

Intervention 1: Improving insulation

External wall insulation refers to a layer of insulation fixed to the outside face of an existing wall. The insulation can be finished with render or cladding. Additional insulation can be fitted internally, or even within wall cavities.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Reduced energy consumption. Insulation can help reducing the energy need for heating in the colder months, and cooling in the hotter months.

OTHER CHALLENGES

Loss of internal room volume if inside.

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Intervention 2: Reorganising the layout of interior spaces

Optimising the distribution of spaces according to their functions and therefore their solar needs. This could be done to optimize solar gain all year round, according to their solar needs or hazard exposure, to provide cool shaded work areas, to remove critical equipment from overheating risk or flooding risk.

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★★
COST	£(£)
FEASIBILITY	★★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Reduced energy consumption. Because the aim is to optimise for solar gain, it can reduce the energy need for heating and cooling. The reorganisation could address the flow of patients, and the consideration of the services provided in spaces which would be most warm/cool.

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Intervention 3: Replacing window/door glazing

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Updating windows by replacing glazing with low solar gain, vacuum or smart glass alternatives or fitting existing glazing. Low solar gain glass has a thin coating that reflects heat. Vacuum glazing is a high-performance insulating technology that uses a vacuum layer between two glass panes to significantly improve thermal insulation in windows and doors.

Installing impact-resistant glass on windows either during the manufacturing process helps to prevent air entering the building that could otherwise create a change in pressure, which could lead to walls becoming overstressed or roof uplift.

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★★
ANTICIPATION	!!

OTHER CO-BENEFITS

Reduced energy consumption and noise reductions. Updating windows can prevent thermal loss from inside a property and reduce heat entering a property from outside, and thus reduce the energy need for heating.

Intervention 4: Adding window film to glazing

UV-filtering window films are flexible films that adhere to glass and block ultraviolet and visible light to varying degrees.

By adding impact resistance film to windows helps to prevent air entering the building that could otherwise create a change in pressure, which could lead to walls becoming overstressed or roof uplift.

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!!

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Intervention 5: Installing passive cooling solutions

Using design choices to reduce heat gain and increase heat loss. Passive cooling is an approach to building design that enables interiors to be cooled with low or zero energy consumption.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Reduced or minimal energy consumption to cool the building

OTHER CHALLENGES

Need to take into account stringent infection prevention and control standards in healthcare settings which may make this more challenging to implement..

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Intervention 6: Installing a mechanically ventilated system

A CMV or controlled mechanical ventilation is an aeraulic system installed within a building. Its main function is to renew the air in a building. The ventilation network of the CMV is equipped with inlets and outlets to manage the incoming and outgoing airflow.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★★
ANTICIPATION	!!

OTHER CO-BENEFITS

Can also help with air filtration, and invovle heat recovery from the recycling process.

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Intervention 7: Installing a green roof (intensive or extensive)

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A green roof system is an extension of the existing roof which involves, at a minimum, high quality waterproofing, root-repellent system, drainage system, filter cloth, a lightweight growing medium, and plants. An intensive green roof has more soil depth than the extensive.

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★
ANTICIPATION	!!!

OTHER CO-BENEFITS

A green roof can help to cool the city during hot spells. It also contributes to the presence of biodiversity and the retention of rainwater, and can improve summer comfort for residents thanks to the evapotranspiration of the plants. Green roofs can also help protect the waterproofing of the roof.

OTHER CHALLENGES

They can be very heavy to install - existing structures may need to be reinforced.

Intervention 8: Installing green facades (green walls)

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A green façade is a wall completely or partially covered with greenery. A green façade with climbing plants uses a trellis system to hold the vines of plants that are rooted in the ground or containers.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Able to improve air quality by trapping particulate matter from the traffic emissions. Can also reduce the energy need for heating and cooling. A green façade can help to purify the air, cool the temperature, reduce noise, retain rainwater and encourage biodiversity, whilst improving a building's thermal insulation, reducing energy consumption for heating and cooling.

OTHER CHALLENGES

There may be a fire risk if it dries out. There may be an allergen risk depending on plants used

Intervention 9: Planting trees and shrubs outside buildings.

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Appropriate tree planting can reduce temperatures inside the building by screening the sun, and also attenuate water flow into drainage systems, and can also provide more cool spaces outside.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Nature based solutions can also provide pleasant environments for patients and staff, as well as increasing biodiversity. Can also be used in conjunction with other edible plants to create edible produced for the kitchen, or as a therapeutic area/activity. And may also reduce patient recovery times.

OTHER CHALLENGES

Incorrect planting - poor choice of species can cause water issues or the plant may not survive if not suited to the area without additional watering being required (therefore using scarce resources). Appropriate knowledge of appropriate species is required to select the right tree for the right space.

Intervention 10: Applying light-coloured/reflective materials for external surfaces

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For a strong albedo. A coating of light or white colours reflect more of the sunlight and reduce the heat gained by building materials. Special surface coatings or materials using nano-technologies to create minuscule mirrors can be used to reflect incoming sunlight and thereby avoid heating the building.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!!

OTHER CO-BENEFITS

One of the quickest and least expensive solutions. It is a particularly interesting solution in the short to medium term for roofs where green roofing is not possible, or for buildings awaiting renovation work and overall insulation, which will deliver better results in terms of summer comfort. On roofs that are very exposed to the sun, this solution uses the albedo effect to improve thermal comfort inside the building and reduce the cooling requirements of a poorly insulated building.

Intervention 11: Installing shutters, shades /blinds over glazed doors/windows

Installing a solar protection system, exterior shading for windows, shutters set into window reveals to control sunlight (roller blinds can be a low-level alternative intervention)

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!!

OTHER CO-BENEFITS

See also shading with trees.
Solar protection can improve thermal comfort inside the building and reduce the need for cooling in summer. Could also use solar panels as screens thus also generating energy as well as reducing temperatures inside the building.

Intervention 12: Using portable heating/ cooling units

Using mobile devices to provide cooling/heating.

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!

OTHER CO-BENEFITS

Very quick to install, can be moved around easily.

OTHER CHALLENGES

Energy intensive.
Does not address the hazard in a long term manner - so more of a sticking plaster approach.

Intervention 13: Installing a climate monitoring system

Installing a monitoring station (IT devices, PCs, data storage space) in order to monitor the temperature, air quality, humidity etc at different points in a building - to assist with identifying risks and making appropriate investment decisions / immediate intervention actions

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★★
ANTICIPATION	!!

OTHER CO-BENEFITS

Can be integrated with carbon reduction monitoring.

OTHER CHALLENGES

Other challenges: Monitoring alone will not address any risks, but it is an important tool to ensure more informed and targeted decision making.

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Intervention 14: Installing or maintaining permeable surfaces

Having permeable or pervious soils, porous roads and pavements that can naturally detain and filter water

PRIMARY/ SECONDARY HAZARD		
EFFECTIVENESS	★★★	
COST	££	
FEASIBILITY	★★★	
ANTICIPATION	!!!	

OTHER CO-BENEFITS

Increase in biodiversity can be achieved if permeability is increased by vegetation, and the choice of vegetation is indigenous and appropriate for the local climate

OTHER CHALLENGES

Permeability close to foundations could increase vulnerability to subsidence. Consider whether the soil is prone to shrinkage and swelling

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Intervention 15: Installing temperature resistant surfaces

Making pavements and walkways resistant to high and low extremes of temperature.

PRIMARY/ SECONDARY HAZARD		
EFFECTIVENESS	★★★	
COST	££	
FEASIBILITY	★★★	
ANTICIPATION	!!	

OTHER CHALLENGES

Could be in contradiction with the idea of permeable surfaces

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Intervention 16: Installing rainscreen cladding systems

A rainscreen system is an exterior wall detail where the cladding stands off from the water barrier to create a capillary break that allows drainage and evaporation.

PRIMARY/ SECONDARY HAZARD		
EFFECTIVENESS	★★★★	
COST	££	
FEASIBILITY	★★★★	
ANTICIPATION	!!!	

OTHER CO-BENEFITS

Prevents deterioration of outside walls (reduced maintenance costs). Improves thermal performance of the building.

As it is external it may have limited interruption to services inside the building.

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Intervention 17: Keeping critical services above flood levels

Installing electrical, mechanical systems and utilities above flood level - or installing plug sockets at a raised height.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★
ANTICIPATION	⚠️⚠️

OTHER CHALLENGES

Changing these critical points may be entirely impossible as a retrofit, given the layout and resource reconfiguration this may require.

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Intervention 18: Keeping entrances & escape routes (emergency entrances & routes to them) above flood levels

Ensuring emergency vehicle access and the heliport, are not located in a flood zone or in an area with low wind exposure. Ensuring evacuation routes are out of flood risk level

PRIMARY/ SECONDARY HAZARD	 
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★
ANTICIPATION	⚠️

OTHER CHALLENGES

Could involve significant upheaval of patient flow through the site. Better designed in from the start.

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Intervention 19: Installing non-return valves for toilets and sinks/sewage pumps

Non-Return valves allow water to flow through them in only one direction. The valves have two openings in the body, one for fluid to enter and the other for fluid to leave.

Prevents property flooding from backflow through drainage and sewer systems during heavy rain. Helps prevent infection issues and water contamination from sewerage.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	⚠️

OTHER CHALLENGES

Requires regular maintenance and replacement.

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Intervention 20: Installing roof sheathing

Attached to the roof's support beams, roof sheathing helps make sure heavy loads such as rain don't cause sagging or bowing. The sheathing distributes weight evenly across the entire roof.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★
ANTICIPATION	⚠️⚠️

OTHER CO-BENEFITS

Increases structural resilience of roof. Sheathing also provides an additional barrier to prevent leaks.

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Intervention 21:

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Installing wet floodproofing

Wet floodproofing allows flood waters to enter enclosed areas via openings to let the flood water in and out, using water resistant materials, protecting service equipment and utilities. Wet floodproofing lets water into the building but protects the structure, contents and building systems independently, while dry floodproofing keeps the building interior dry by holding water outside (eg flood barriers).

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£££
FEASIBILITY	★★★
ANTICIPATION	⚠️⚠️

OTHER CO-BENEFITS

Wet floodproofing is cheap compared to dry floodproofing, The benefit of wet floodproofing it allows flood waters to enter and quickly reach the same level as the flood waters outside, the effects of hydrostatic pressure, including buoyancy, are greatly reduced. As a result, the loads imposed on the house during a flood, and therefore the likelihood of structural damage, may be greatly reduced. Generally used to limit damages to enclosures below elevated buildings, eg. basements, crawlspaces, or attached garages.

OTHER CHALLENGES

It is not practical for areas that are to be used as living space

Intervention 22:

Installing flood defence - permanent

Barriers can be permanent fixtures such as flood shields, valves and gates that are closed when extreme water is experienced or anticipated to prevent water from entering through entrances and other openings, such as windows, doors, pipeworks, ventilation shafts (e.g. anti-flood airbrick covers, self-activating barriers). They can also be demountable so not fully in place all the time and barriers can also be glazed.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★★
ANTICIPATION	⚠️

OTHER CO-BENEFITS

Some items might also help with thermal efficiency and be easy to clean during flood recovery.

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Intervention 23:

Installing flood defence - temporary

Using temporary protection such as sandbags, water pumps and movable deployable inflatable barriers to move water away from or to temporarily protect specific areas (e.g. inflatable sink bung)

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★
COST	£
FEASIBILITY	★★★★★
ANTICIPATION	⚠️

OTHER CO-BENEFITS

Temporary barriers can be moved around the building to where they are needed.

Helps reduce infection risk from sewerage in the water.

OTHER CHALLENGES

Temporary barriers may need replacing after every use and may not be as robust against large volumes of water as more permanent solutions.

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Intervention 24:

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Installing or improving drainage system (not NBS)

This concerns the manmade structures that carry water away from where it lands on the building, across the building into sewerage systems and includes considerations of slope and things like flap valves which automatically close off a pipe if the water on the outside rises above the height of the pipe outlet, or pump and sump systems which move water through a building quicker than it would do on its own.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★★
COST	£££
FEASIBILITY	★★
ANTICIPATION	⚠️⚠️

OTHER CO-BENEFITS

Prevents water pooling and leakage into building interior (and potential mould growth). Can be used to prevent concentrated snow loads at the eaves (low risk for UK hospitals).

Can be used alongside SUDS and other NBS solutions for greater effect

Intervention 25: ^{Healthcare Adaptation Resource Kit, developed for PEACCH}Installing Sustainable Drainage Systems (SUDS)

A natural approach to managing drainage in and around properties/developments. SuDS slow/hold back the water that runs off from a site, allowing natural processes to break down pollutant (rain gardens and swale). A swale is a shallow drainage channel with gentle side slopes in the ground where water running off a site can collect and soak away. Swales can carry water through a site and mitigate its flow-rate; rain gardens collect and retain water for a period of time (releasing the water over a period of time).

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Can be combined with rainwater harvesting measures (e.g. grey water collection tanks) – to address water scarcity. Lower risk of flooding in the wider catchment area. Contributes to increased biodiversity as it involves planting areas, nourished by available water. Natural protection against flooding, wetlands help to recharge groundwater and support low-water levels. Act as natural filters, reservoirs of biodiversity & climate regulators.

OTHER CHALLENGES

Any large water collation area must be placed at an appropriate distance from buildings; overflow may occur in heavy rainfall or flooding

Intervention 26: Installing a rainwater collection system

Installing a system of pipes and water storage containers to collate rainwater for later use.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

If the primary purpose is to collate water to reduce the need for external water supplies, water collation on site can also prevent or reduce flooding. Can be used in connection with rain gardens, or green roofs/facades.

OTHER CHALLENGES

Consideration will need to be given to where collected water can be used and how it gets to the site of use. May need additional filtering.

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Intervention 27: ^{Healthcare Adaptation Resource Kit, developed for PEACCH}Improving air filtration systems

A HEPA (High Efficiency Particulate Air) filter is a specialized air filter designed to trap extremely small particles, including dust, pollen, mold, bacteria, and even some viruses. Local HEPA filter-based air cleaners (also know as air scrubbers) are one option for improving and supplementing ventilation. The installation of a HEPA filter air cleaner can reduce the risk of airborne transmission. Air scrubbers can be used to protect hospital occupants during a wildfire event when air quality from outside air is low. They may be built into the HVAC system or may be used as portable scrubbers.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!

OTHER CO-BENEFITS

These filters were purchased for pandemic flu preparedness to purify the air and to support the central ventilation system for maintaining zero pressures (which is critical for quarantine rooms). In this case, the utilization of equipment intended for one purpose actually helped the hospital remain open and functional during a fire/weather event. Many hospitals will have HEPA filter systems in place already for infection prevention.

Intervention 28: Planting drought-tolerant plant species

Using plants and trees that are tolerant to higher temperatures and reduced water in new or renovated planting schemes. This means they will be more likely to survive and will reduce the need for watering systems which use large volumes of water to keep them alive or in a healthy condition

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	
COST	£
FEASIBILITY	★★★★
ANTICIPATION	!!!

OTHER CO-BENEFITS

Any Nature Based Solution will improve biodiversity and has the potential to create a more calming and therapeutic environment for staff and patients

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Intervention 29: Regular maintenance and inspections

Ensuring routine maintenance and inspections are completed to ensure that any deterioration is identified as soon as possible and to ensure protection systems are working as they should. Notable signs include the appearance of cracks in a building's internal or external envelope. This is particularly important during and after a period of prolonged dry weather, or drought. Other systems include ensuring flooding systems are operational, that water discharge and drainage systems are clear of debris and that HVAC systems are operating effectively.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	⚠️

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Intervention 30: Underpinning foundations

This includes raising, releveling, and re-supporting a building with an additional foundation layer, and is especially important as a post subsidence action. This could include mass concrete underpinning, beam and base underpinning and micro piles.

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£££
FEASIBILITY	★
ANTICIPATION	⚠️⚠️⚠️

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Intervention 31: Installing movement joints

Movement joints are essential to incorporate in all building parts that do not have the same foundations, have different weights load or are built on ground conditions at risk of subsidence. The installation of movement joints allows the building frame / wall to adapt to soil movements by allowing each part of the building to move and adjust, thus helping to avoid damage from the different movement rates.

It also protects buildings against the possibility of cracking as a result of high temperature variability

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	££
FEASIBILITY	★★★
ANTICIPATION	⚠️⚠️

OTHER CHALLENGES

Unlikely to be able to be retrofitted and may only be suitable for new buildings

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Intervention 32: Local independent energy production

Local alternative energy production, not connected to traditional grids to ensure that electrical installations operate without mains power during prolonged outages

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£££
FEASIBILITY	★★★
ANTICIPATION	⚠️⚠️

OTHER CO-BENEFITS

This can also complement a carbon reduction agenda - depending on how the system works it could also generate income for the site if producing more energy than is needed. If also integrated with renewable energy production on site (e.g. solar or wind), has a Net Zero benefit.

OTHER CHALLENGES A very expensive option.

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Intervention 33:

Installing drainage water pumps

Installing devices to pump out areas likely to become flooded (e.g. basement). The collected water can be poured into the wastewater network

PRIMARY/ SECONDARY HAZARD	
EFFECTIVENESS	★★★★
COST	£
FEASIBILITY	★★★★
ANTICIPATION	⚠️⚠️

OTHER CO-BENEFITS
Can also complement a water scarcity agenda.