:

- Urban storm water management in Augustenborg, Malmö, Sweden: http://climate-adapt.eea.europa.eu/metadata/case-studies/urban-storm-water-management-in-augustenborg-malmo
- LIFE+ Urban Oases, Helsinki, Finland: www.helsinki.fi/urbanoases
- City of Copenhagen Cloudburst Management Plan 2012: http://en.klimatilpasning.dk/media/665626/cph_-_cloudburst_management_plan.pdf
- Philadelphia's Green City, Clean Waters 25 year plan to reduce stormwater pollution through green infrastructure: www.phillywatersheds.org/what_were_doing/documents_and_data/cso_long_term_control_plan/
- Portland's Green Street Programme, Oregon, USA: www.portlandoregon.gov/bes/45386

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