Holding Water: *concepts*

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Slow, store and filter water for healthier catchments

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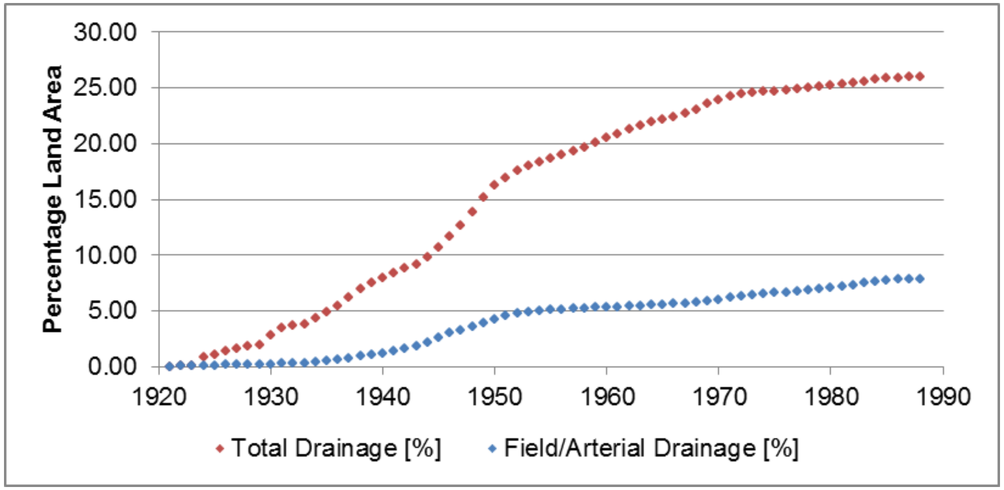
A loss of water holding capacity in our landscapes

- Water moves faster through drainage systems as they have been "improved“ increasing peak flow
- Moving water off land faster is seen as better (e.g. by farmers and developers), but the water has to go somewhere
- There are implications for:
  - Sediment dynamics
  - Ecological habitat, both physical and chemical
  - Flood response speed
  - Riparian connectivity



Cumulative drained land in Scotland according to drainage grants (1921-88) – Lilly et al. (2012) Report on drainage & GHG abatement in Scotland. ClimateXChange.

Tarland: 2011

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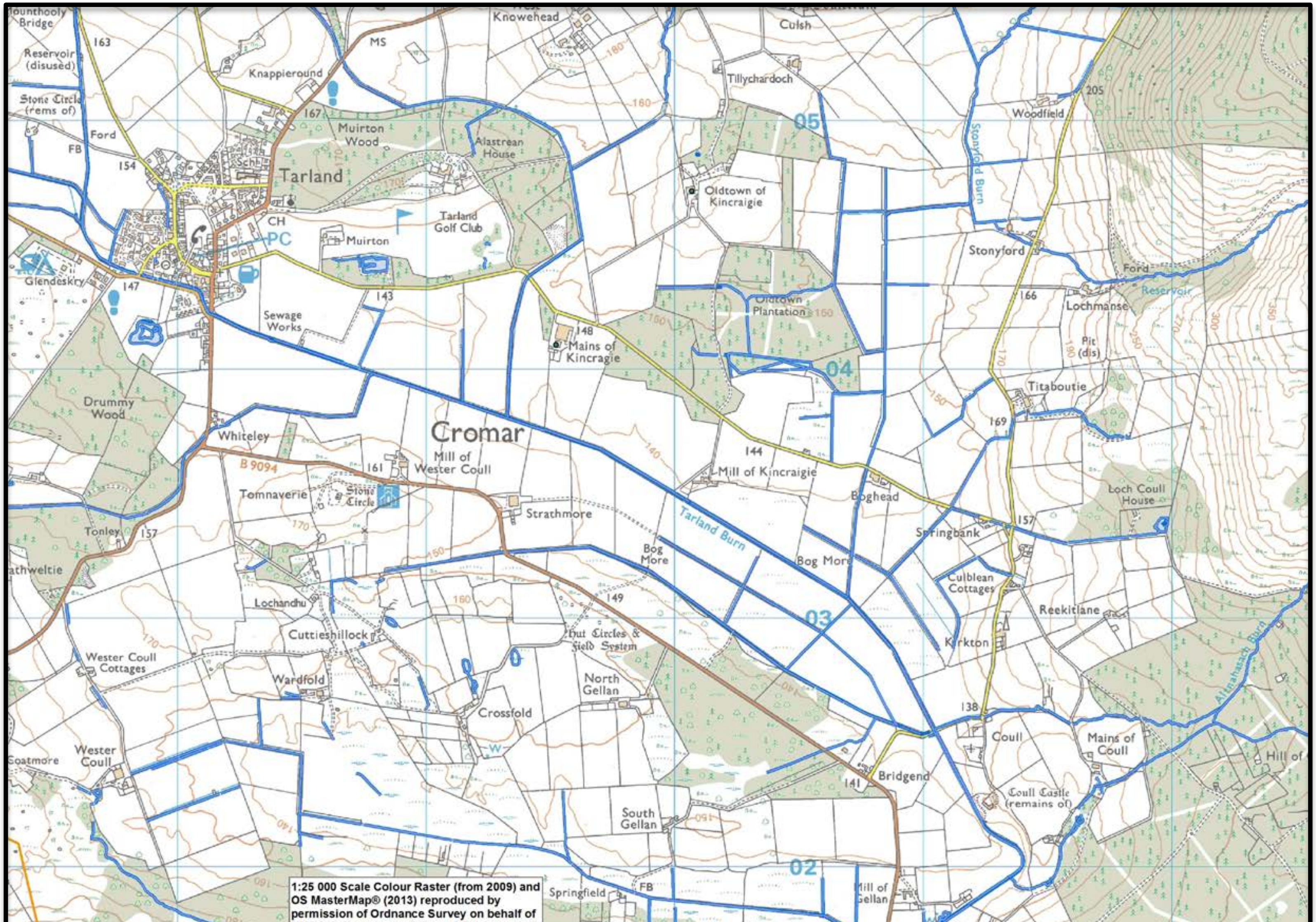


Our starting premise....

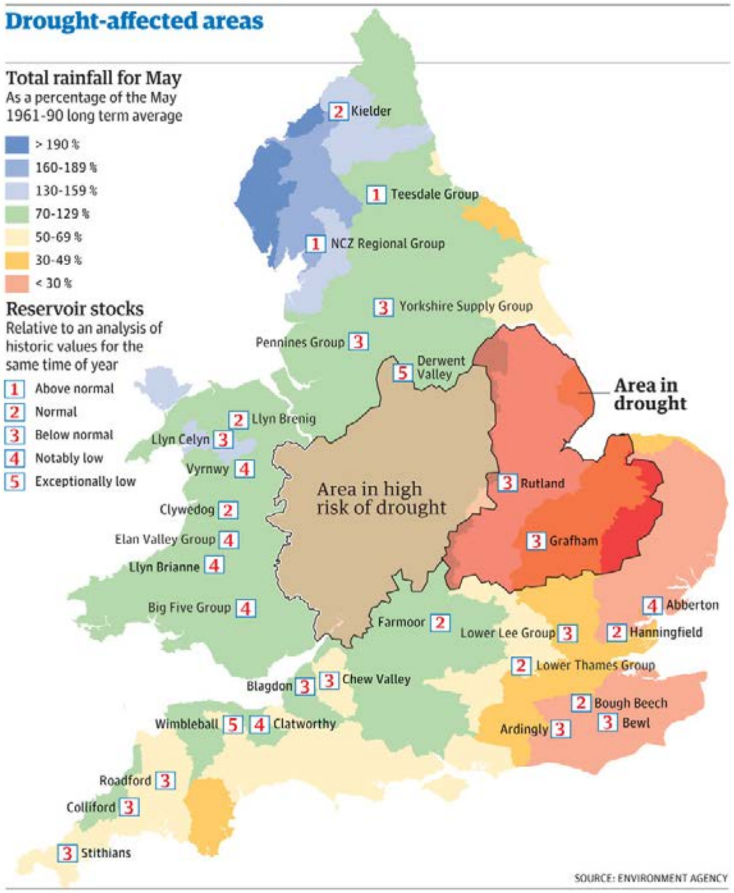
We must maintain a productive landscape....
....but we have lost the landscape's water holding capacity,
so an interventionist catchment engineering approach must be adopted to offset this with space for water holding features

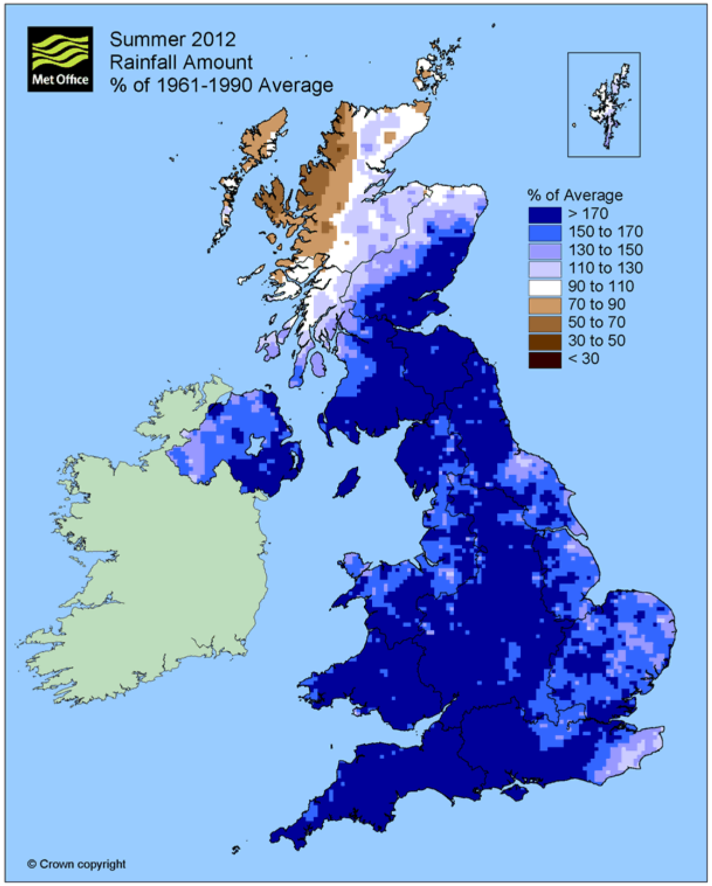
Policy must be simplified and work more effectively....
....then interventions are best done by local practitioners

Simple water retention measures can provide cost-effective and least disruptive options for medium flood and drought events....
....but may need to be backed up by harder engineered features downstream

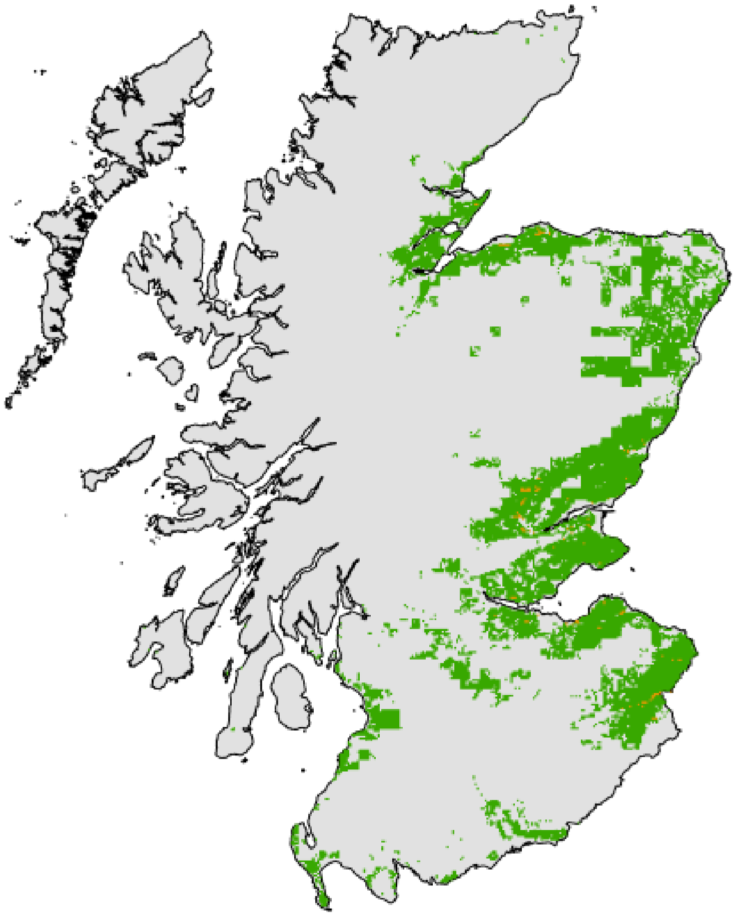
The case for resilient landscapes: either too little, or too much rainfall…

2011… and …2012



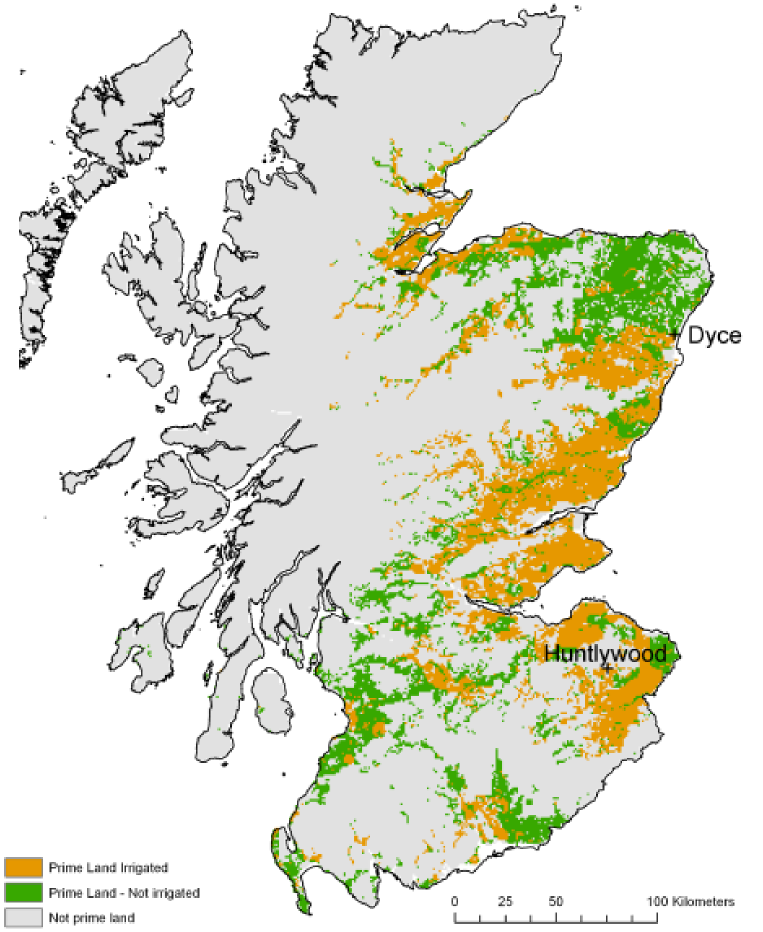


Future water demands
– projected changes in prime agricultural land



2011

- Irrigation needs & impacts
- Water-use efficiency



2050s

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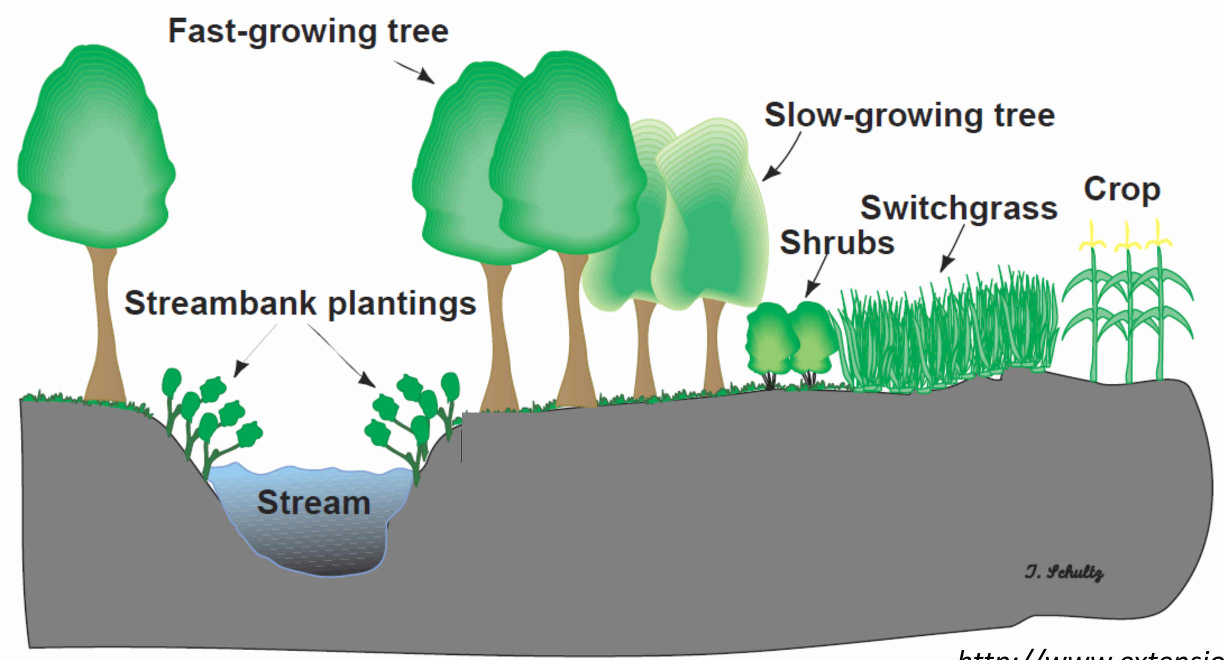
The case of buffer strips

- Making buffers work in landscapes:
  Their potential, issues and approaches for ‘eco-engineered’ features

Riparian benefits for water quality



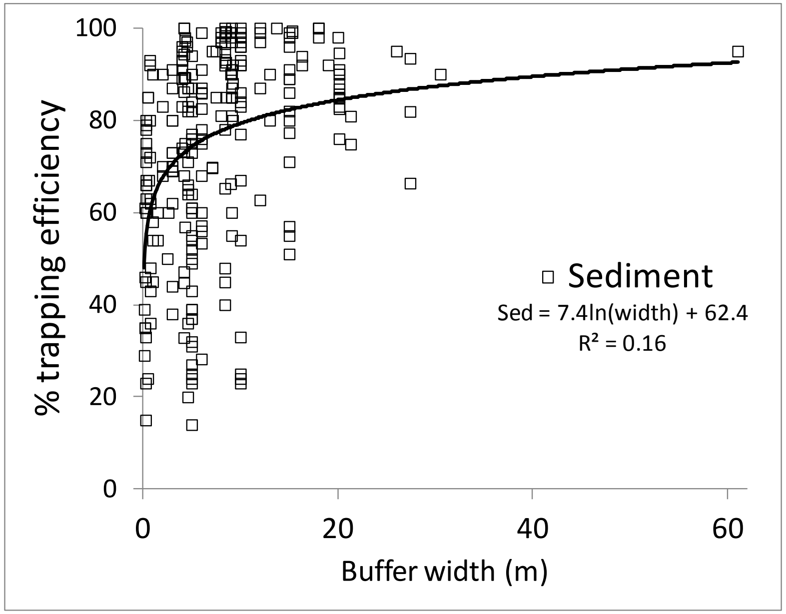
http://www.extension.iastate.edu/Publications/PM1626B.pdf

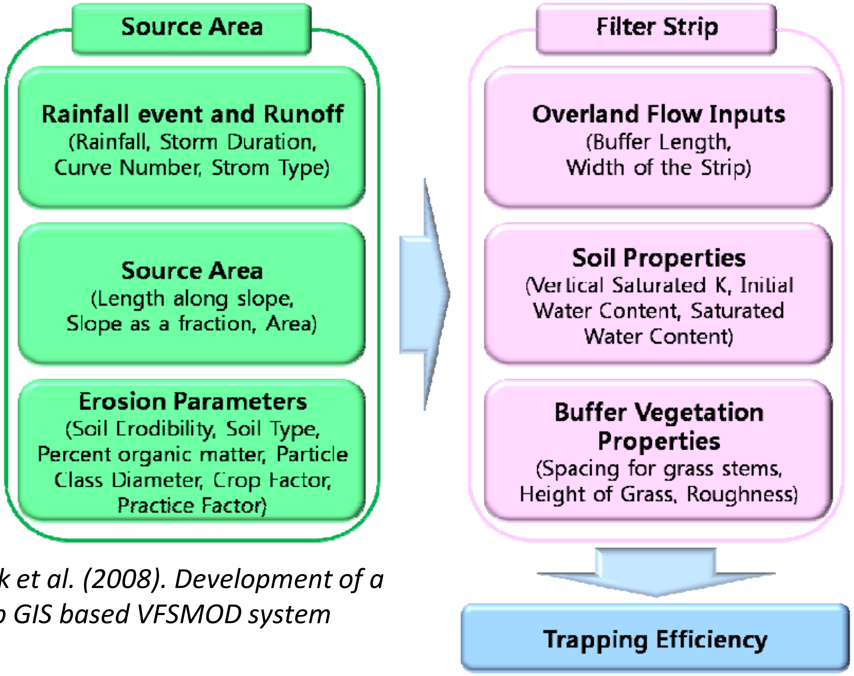
3 aspects to benefiting water quality

- Runoff control of sediments and associated contaminants
- Within soil nutrient processes
- Beneficial interactions between terrestrial biodiversity, aquatic ecosystems and nutrient processing

The science: can you model and predict effectiveness from the evidence base?

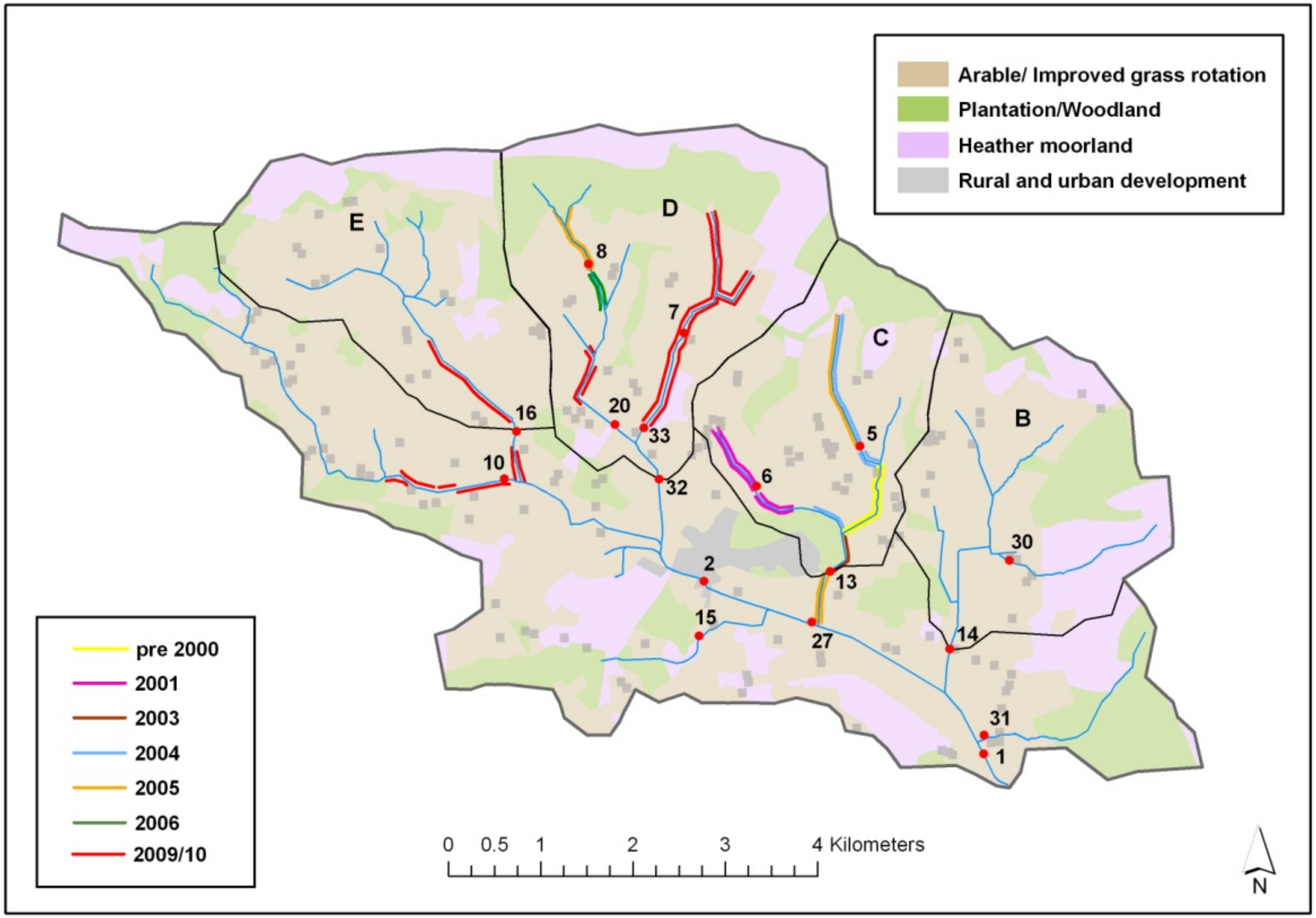
- Literature database developed of buffer width vs effectiveness (60 studies, 300+ observations, 20 countries)
- Studies were either hydrologically based, or soil science based, few reported both sets of crucial parameters



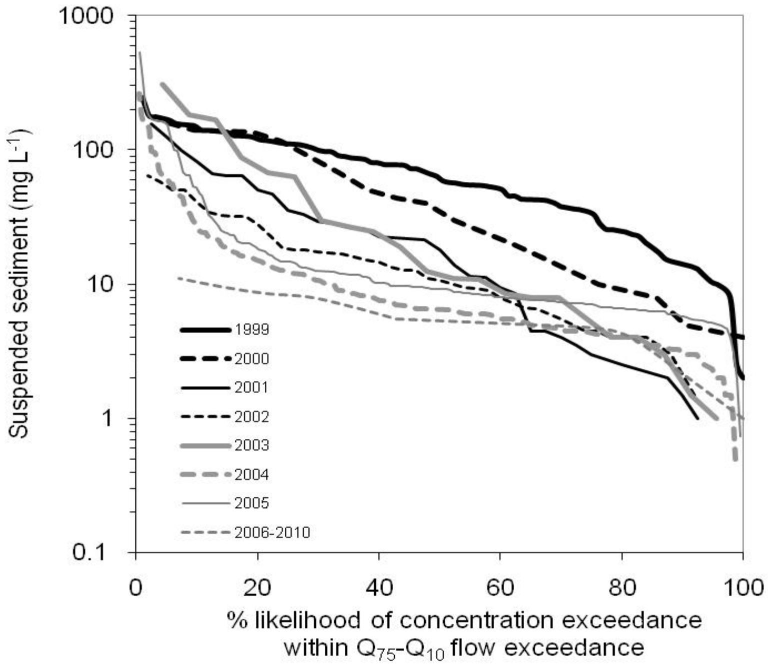


Park et al. (2008). Development of a web GIS based VFSMOD system

Buffering in the Tarland catchment

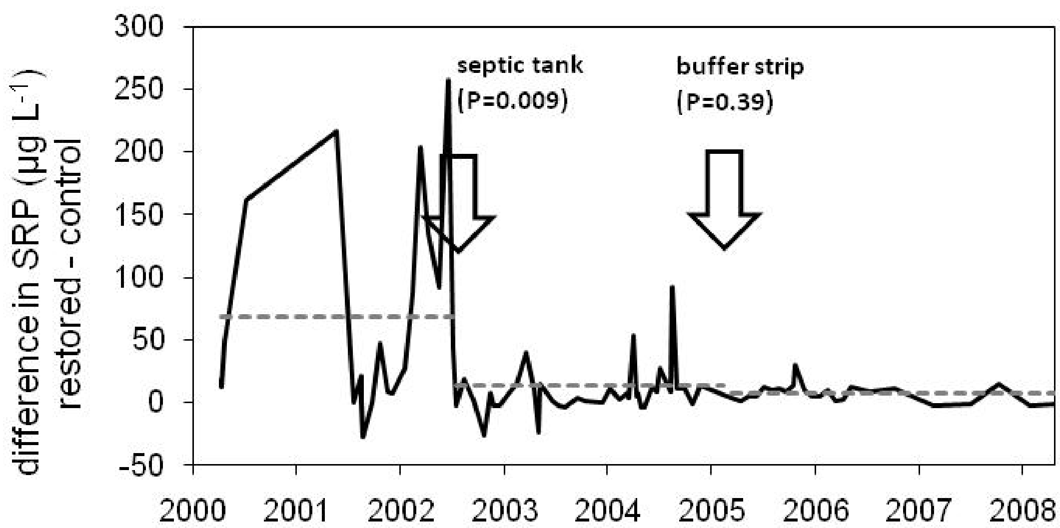


Signs of improvement? Stream chemistry



Sediment concentrations were reduced through the years of restoration, when observed at the whole catchment scale

But evidence was not clear at tributary scales and subtle effects of buffering were masked by point source measures



Bergfur, Demars, Stutter, Langan, Friberg. 2012. The Tarland Catchment Initiative and its effect on stream water quality and macroinvertebrate indices. JEQ 41, 314-321.

Contentious Danish buffer zones!

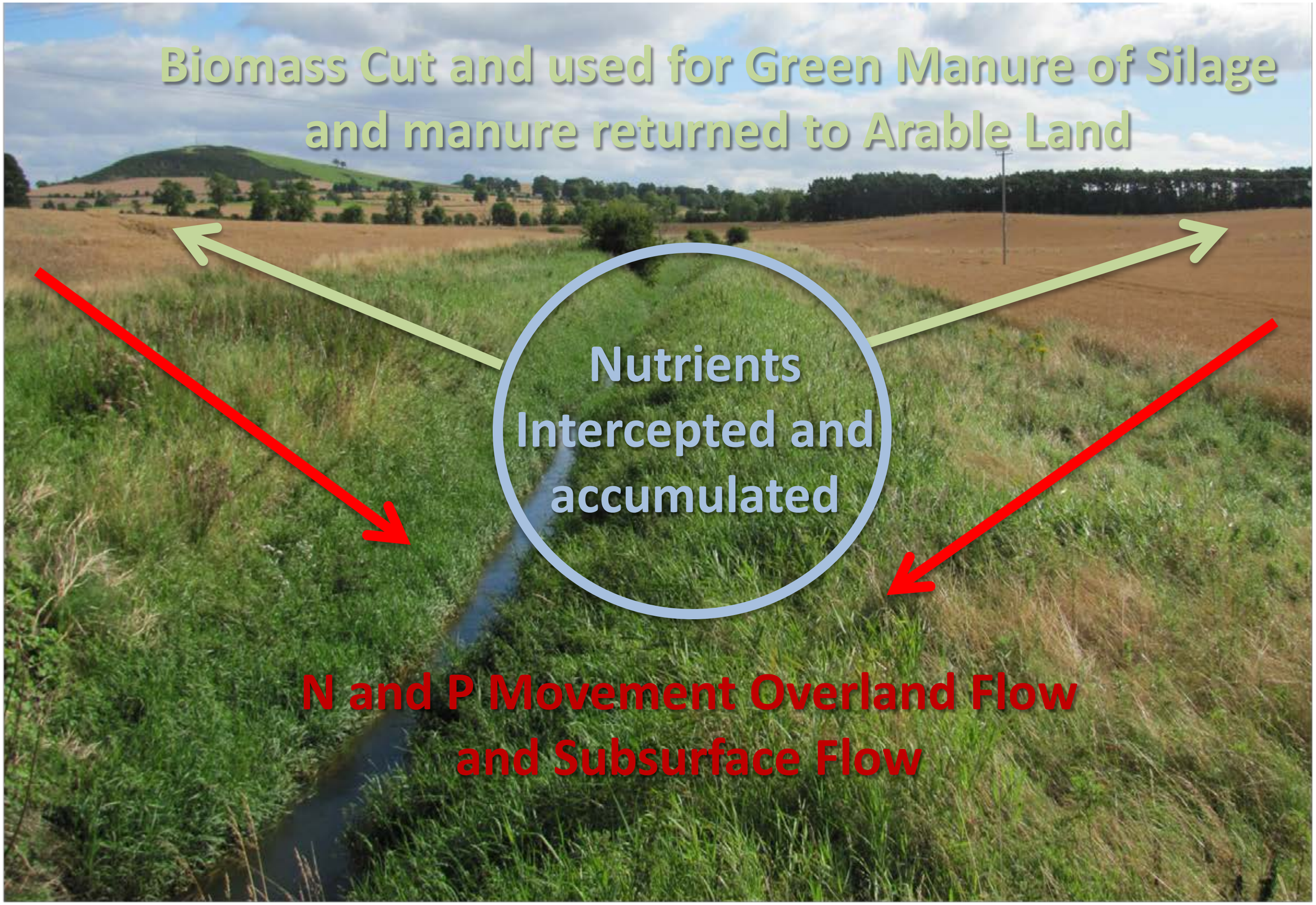
- In Denmark long term 2 m stream buffer uprated to mandatory fixed 10 m buffers brought in against all crop land
- Danish buffer zone act 2012 highly contentious:
    - *Government stealing land*
    - *Didn't want public access*
    - *No reliable watercourse maps*
    - *No science for effectiveness for N, P*
    - *No sense for flat, sandy soils*
- In Feb 2014 softened act back to 2m, with additional 8m in protected areas (25 000 ha of prime land taken out of buffers)
- Buffers must be managed for grass, trees not currently allowed

Buffer multiple benefits

Functions	Issues	Benefits	Evidence base
Controlling diffuse pollution transport	Site specific soil and flowpath factors Insufficient knowledge of catchment scale effectiveness Long term P storage, GHG trade-offs.	Sediment:	++
		Bank stabilisation	+
		N	++
		P_{tot} P_{diss}	+
		Pesticides	+
		Pathogens	-
Habitat and ecological connectivity	Conflict with nutrient retention, best as part of combined in-field and edge of field conservation measures.	Aquatic	+
		Terrestrial	+
Stream shading	Should be broad leaved trees. Protects watercourse from temperature extremes. Increases woody debris and C inputs.	Temp. regulation	+
		Woody debris	+
Hydrological connectivity	Conflicts with soil drained for farming. Wetlands are effective bioreactors for N. Stores flood peak flow.	Wetlands	++
Carbon sequestration	Interaction with DOC , N, P leaching and GHG emissions.	Carbon	-
Biomass production	Timber or biofuel production may offset lost income. Need appropriate harvesting methods.	Biomass	-
Cultural services	Habitat for hunting (fishing, deer, game birds), public access, recreation and education, crop pests issues.	Cultural services	-

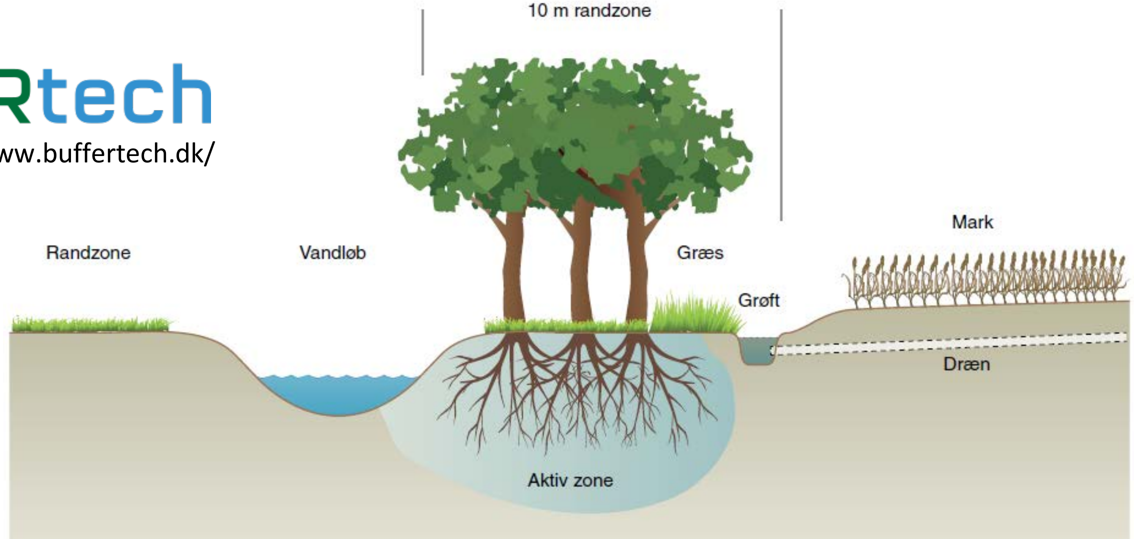
Stutter et al. (2012) Riparian buffer strips as a multifunctional management tool in agricultural landscapes: Introduction. JEQ, 41, 297-303

Potential landscape management of nutrients



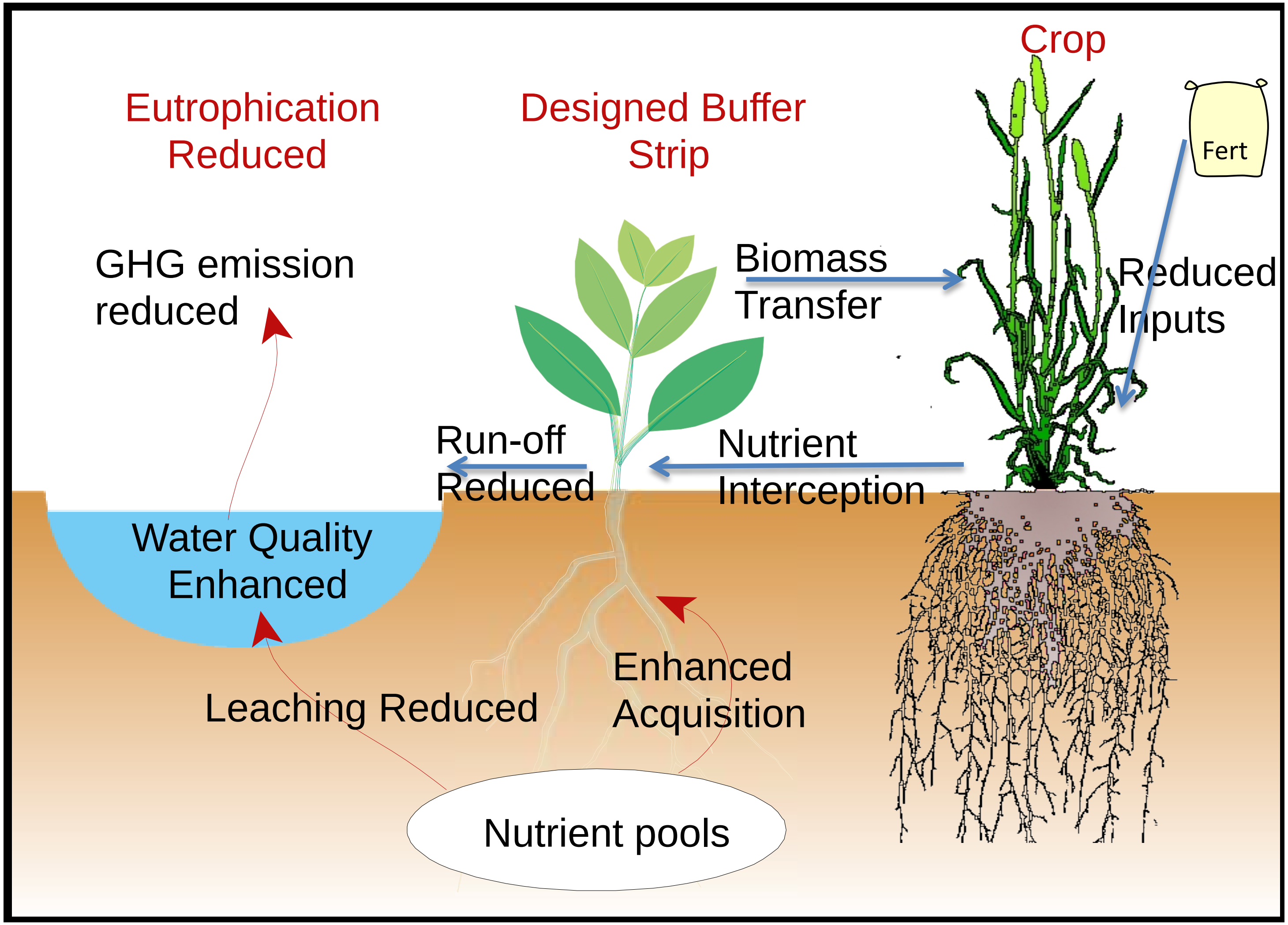
BufferTECH collaboration: Denmark, Scotland

BUFFERtech
http://www.buffertech.dk/



Zoned buffer, Denmark,
photos Ben Christen

System with designed buffer strip and biomass transfer



Rural SuDs

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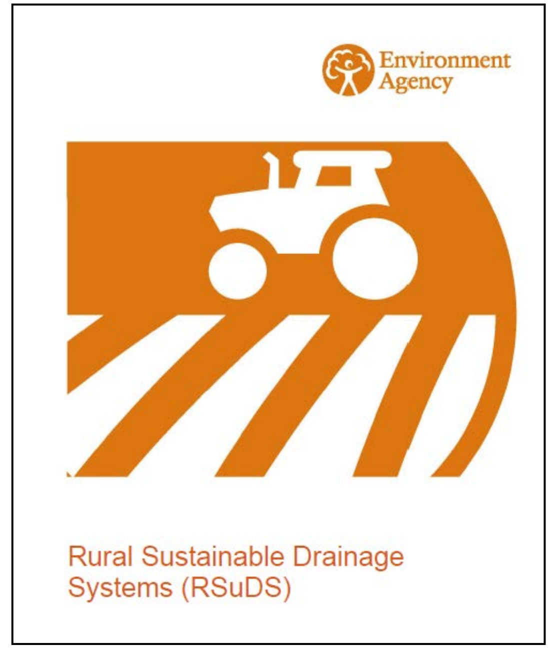
Individual, or multiple linked component structures replicating natural processes, designed to attenuate water flow by collecting, storing and improving the quality of run-off water within rural catchments

- Should be: low energy input; zero or only positive environmental impact; low capital and running costs; with multiple benefits
- Currently being embedded into the new SRDP scheme.
- Conceptual step forwards: multiple, small, unobtrusive measures as part of a ‘treatment-train’ approach
- Needs: landscape planning, demonstration & shared learning

Rural SuDs

Slow, store & filter

Rural SuDS Component (results for basic version of system)	Multiple Benefits: Flow	Water Quality	Biodiversity	Amenity	Performance: Flow	Suspended solids	Total Phosphorus	Total Nitrogen	Pathogens	[illegible]icides	Costs: Set-up	[illegible]unning	Cost effectiveness	Lifespan	Site suitability limitations
In-ditch options															
Swales										E					
Infiltration trench					E					E					
Filter/French drains					E										
Barriers & traps (basic)					E	E	E	E							
Wetland					E					[illegible]					
Ponds[3]															
Detention															
Infiltraion									E	E					
Retention									E						
Woodland/Forestry															
Woodland shelter belts															
Buffer strip/headland technology															
New hedges/dry stone dyke					E	E	E	E	E	E					
Dry grass filter strips					E										
Buffer strip (dry)															
Buffer strip (wet)[1]					E				E	E					
Contour bund					E	E	E	E	E	E					
Filter Berm					E	E	E	E	E	E					
Wetland															
Artificial/restored wetland										E					
Biobeds															
Farm buildings															
Rainwater harvesting					E										
Cross-drains					E										
Green roofs															
Other															
Sediment [illegible]ap															
Pervious [illegible]									E	E					
Sedimentation bo[illegible]s						E	E	E	E	E					
Soak away							E			E					
Grip (gully) blocking										E					



Avery et al. 2012.
Report for the EA
(commissioned by J. Letts)