Paper and presentation for Scottish Government and COP 26.

Houseplot SUDS – visualising a more climate change resilient landscape for new and existing development

[1]BJ D'Arcy & [2]Fiona Welch

[1]Houseplot SUDS Ltd

[2]Collective Architecture

Contact: b.darcy@btinternet.com

Outline content*

1. INTRODUCTION *Stormwater, pollution, flooding & climate change*
2. "BUSINESS AS USUAL" *Sustainable drainage and the status quo*
3. DON'T LOSE THE PLOT *Envisaging a stormwater resilient sustainable housebuilding sector*
4. ACTIONS NOW: *Steps to achieve greater resilience*

**This project was funded by SEPA, Perth & Kinross Council and Scottish Government, with additional support from Tayside Biodiversity Partnership and Kinross Community groups*

Loch Leven, Kinross, Scotland UK

1. INTRODUCTION

Stormwater, pollution, flooding & climate change

Stormwater, pollution, flooding & energy demand: the urban noxious nexus

POLLUTION

- Small frequent storms scour surfaces & generate first flush of pollutants
- Combined sewer overflows often operate at scale of small storms e.g. = or > 4x p.a.
- Relief sewers and storm tanks require concrete construction; 10 tonnes of CO2 per tonne of concrete produced

FLOODING

- Cloudbursts – high intensity rainstorm cause pluvial flooding when drainage systems are overwhelmed
- Storm tanks detain flood flows and need energy to pump them out at treatment works
- High flows still mobilise pollutants (more extensive reach and more energy for settled material in sewers)

ENERGY DEMAND

- Pumping rainwater runoff is a significant energy demand and is a recognised cost for water utilities & targeted for reduction by disconnection and not allowing new connections*

*Reference: Scottish Government, *Water-Resilient Places – A policy framework for surface water management & blue-green infrastructure*, Feb. 2021.

Loch Leven & Kinross raingardens: “thinking global and acting local”

Adapt to protect and restore natural habitats

- Action on point and diffuse pollution sources was effective in mid-1990s. Combined sewer overflows remain as a concern.
- *Climate change exacerbates* sewage overflows (& diffuse rural pollution) due to more cloudburst events
- *Climate change exacerbates* P-release from sediments due to rising water temperatures (when oxygen concentrations are lower)
- A raingardens challenge can help address the sewer capacity and overflows problems.

Kinross-shire Raingardens Challenge:
Thinking globally & acting locally (Loch Leven catchment)

ADAPTATION

Working together: Kinross-shire Civic Trust, Kinross/Kinnesswood-in-Bloom groups, Rotary, local schools, local Councillors

Protect & restore
Loch Leven
Ramsar wetland
National Nature Reserve

Build resilient infrastructure as place-making enhancements

MITIGATION

Reducing surface runoff to combined sewers reduces pumping *energy demand*

Building raingardens for distributed flow management uses *less concrete and hence CO2 production* than storm tanks and relief sewers

2. BUSINESS AS USUAL: THE BIG CHALLENGE

Sustainable drainage & the status quo

Where in the built environment is occasional inundation most unacceptable?

- Is it the property?
- Is it the road?
- Neither; apparently it is the greenspace…

- In practice the greenspace is often the highest ground and the last area to be flooded!
- It's the one area which could use the water…
- ***Is that really a flood resilient outcome?***

Housebuilding industry, sustainable drainage & climate change agenda

Sustainable urban drainage Systems (SUDS)

- Initially, for housing developments just end of pipe ponds or basins
- Later added a degree of source control as well, with permeable pavements & a very few grass swales driven by flooding concerns[Flood Risk Management (Scotland) Act 2009).
- But roof drainage still often direct to surface water sewers and end-of-system structures

SUDS-compatible measures in Building Regulations (2005), required measures on each plot, but not enforced or even advocated.

SUDS primarily driven by government CAR 2006 regulations, enabled by statute under the WEWS Act 2003.

[*See tables below from Kinross-shire case study*]

Build as usual then add a giant soakaway or pond or basin

Status quo housebuilding; does it protect individual properties?

One in 200 yrs plus 30% design requirement: --> huge excavation *at furthest end of the development* … to provide the flood risk management capacity to protect the whole development… is this sustainable drainage?

The road is higher level than the properties. Downslope, only a tiny slotted drain to protect each property…

This is not uncommon, and drains are easily blocked too

Kinross-shire Civic Trust Raingardens Challenge: SUDS Survey

Types of SUDS (some premises had more than one type on site)	No. of sites	No. of units
Monoblock permeable pavement	10	Off-the-shelf SUDS preferred option
Gravel car park/road surfaces	6	6
Gravel filter drains (mainly in South Kinross industrial estate)	6	6
Buried gravel filter drains, no swale	2	2
Large end-of-pipe soakaways, [new schools and housing developments]	3-5	3-5 (where are they? Do they exist?)
Constructed wetlands & basins	6	11
Vegetated infiltration channels & lawns e.g. Park & Ride	2	5
Grass swales (along roads or within premises)	5	17
Raised bed raingarden	2	2
Raingarden soakaway (house plot)	1	1
Natural raingardens (wet lawn park margin: vegetation receiving runoff not cut; grows & becomes wetland)	1	3

Survey of SUDS in Kinross-shire [33 sites]

Category	No.	% total	notes
No. sites with hard engineering SUDS	24	73%	Includes some sites with soft too
No. sites with soft engineering SUDS	15	45%	Includes some sites with hard
No. sites with hard & soft types of SUDS	6	18%	
Hard features only	18	55%	
No. of sites with soft units only	9	27%	*Raingardens*
Total number of individual raingarden features: 39 in 2021 (target was 20 in 2020)			

From: BJ D'Arcy, F Welch and J Shields (2021) The Kinross-shire Civic Trust Raingardens Challenge 2020-2021; Phase 2 Completion Report

3. DON’T LOSE THE PLOT

Envisaging a stormwater resilient sustainable housebuilding sector

Stormwater resilience and leaky towns & cities

SPONGE CITIES

- The *sponge city* is a concept made in China and now in use in many countries…
- It is not just that a sponge soaks up large amounts of water
- A sponge will *slowly* release it too

PLOT-SCALE DRAINAGE

<u>Slow</u> <u>release</u> of attenuated runoff into drains can allow progress in dense developments

Plot by plot SUDS:
Raised bed raingardens
In-ground raingardens
Green roofs
Raingarden-soakaways
Permeable pavement
Hedgerow planters

Houseplot SUDS - for new development

[*In the context of trying to solve climate change problems, is this really so difficult?*]

1) The property should not be the lowest part of the development, but instead should be on a higher level than the garden/landscape of the plot.
2) Houseplot flow attenuation and treatment features should be designed to be "gardening or household" maintenance requirements, not requiring pumping, sludge removal, oiling moving parts etc.
3) Houseplot SUDS should be passive, with no energy requirements.
4) Houseplot SUDS techniques should not be '*nice-to-do but ineffective add-on features*' to conventional housing designs, but instead should be designed for significant flow attenuation and/or management of diffuse pollutants ('*significant*' meaning enough to alter a design for those purposes for downstream features on a development).
5) Failure of houseplot techniques due to errors, lack of maintenance, or abuse by houseplot occupants (e.g. foul into surface water wrong connections) *should result in problems for them on the plot*, not downstream on the public network to be expensively resolved at public expense.

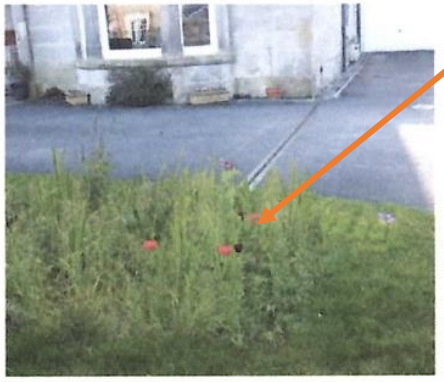
Envisioning a more climate change resilient housebuilding in Kinross (1)

Before | After

Roof areas are typically the most extensive areas of positively drained impervious surface in towns & cities:
a purpose designed raised bed unit can accept roof runoff from a M30:60 rainstorm, & drain down as if a one in ten year event.

Envisioning a more climate change resilient retrofit street in Kinross (2)

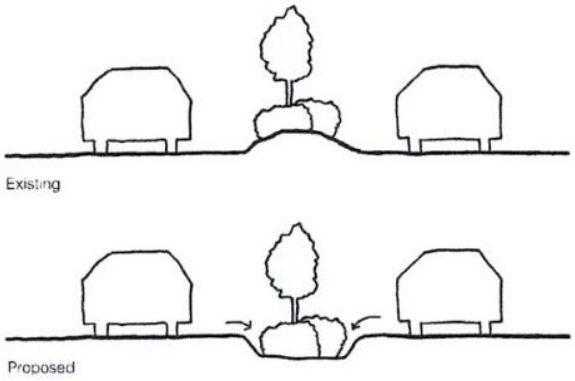
Before | After



Roof areas are typically the most extensive areas of positively drained impervious surface in towns & cities:
An in-ground purpose designed raingarden can accept roof runoff and drain back to sewer after attenuation at a slower rate, with some reduction in volume (depending on evapotranspiration and infiltration)

Envisioning a more climate change resilient retrofit street in Kinross (3)

Before	After



Landscaping can allow greenspace adjacent to car parking spaces to drain into the soil-vegetation, rather then pass directly to drains.

If a gully is sealed and a kerb removed, then a re-graded greenspace could take runoff from the driveway/car parking area.

Envisioning a more climate change resilient retrofit street in Kinross (4)

Before After

A local flooding problem (drains cannot cope in wet weather due to combined sewer capacity problem) could be resolved by creating a raingarden for the road runoff, with flows overflowing to the combined sewer *after attenuation*.

Retrofit raingardens can also green the grey spaces in a town, as they attenuate runoff.

4. ACTIONS NOW

Six Steps to more sustainable management of water in new development

ACTIONS NOW

1. *Support innovators* for creation of new products & businesses
2. *Don't penalise innovators by requiring them to fund universities*
3. Encourage research institutions to undertake evaluation of new ideas
4. Make it easy for builders to incorporate on each plot first level attenuation measures: *they need options*.
5. *New policy guidance*: house plot techniques as a priority 1st level of resilience measures for new SUDS schemes
6. *Use existing legislation* (often existing powers not used enough) to drive uptake of innovative & existing solutions

Marmax Raised bed raingarden [SUDSBOX] in *Oslo, Norway* 2019. In the UK there is the same need, but is there a market? Additional options needed too.