Impact of septic tank systems on water quality in rural areas

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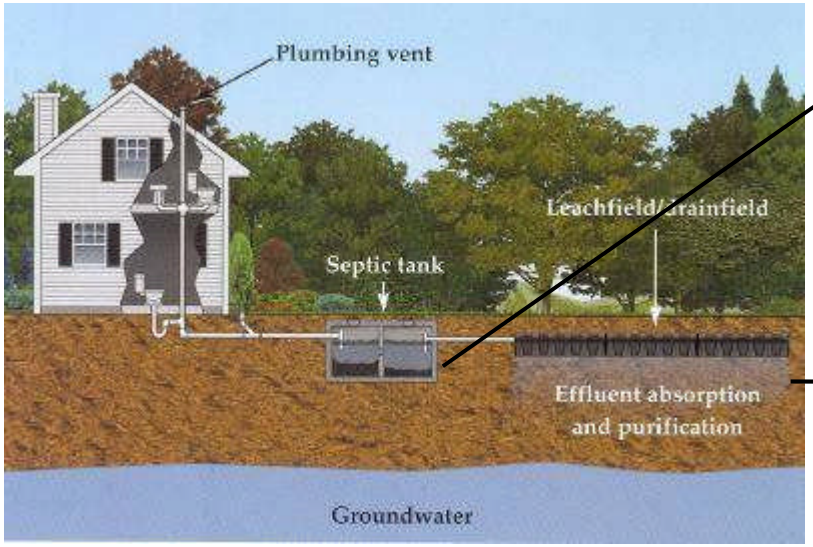
Septic tank systems (STS)

Estimated 2 million STS in UK/Ireland

Many are sited close to watercourses



Two chamber system where solids settle and liquid effluent flows out to a soakaway

Biotic/abiotic processing of pollutants (BOD, SS, N, P, pathogens) occurs in and below a biomat layer that develops in the soakaway

When things go wrong …

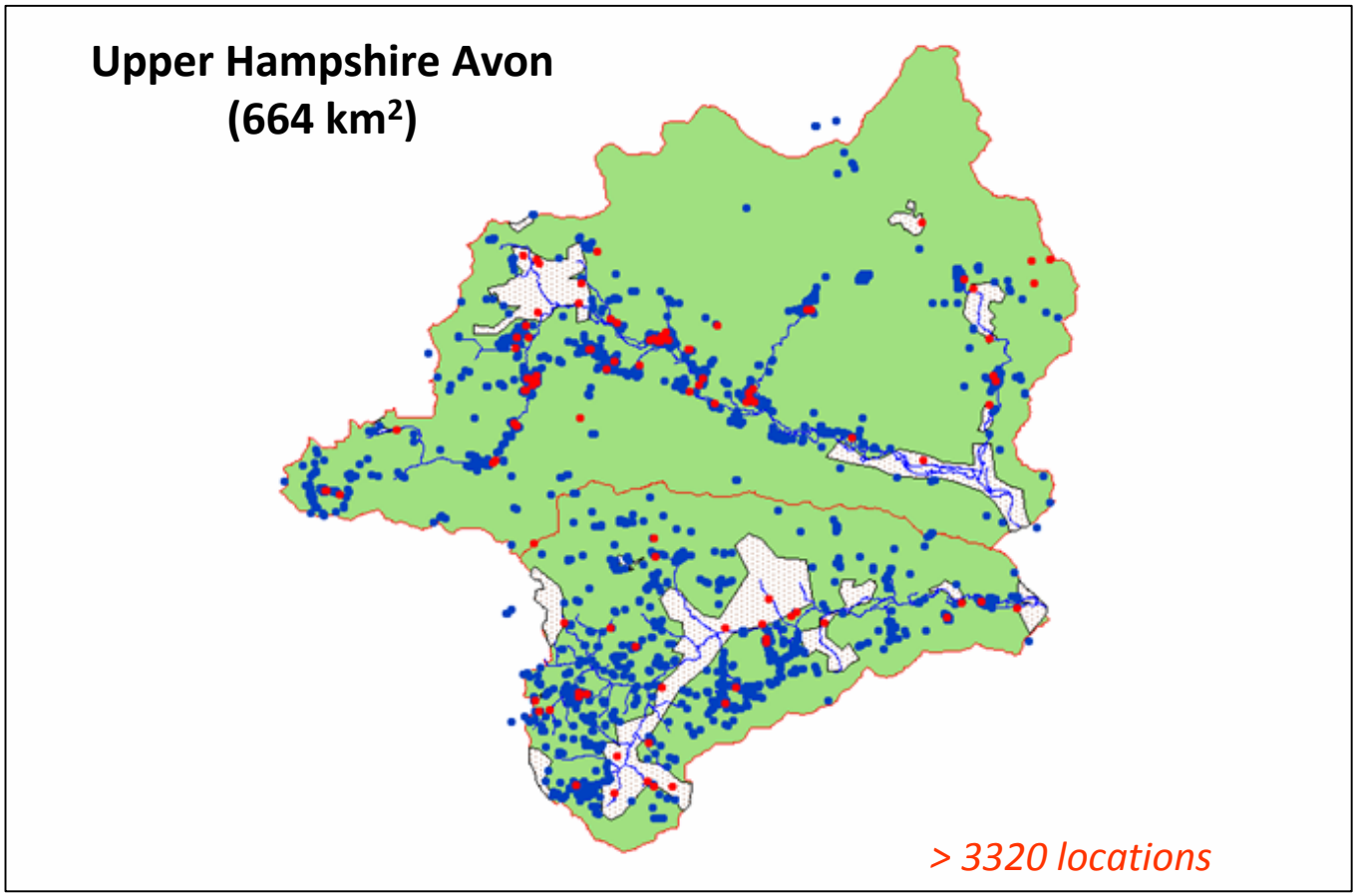
Poor design
- old systems not coping
- direct discharge to stream
- storm runoff sensitive

Incorrectly sited
- hydraulic failure on impermeable soils
- too close to a watercourse

Poor management
- leaks, blockages, chemicals
- lack of emptying
- blockage of biomat

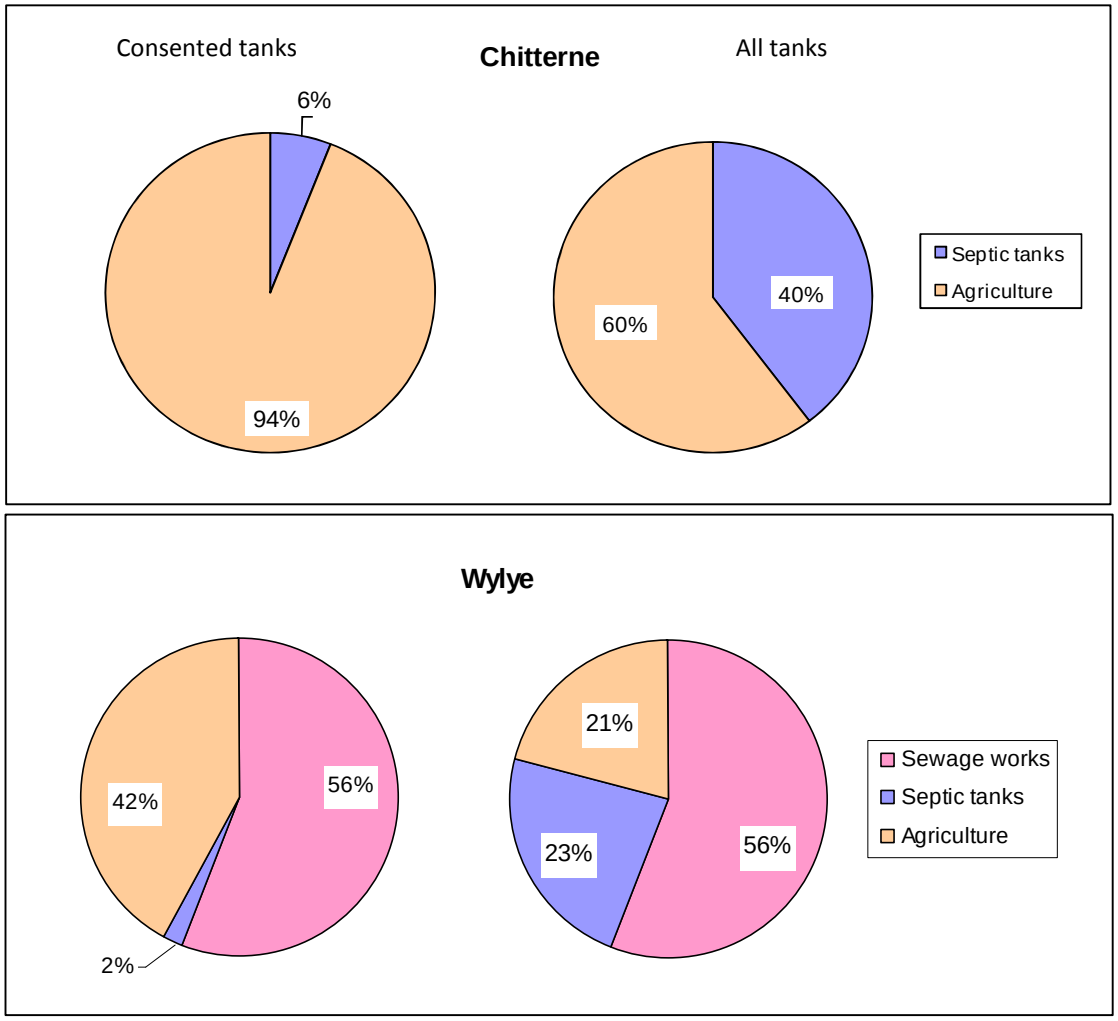
Reduced processing
Increased surface runoff
Discharge to watercourses

System location often unclear



May et al. (2010) Report to Natural England & Broads Authority

Septic tank systems contribute to P load



Contribution of septic tank systems often assumed to be negligible!

Export coefficient modelling that takes account of all septic tanks systems, and not just consented ones, suggests otherwise!

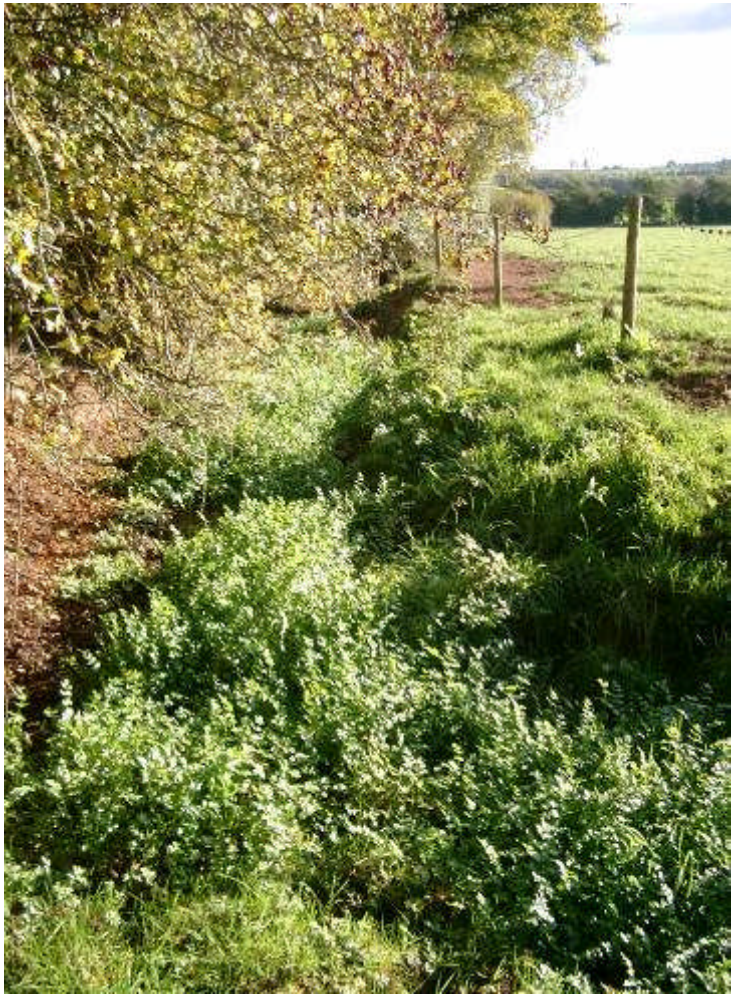
May et al. (2010) Report to Natural England & Broads Authority

Impacts on water quality

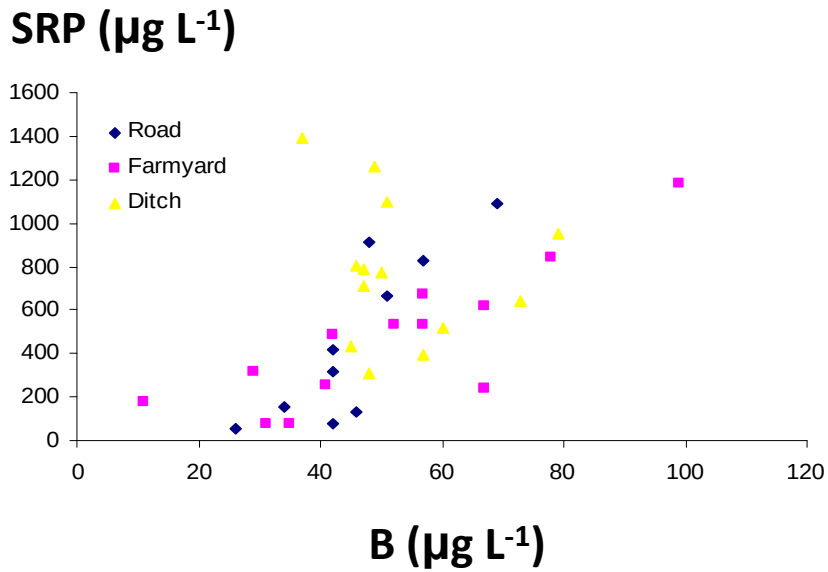
Typical rural scene with groups of houses dotted about the landscape; septic tank systems are hidden away, impacts on water quality not immediately obvious!

Direct discharge from drainage pipes into the stream; sewage fungus growing just below the discharge point gives the game away!

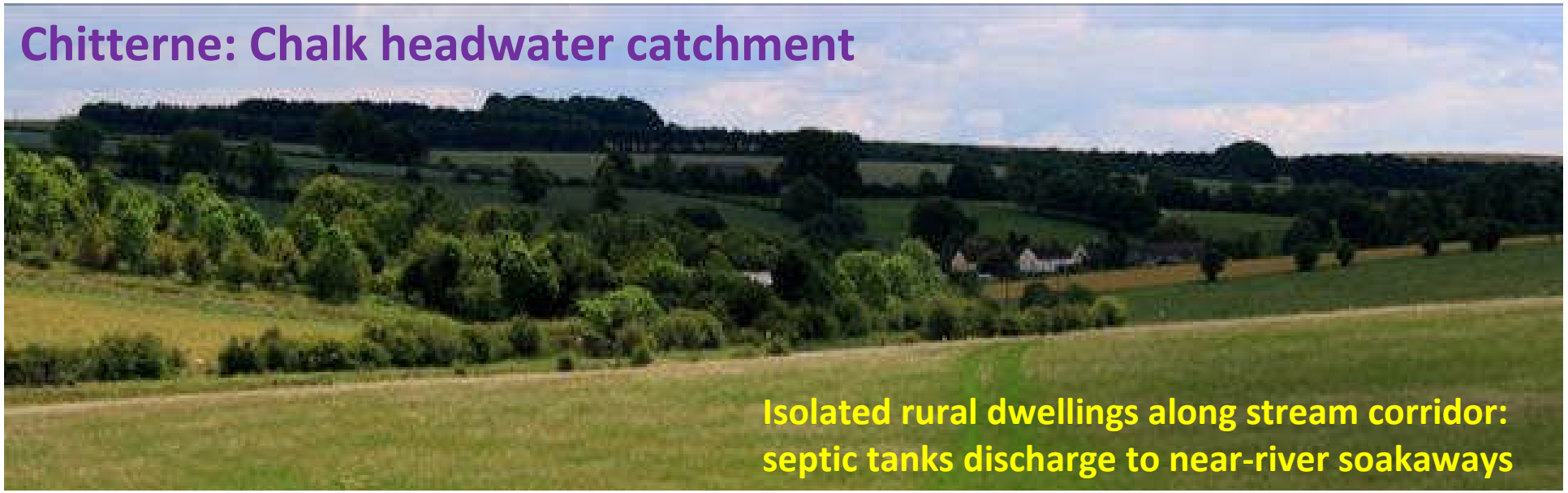
Catchment walks and spot sampling

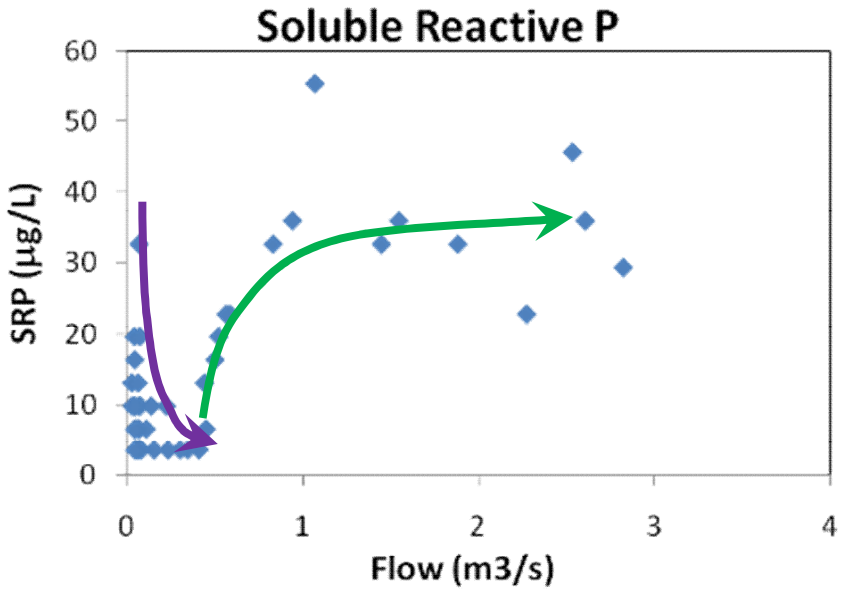


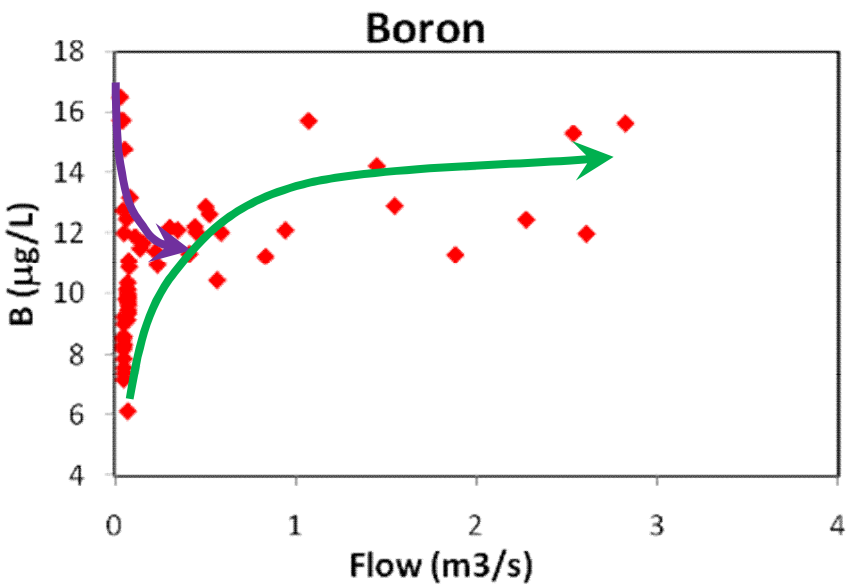
Ditch receiving septic tank overflow from the local village hall is choked with macrophytes in a Wye sub-catchment



Chitterne: Chalk headwater catchment







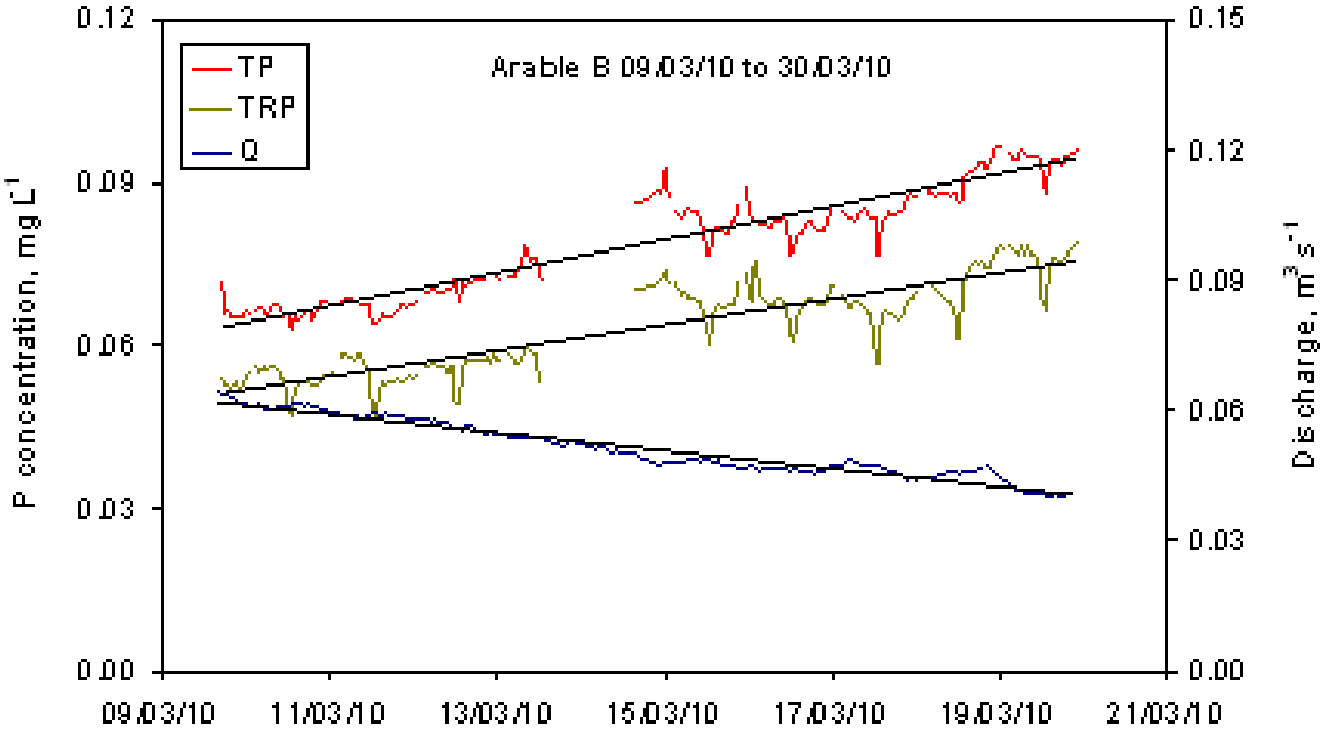
Initial dilution of point sources

Mobilisation of SRP and B as groundwater levels rise and intercept septic tank soakaways

Jarvie et al., 2008

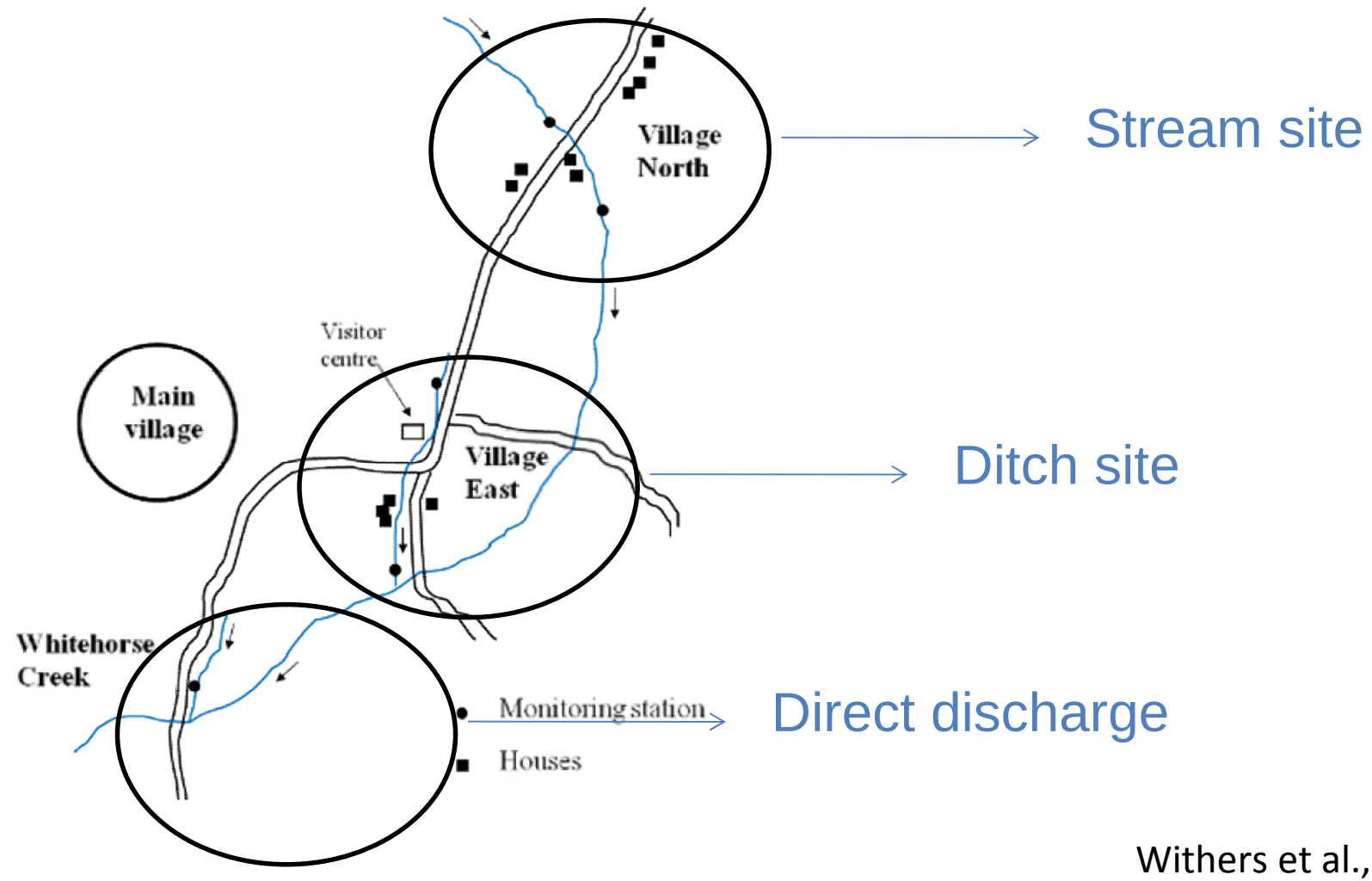
Storm independent transfers

Loss of dilution at baseflow; P increases (storm independent)



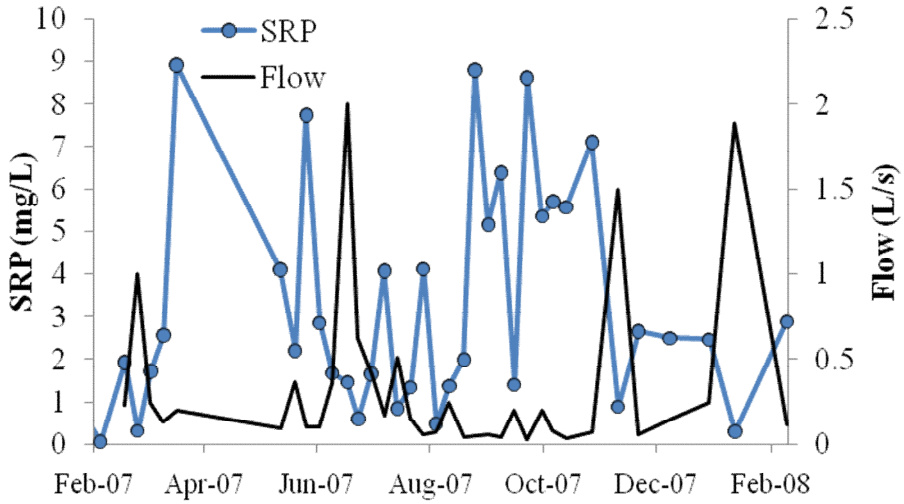
Heavy soils in County Louth, Ireland

Monitoring in an English village

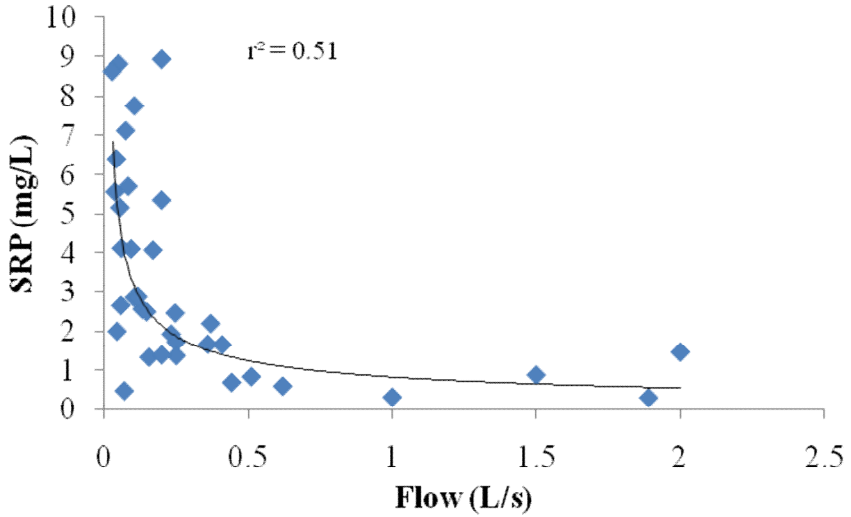


Withers et al., 2011

Direct discharge

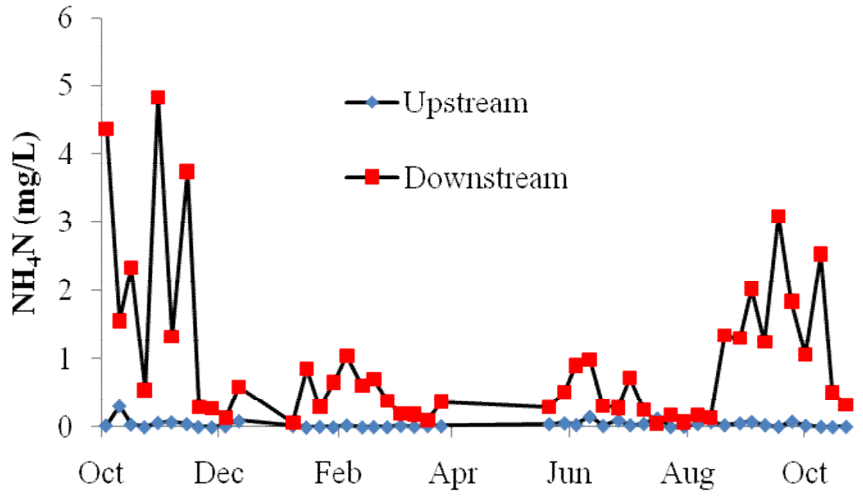


	Range	Mean
SRP (mg/L)	<1 - 9	3.2
NH_4N (mg/L)	<1 - 72	18
Na (mg/L)	13 - 119	49
B (µg/L)	54 - 213	109
SO_4S (mg/L)	11 - 42	31
Mn (µg/L)	11 - 169	68

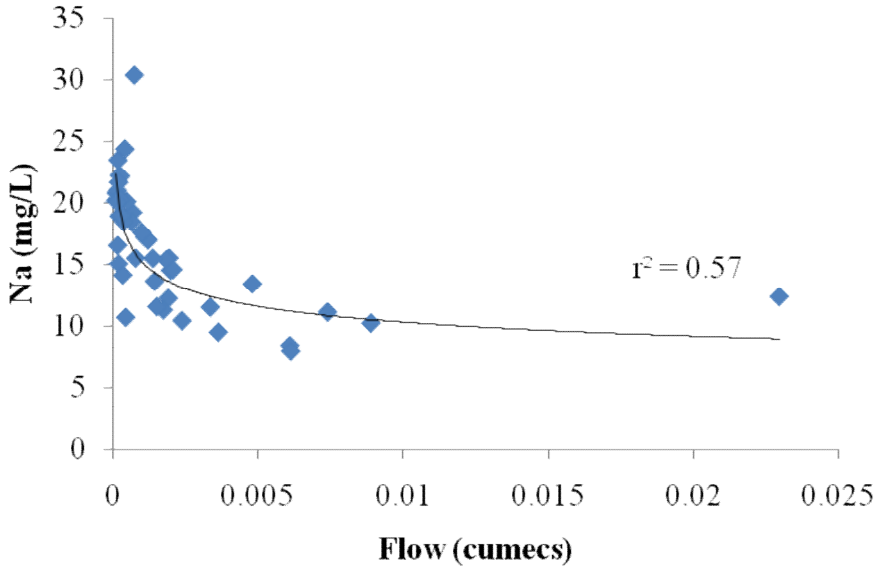


Range in nutrient concentrations and dilution with flow is typical of point source effluent discharge

Village East (Ditch site)

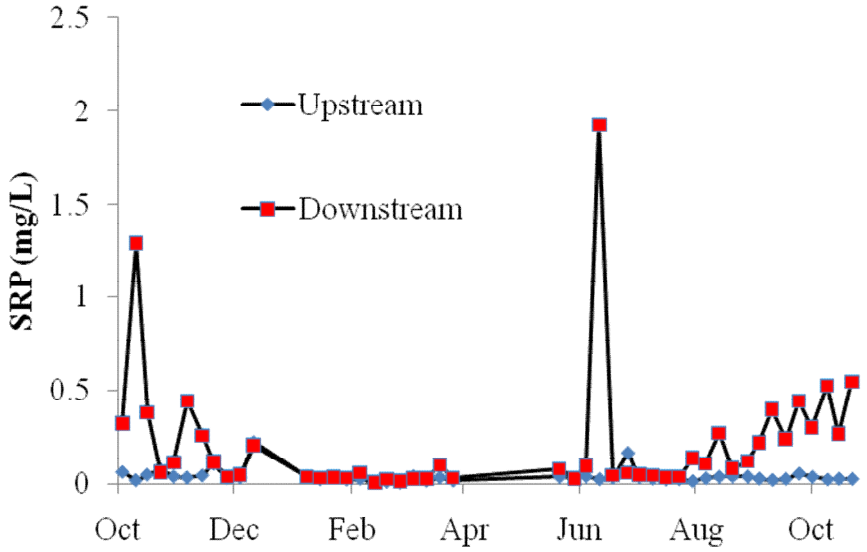


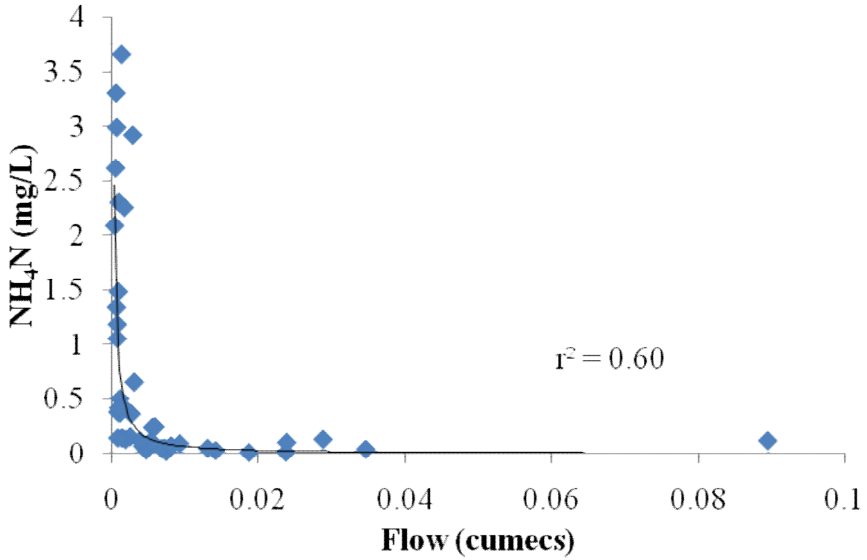
	Upstream	Downstream
SRP (µg/L)	78	321
NH_4N (mg/L)	0.05	1.0
Na (mg/L)	8	17
B (µg/L)	56	109
SO_4S (mg/L)	13	25
Mn (µg/L)	21	48



Large increases in nutrient concentrations downstream of houses when flow rates are low

Village North (Stream site)

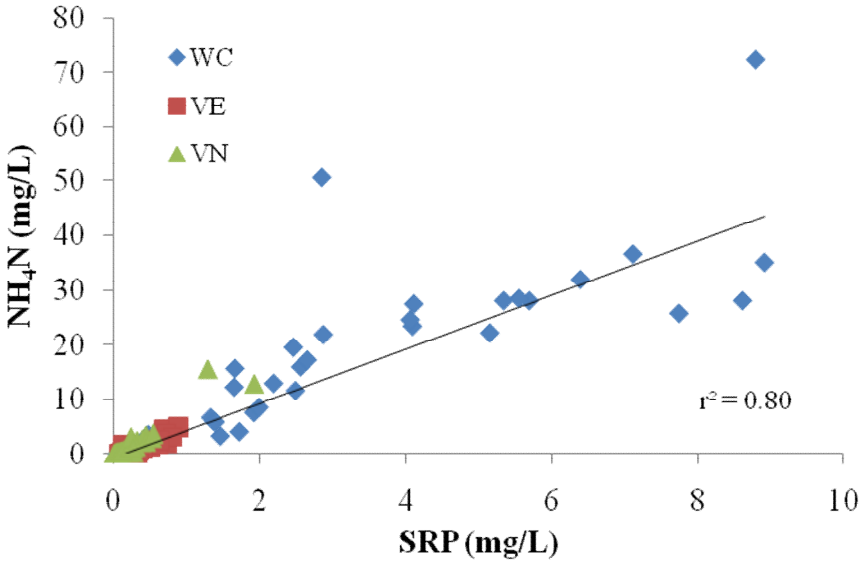


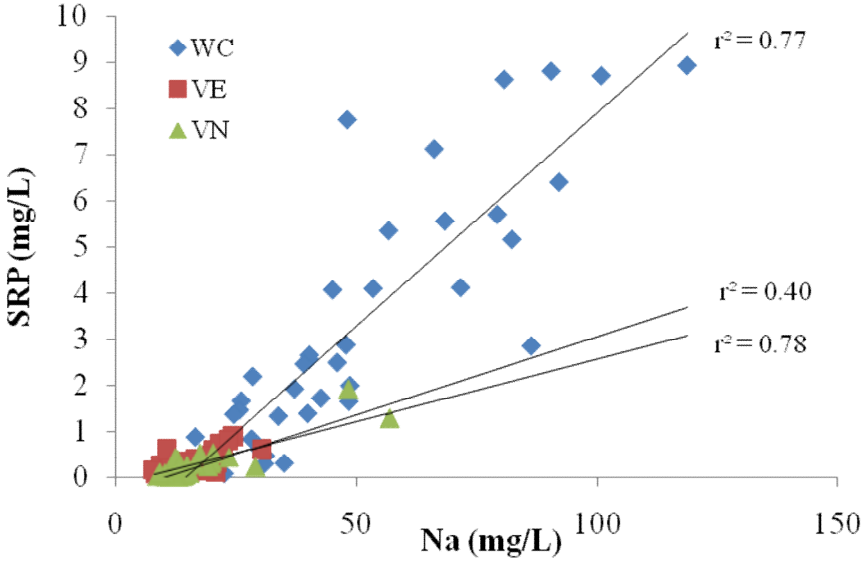


	Upstream	Downstream
SRP (mg/L)	0.03	0.21
NH_4N (mg/L)	0.03	1.32
Na (mg/L)	13	16
B (µg/L)	52	56
SO_4S (mg/L)	26	26
Mn (µg/L)	12	29

Large increases in SRP and NH_4N concentrations downstream of houses on few occasions when flow is very low.

Nutrient inter-correlation



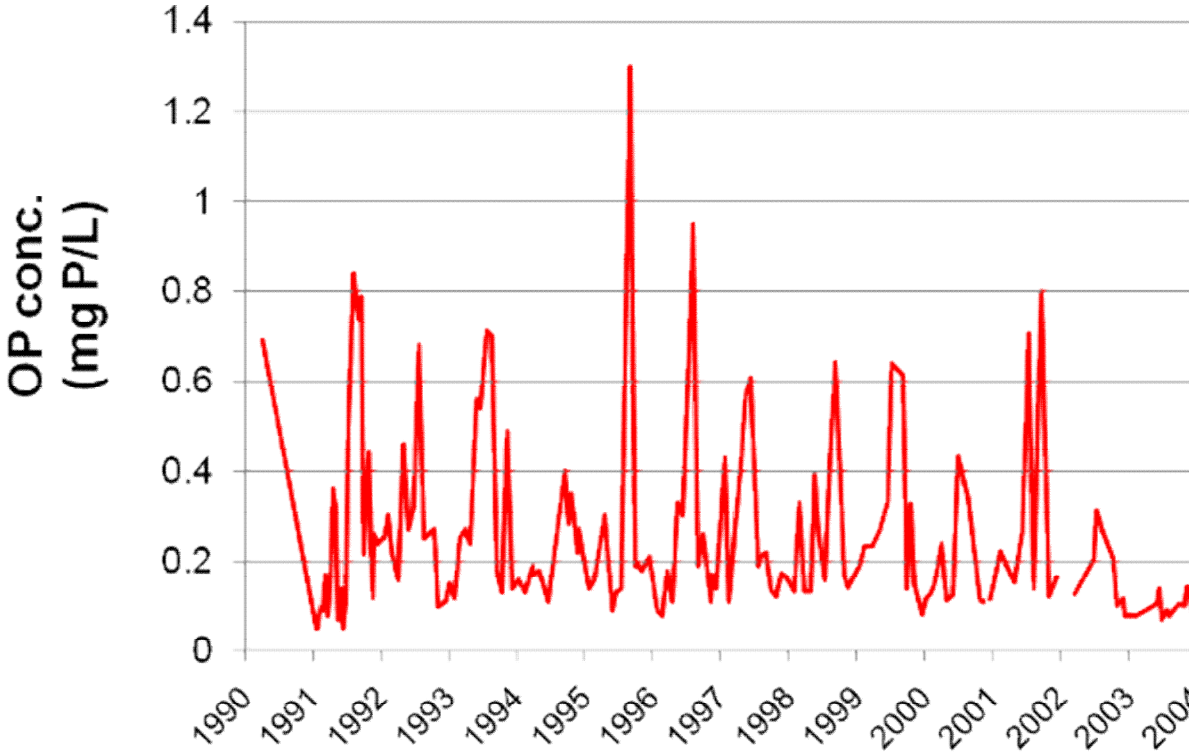


High degree of nutrient inter-correlation at direct discharge and both downstream sites.

There was no inter-correlation at upstream sites

Combination of direct discharge and STS failure on heavy soils

First time sewerage scheme, River Chew

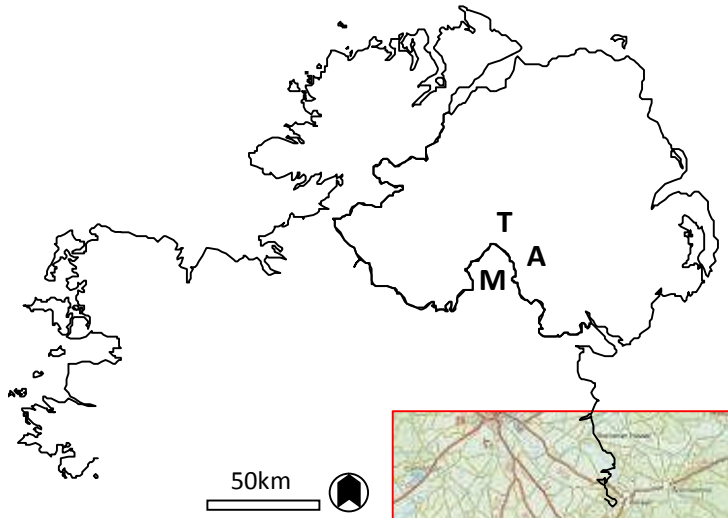


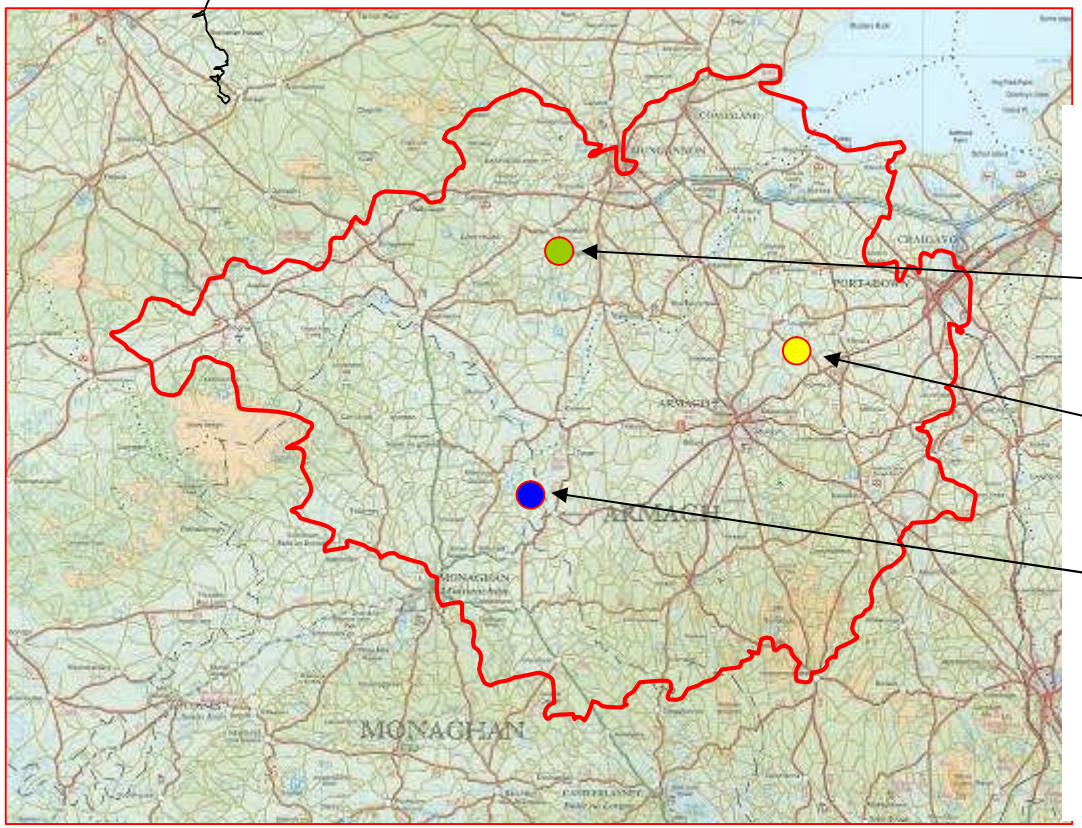
Average SRP concentrations fell from 251µg/L to 86 µg/L after scheme was introduced

Barden (2007) Report to EA

The Blackwater catchment 1,480 km^2

115 STS surveyed in 2006,
28 chosen for upgrade,
18 upgraded, resurveyed in 2010





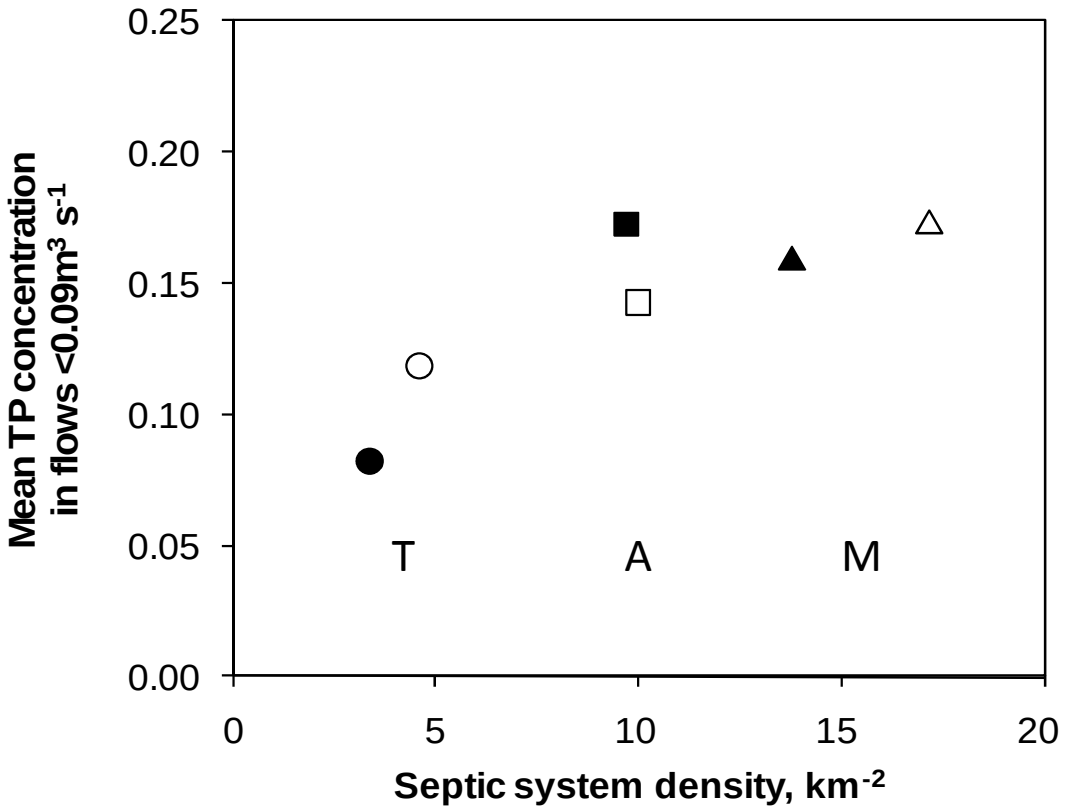
Co. Tyrone
5km^2

Co. Armagh
3km^2

Co. Monaghan
5km^2

Drumlin soils
Gleys, low permeability
Fast runoff – diffuse P source risk
Suppressed baseflows – point source P risk

Blackwater TRACE catchments, Ireland



Closed symbols 2006 Open symbols 2010

Tyrone

Replaced 3 STS, 6 added

Armagh

Replaced 4 STS, 1 added

Monaghan

Replaced 11 STS, 17 added

Low flow P status sensitive to STS density

Are septic tank systems a water quality problem?

- Mounting evidence to suggest they can be!
- System failure seems quite widespread
- STS discharges can occur under both high flow and low flow
- STS do impact on stream nutrient concentrations, especially under low flow
- Catchments with high STS density most vulnerable
- Removing/upgrading of STS does appear to improve water quality
- High risk of ecological impacts because discharge is highly bioavailable, potentially harmful to health or toxic to biota

- STS are poorly understood, need better process understanding to inform best design/practice

Acknowledgements

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