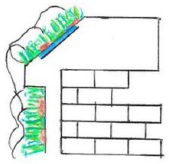
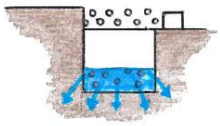
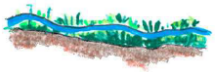
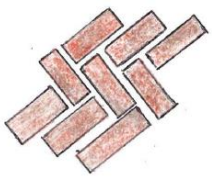
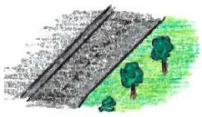
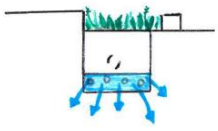
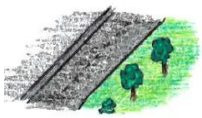
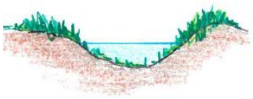
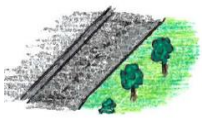
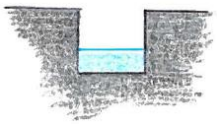
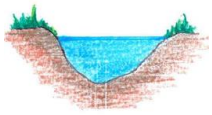
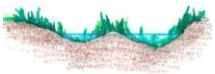
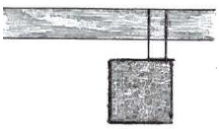
Appendix 4 : Common components of Sustainable Drainage Systems (SuDS) and their green infrastructure benefits

A4.1 There are a number of SuDS features, illustrated below, which can be incorporated into most sustainable drainage systems for most housing or other developments, depending on local context and how the features fit into the SuDS management train for that site.

	Description	Setting	Required area
 *Green roofs*	Construction of a planted layer on the roof of a building, creating a living surface. Water is stored in the soil layer and absorbed by vegetation.	 *Building*	Building integrated
 *Rainwater harvesting*	Rainwater is collected from the roof of a building or other paved surfaces to be stored in an above ground or underground tank for treatment and re-use locally. E.g. water could be used for flushing toilets and watering plants.	 *Building*	Water storage (underground or above ground)
 *Soakaway*	Soakaways are designed to allow water to soak quickly into permeable layers of soil. An underground pit ('dry well') is dug and filled with gravel or rubble. Water can be piped to a soakaway where it will be stored and allowed to infiltrate gradually into the ground.	 *Open Space*	Dependent on run-off volumes and soil permeability
 *Filter strip*	Filter strips are grassed or planted areas that runoff is allowed to run across to promote infiltration and natural cleansing.	 *Open Space*	5 metres minimum length
 *Permeable paving*	Paving which allows water to soak through it; e.g. paving blocks with gaps between them which allow water to move through, or porous paving where water filters through the block itself. Water can be stored in the sub-base beneath or may infiltrate into the ground below.	 *Street / open space*	Typically, can drain double its area.
 *Bio-retention area*	A vegetated area with gravel and sand layers beneath it; designed to channel and filter water vertically, and clean it. Water can infiltrate into the ground below or drain to a perforated pipe for conveyance elsewhere. Bio-retention systems	 *Street / open space*	Surface area typically 5-10% of drained area, with storage below.

	Description	Setting	Required area
	can be integrated within gardens, verges and tree–pits.		
 *Swale*	Vegetated shallow depressions, designed to convey and filter water. Swales can be 'wet', where water gathers above the surface; or 'dry', where water gathers in a gravel layer underneath. Swales may be lined, or unlined to allow infiltration.	 *Street / open space*	With should allow for safe maintenance, hence typically 2-3 metres wide
 *Hard landscape storage*	These hard landscaping water features can be used to store run-off above ground within a constructed 'container'. Within urban areas storage features can be integrated into public realm areas.	 *Open Space*	Can be above or below ground, with their size dependent on storage need.
 *Pond / basin*	Ponds and basins can be used to store and treat water. 'Wet' ponds have a constant body of water and any run-off is additional. 'Dry' ponds or basins are empty during periods without rainfall. Ponds and basis can be designed to allow infiltration into the ground, or to store water for a period of time before discharge.	 *Open Space*	Dependant on runoff volumes and soils.
 *Wetland*	Wetlands are shallow vegetated water bodies with a varying water level. Specially selected plant species are used to filter water. Water flows horizontally and is gradually treated before being discharged. Wetlands can be integrated within a 'natural', green or hard landscaping.	 *Open Space*	To provide good water quality treatment, typically should cover 5- 15% of the area to be drained.
 *Underground storage*	Water can be stored in tanks, gravel or plastic crates beneath the ground to provide attenuation, if no soft landscaped (or 'soft engineered') solutions are practicable.	 *Open Space*	Dependent on runoff volumes, and soils.

Delivering green infrastructure and multi-benefits on a development through SuDS

A4.2 SuDS and designated flood storage areas are part of Sefton's green infrastructure network and provide many green infrastructure benefits and functions. SuDS should be designed to achieve as many of these green infrastructure benefits

as possible, where this is appropriate and practicable. Green infrastructure benefits particularly relevant to SuDS are set out below:

- **Infiltration:** Slowing conveyance of water to the nearest watercourse (or sewer) to a 'greenfield' (pre-development) run-off rate, and enabling the recharging of groundwater.

- **Filtration, pollution control and water quality:** Removing pollutants such as metals, hydrocarbons and excess nutrients which may be contained in run-off from roads, car parks or agricultural land. This is likely to improve water quality of rivers, streams & groundwater.

- **Attenuation; slowing rates and volumes:** Vegetated, planted 'naturalistic' SuDS also help attenuate and convey water slowly, reduce soil erosion and mitigate flood risk.

- **Nature conservation and enhancement:** Creation or enhancement of new wetland or other habitats if appropriate, and their on-going management and maintenance which should be informed by an ecological management plan.

- **Reducing the impacts of climate change – carbon sequestration:** Carbon sequestration (take up), as the plants in vegetated, planted 'naturalistic' SuDS can take up carbon in the atmosphere as they grow. Tree and woodland planting, in the right location, potentially can also take up more carbon as well as reducing surface water run-off.

- **Reducing the effects of climate change – thermal cooling:** Vegetated, planted 'naturalistic' SuDS (including trees) have a cooling effect on surroundings (the 'microclimate') because of effects of increased evapotranspiration. Standing water can also moderate temperatures locally.

- **Reduced pressure on physical infrastructure:** Removing surface water runoff from the sewer system could improve its capacity for managing wastewater and reduce flood risk.

- **Water resources:** Water recycling, storage areas or water butts may reduce the amount (and cost) of mains water needed for landscape maintenance.

- **Recreation:** Publicly accessible, vegetated, planted 'naturalistic' or above ground SuDS may have physical health and recreation benefits, and may form part of the public open space provision for a development scheme.

- **Cost savings and ease of maintenance:** Above-ground SuDS can provide long-term solutions to surface-water drainage as blockages, and issues can be easily identified and remedied. If integrated from the early stages of the design process SuDS provide cost savings for design, installation and main compared to more traditional engineered surface drainage systems.

- **Other green infrastructure benefits:** These include the mental health and well-being benefits associated with proximity to the natural environment and trees.