Simulation of the Impact of Nature-Based Solutions on Diffuse Pollution in Ballycanew

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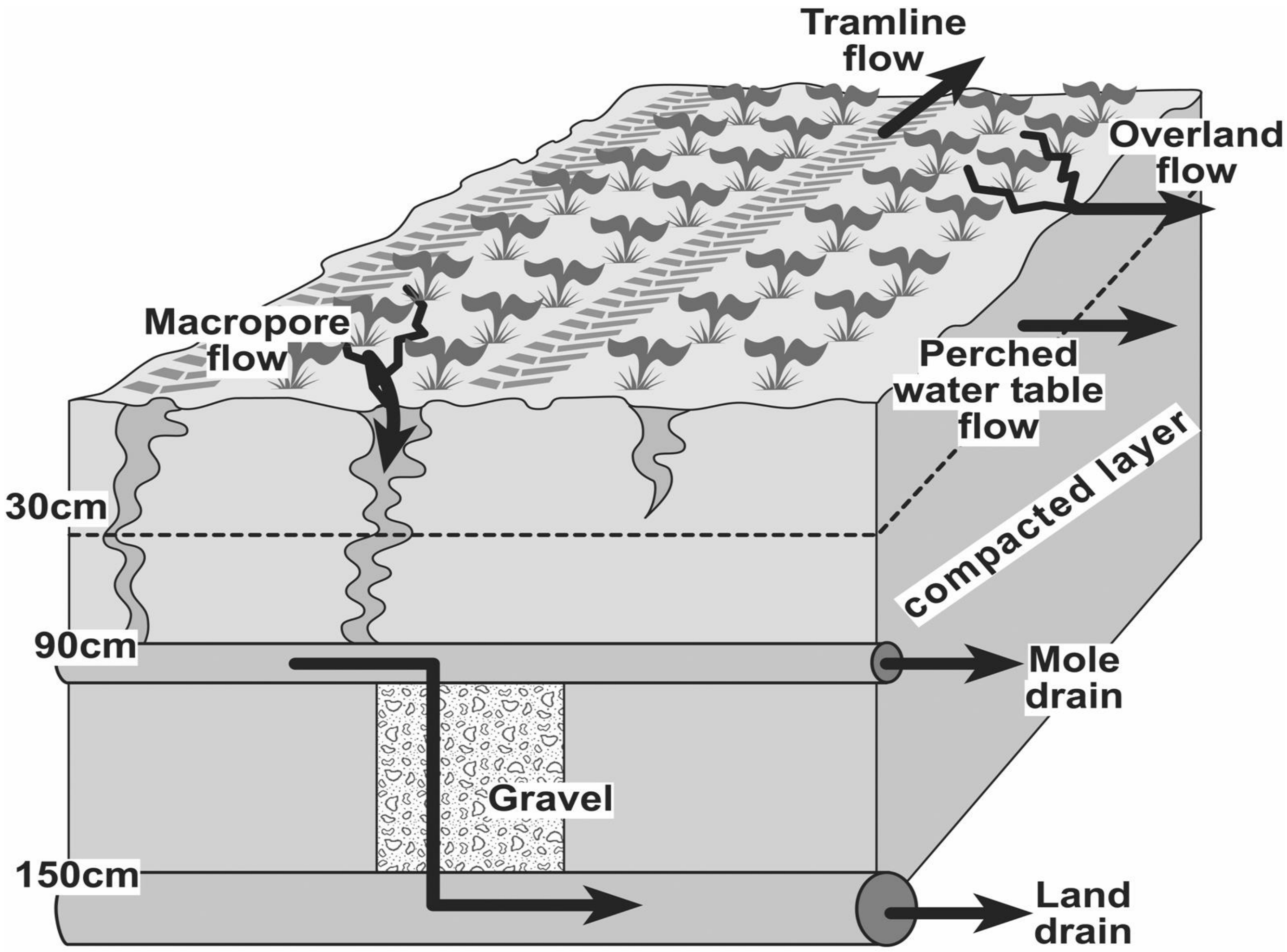
Farmed soil: increased runoff and less recharge



Lower infiltration + lower soil water storage
= lower infiltration capacity

What about the Future?

Soil Degradation Threat

Prof Karen Johnstone (Durham University)

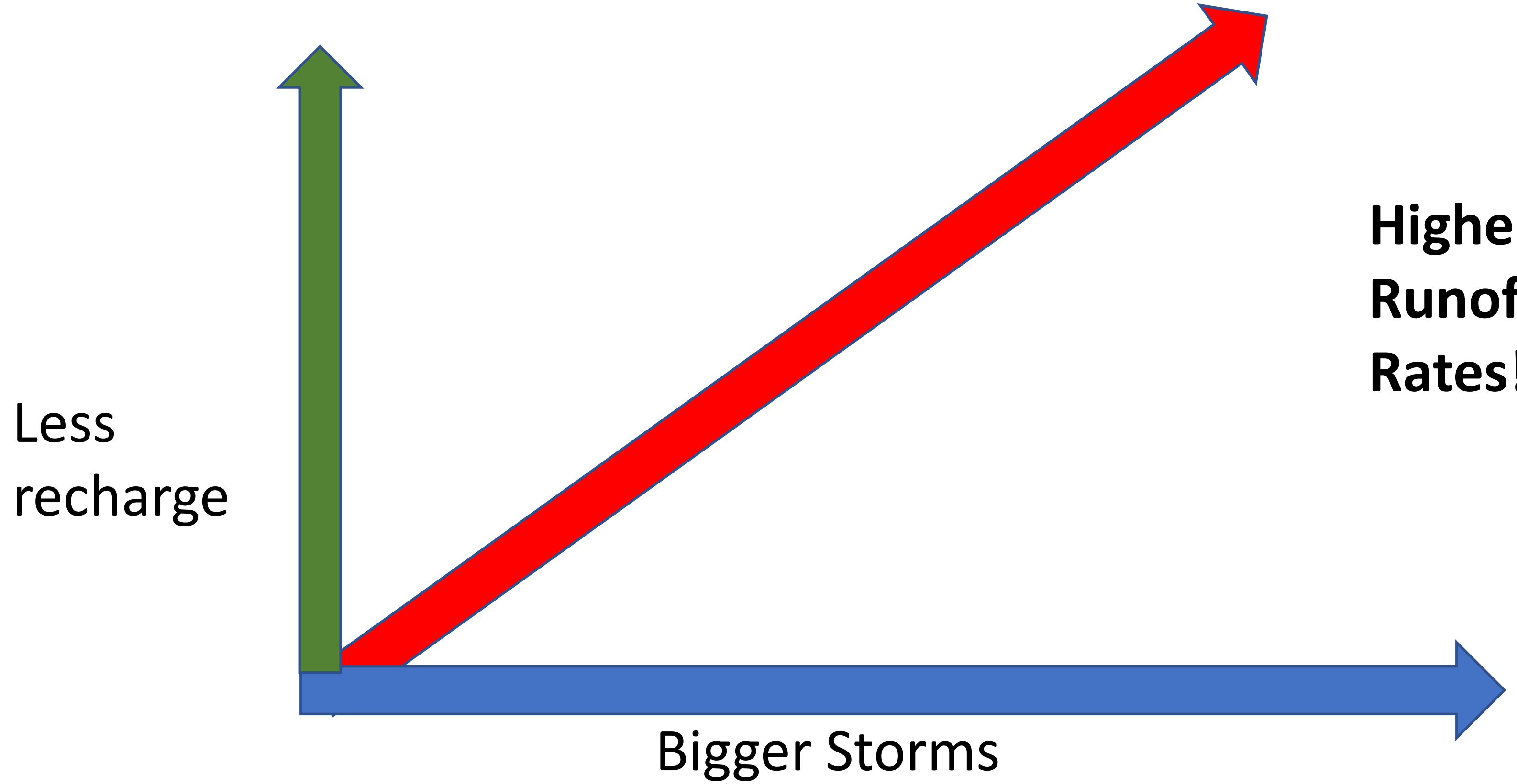
“ a world that does not look after its soil does not look after its future”

Climate Threat

Prof Hayley Fowler (Newcastle University)

“we are looking at larger and larger storms”

Both threats create more and faster runoff and less recharge



Are higher runoff rates a major threat to the future?

We must manage runoff rates.

Modelling Flow Pathways on Farmed Land

CRAFT

Catchment Runoff Attenuation Flux Tool

3 Flow Pathways

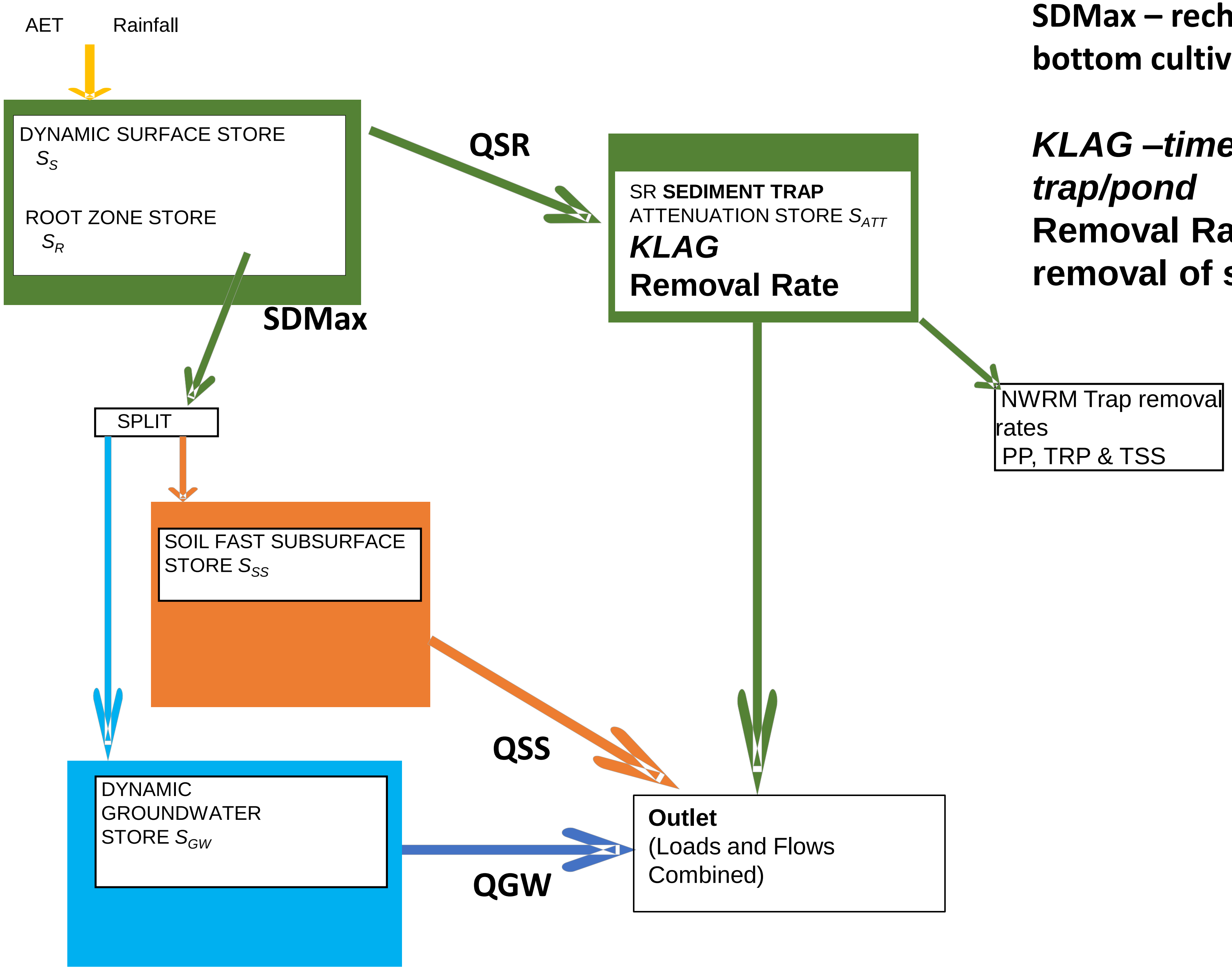
1. Fast near surface and surface flow QSR
2. Fast subsurface soil flow QSS
3. Groundwater flow QGW

How do changes in soil health and climate lead to increased runoff and pollution?

Quantifying impacts using a flow pathway model and high frequency data

Managing Flow Pathways on Farms using NBS

CRAFT Hourly



SDMax – recharge rate at bottom cultivation zone

KLAG –time delay in trap/pond

Removal Rate - % removal of sediment

Study Site

CRAFT is designed to operate at 1-2km^2

but CRAFT can run at any scale

see Poster by Adams *et al.*

And

Adams, R. and Quinn, P., 2023.

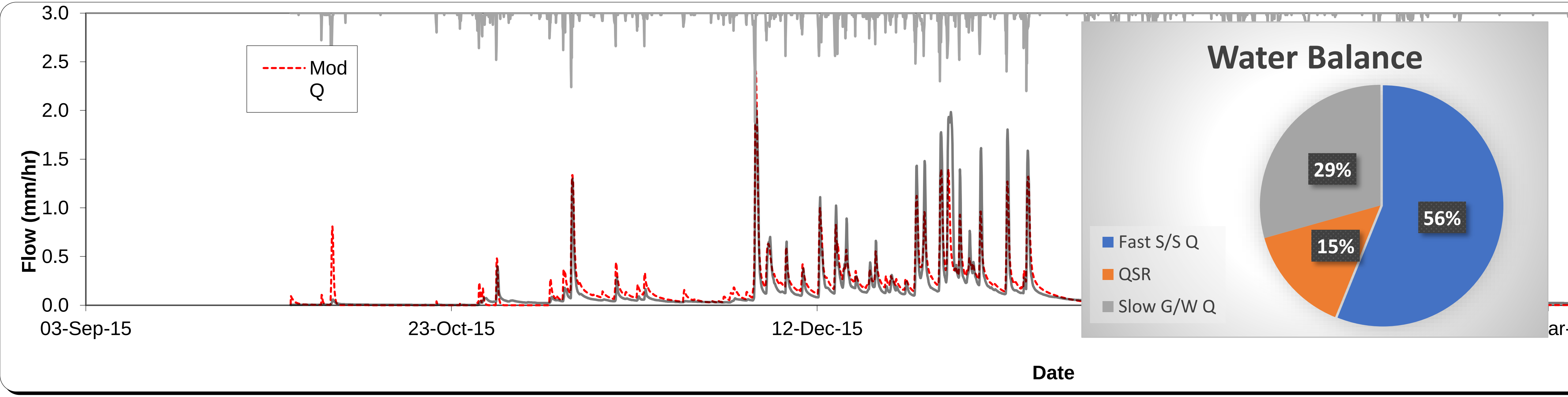
Simulating Phosphorus Load Reduction in a Nested Catchment Using a Flow Pathway-Based Modeling

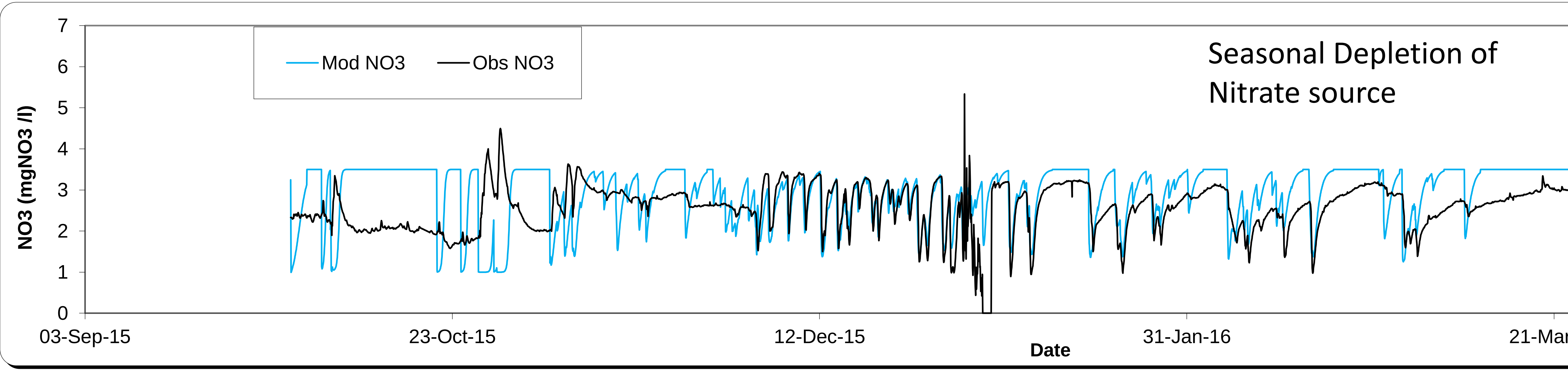
Approach. *Hydrology*, *10*(9), p.184.

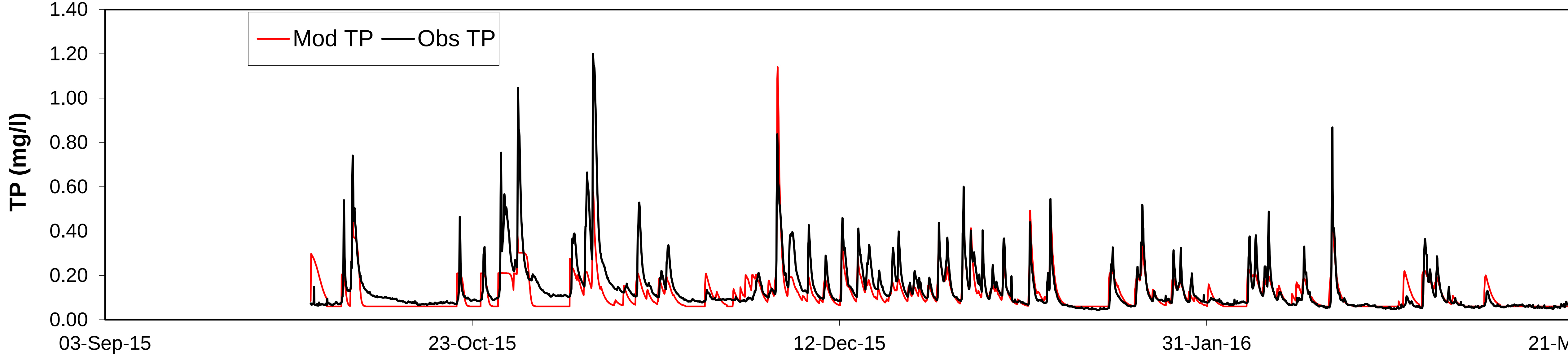
Ballycanew, Co. Wexford

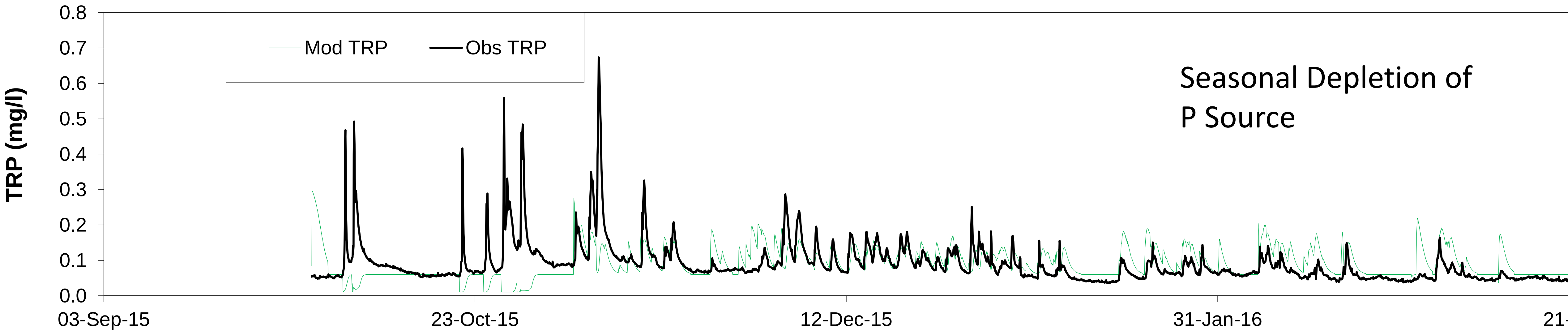
- 11.92km2
- 78% grassland-based farming
- Soils derived from marine deposits of heavy muds, poor drainage
- P at risk through overland flow

Ballycanew Hourly Calibration Dataset



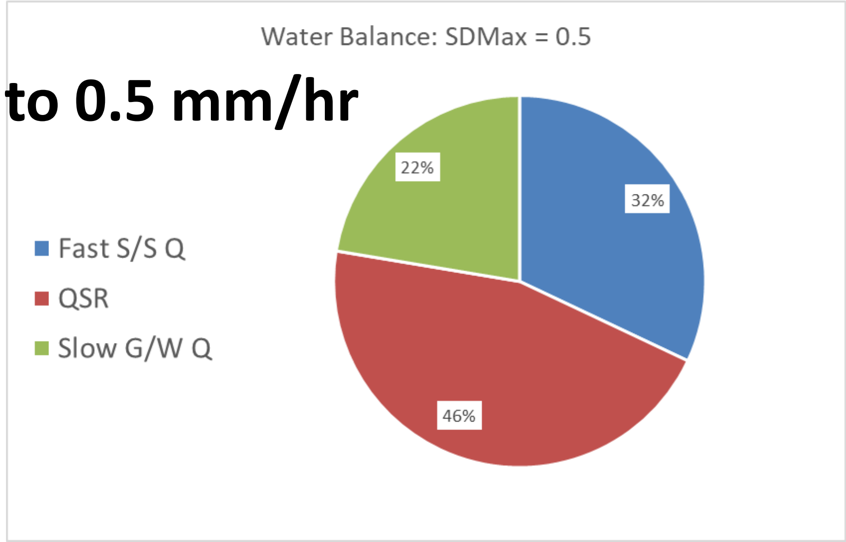



TP (mg/l)
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Mod TP
Obs TP
03-Sep-15
23-Oct-15
12-Dec-15
31-Jan-16
21-M

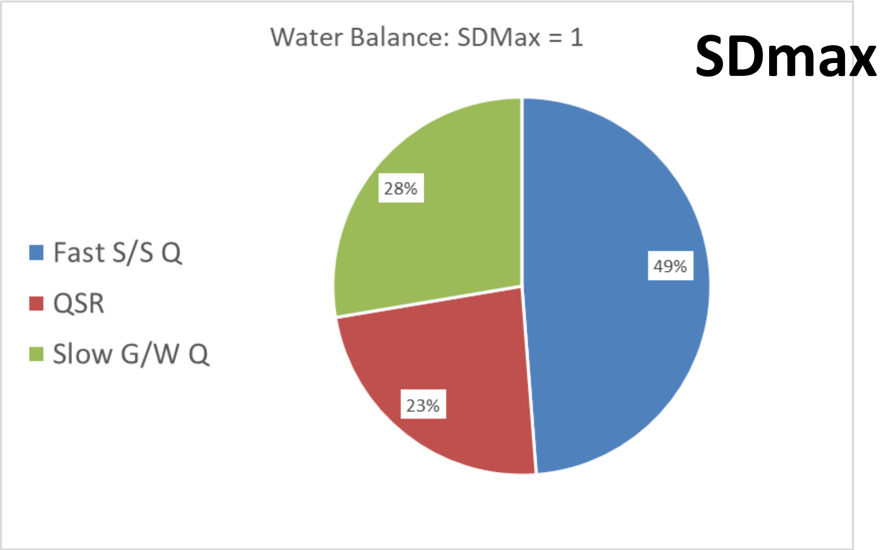

TRP (mg/l)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Mod TRP
Obs TRP
Seasonal Depletion of
P Source
03-Sep-15
23-Oct-15
12-Dec-15
31-Jan-16
21-

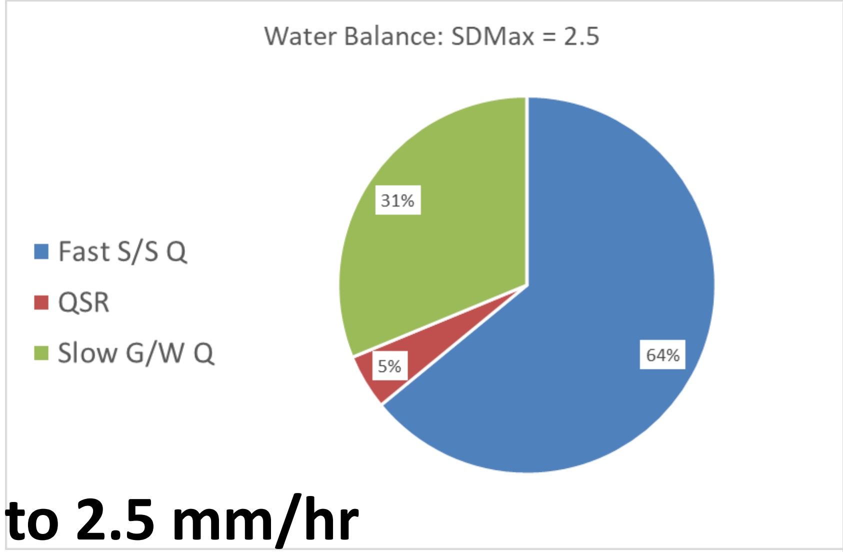
Increasing deeper infiltration rates in the soil

SDmax set to 0.5 mm/hr

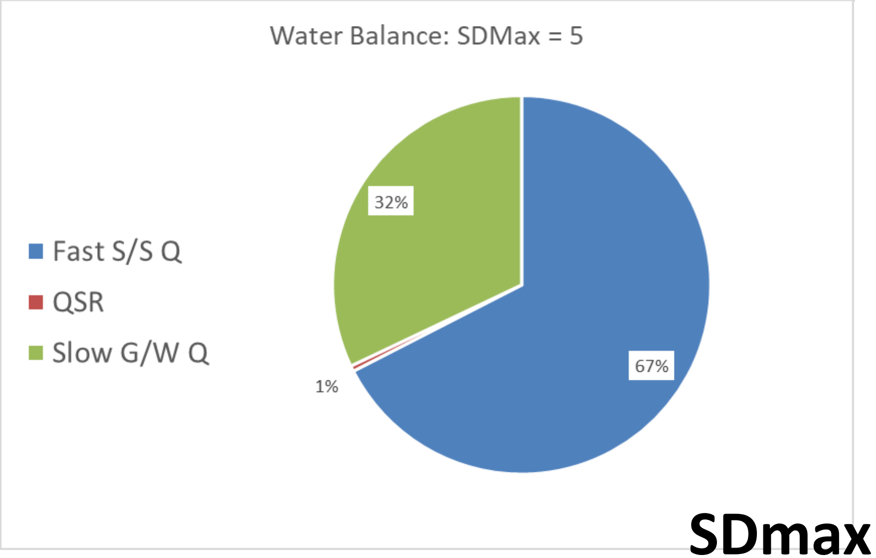


SDmax set to 1 mm/hr





SDmax set to 2.5 mm/hr



SDmax set to 5 mm/hr

Adding a sediment trap

SS reduced by 50% and TP by 30%

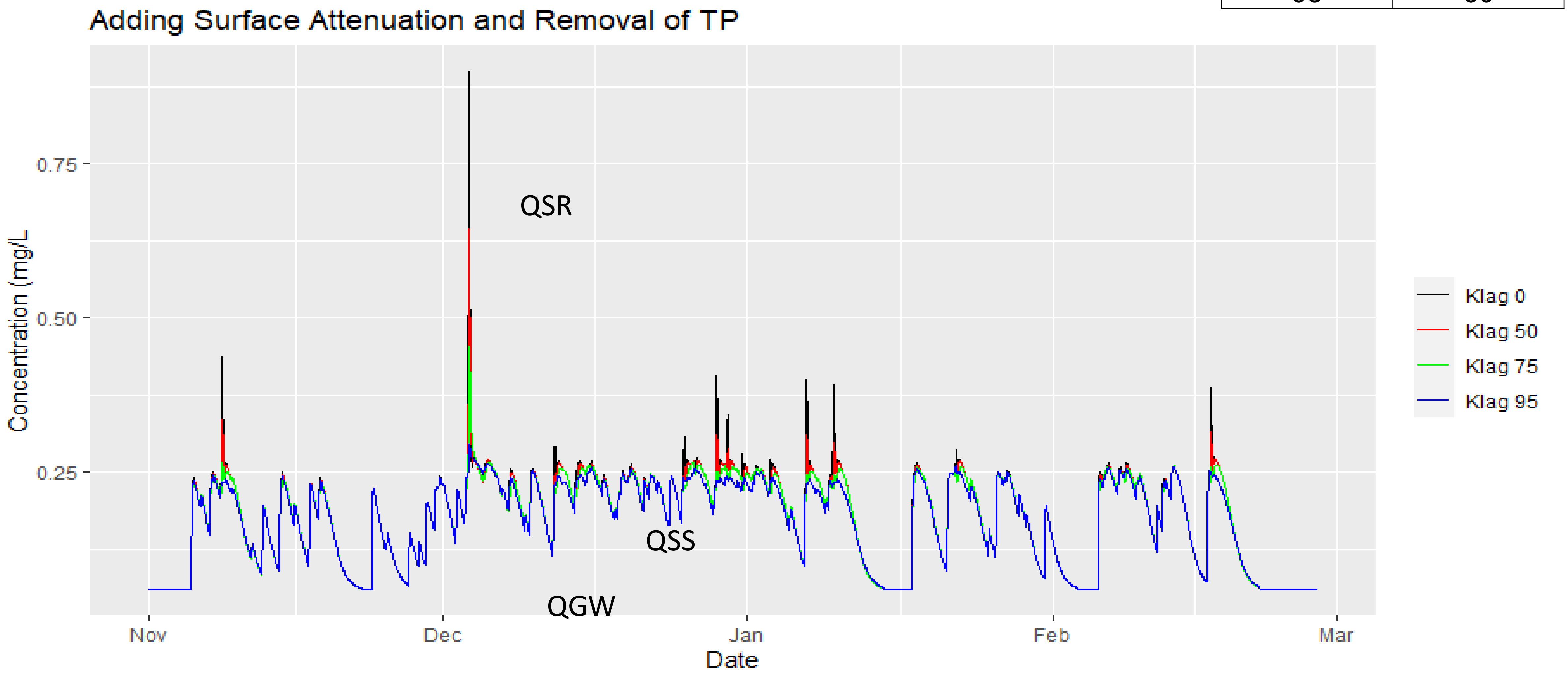
- Water storage capacity ≈ 280 m^3
- 70 ha contributing area

Newcastle University

cheviotfutures

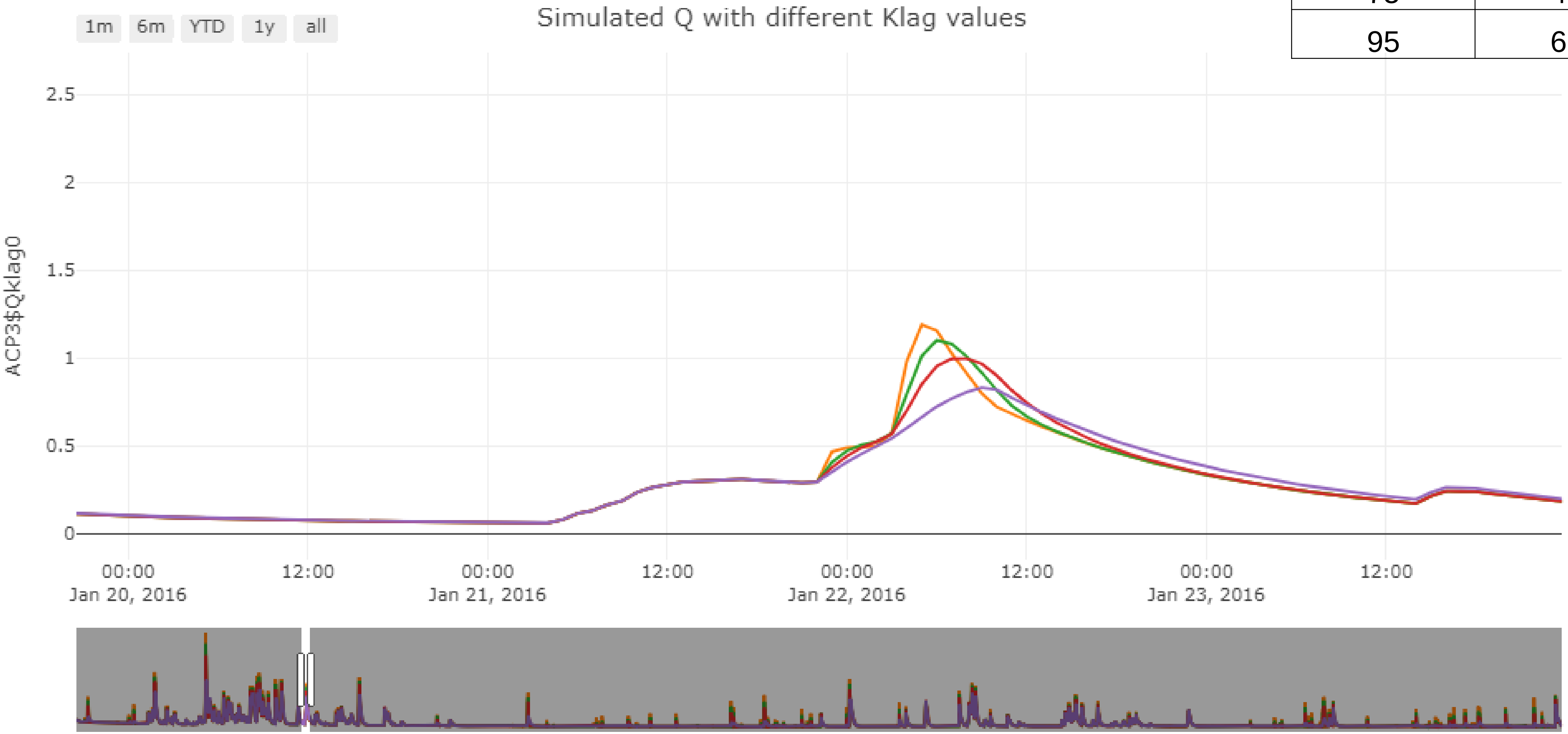
Effects of Sediment Trap Attenuation and Removal Efficiency on TP

Klag	RE%
0	0
50	20
75	40
95	60



Effects of Surface attenuation on discharge

Klag Pond Attenuation	Recovery Efficiency%
0	0
50	20
75	40
95	60



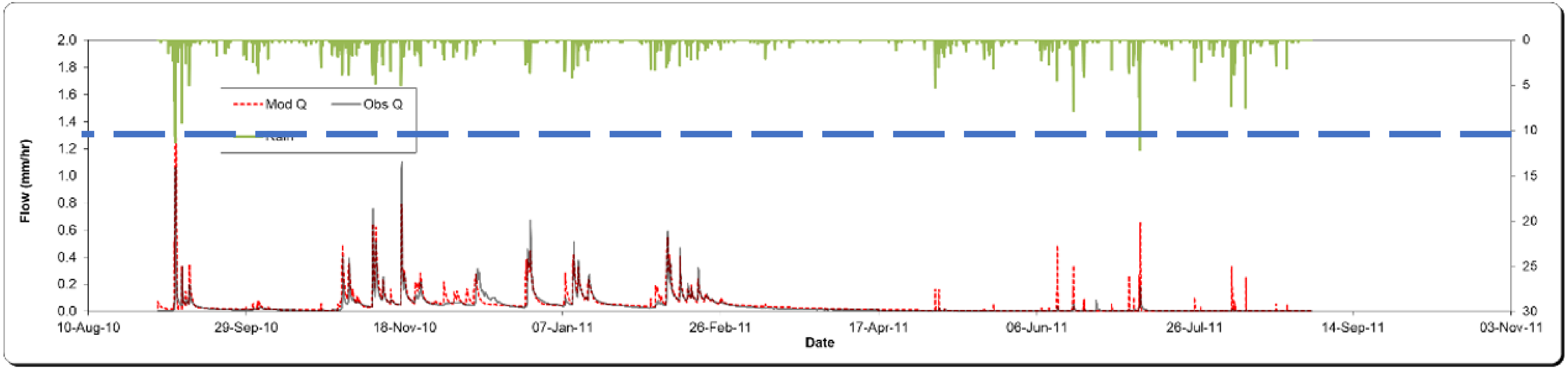
Climate change

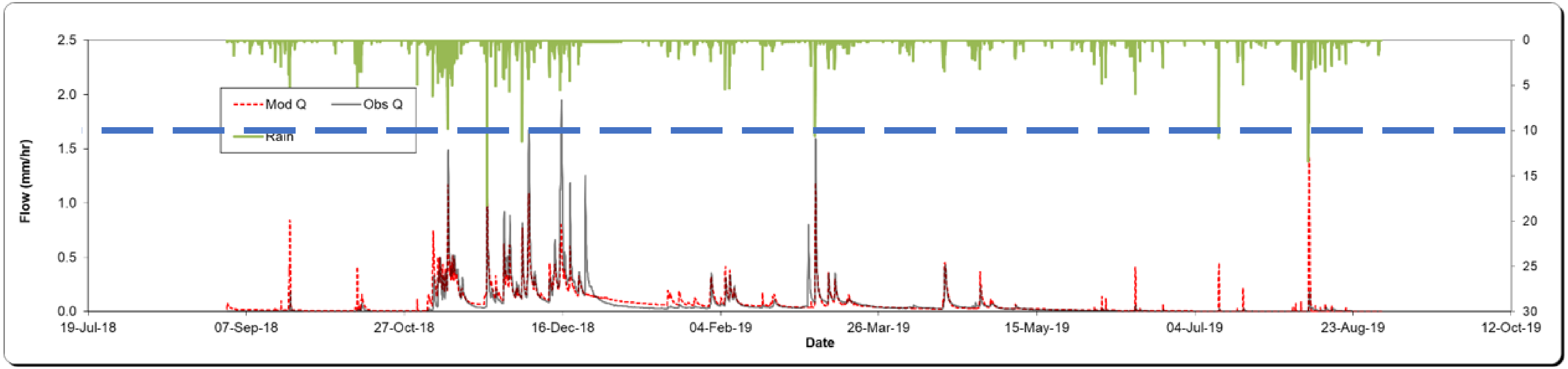
- Has the climate changed in Ballycanew?
- Is there a different distribution of storm types?
- Are there more times when SDmax is exceeded?

If we assume that the climate is changing in Ballycanew

Test to compare 2010/11 with 2018/19

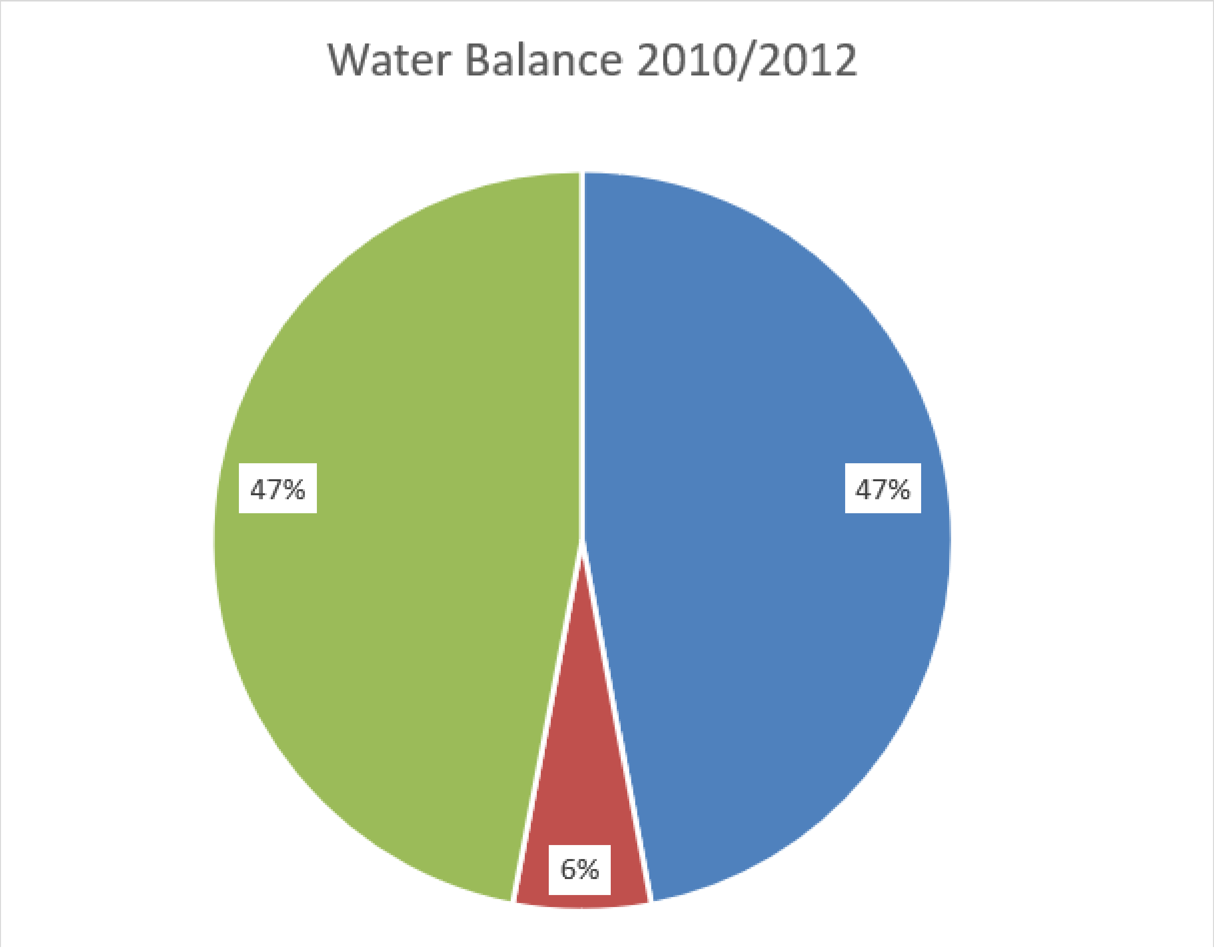
CRAFT Calibrated for 2010 and rerun on 2018

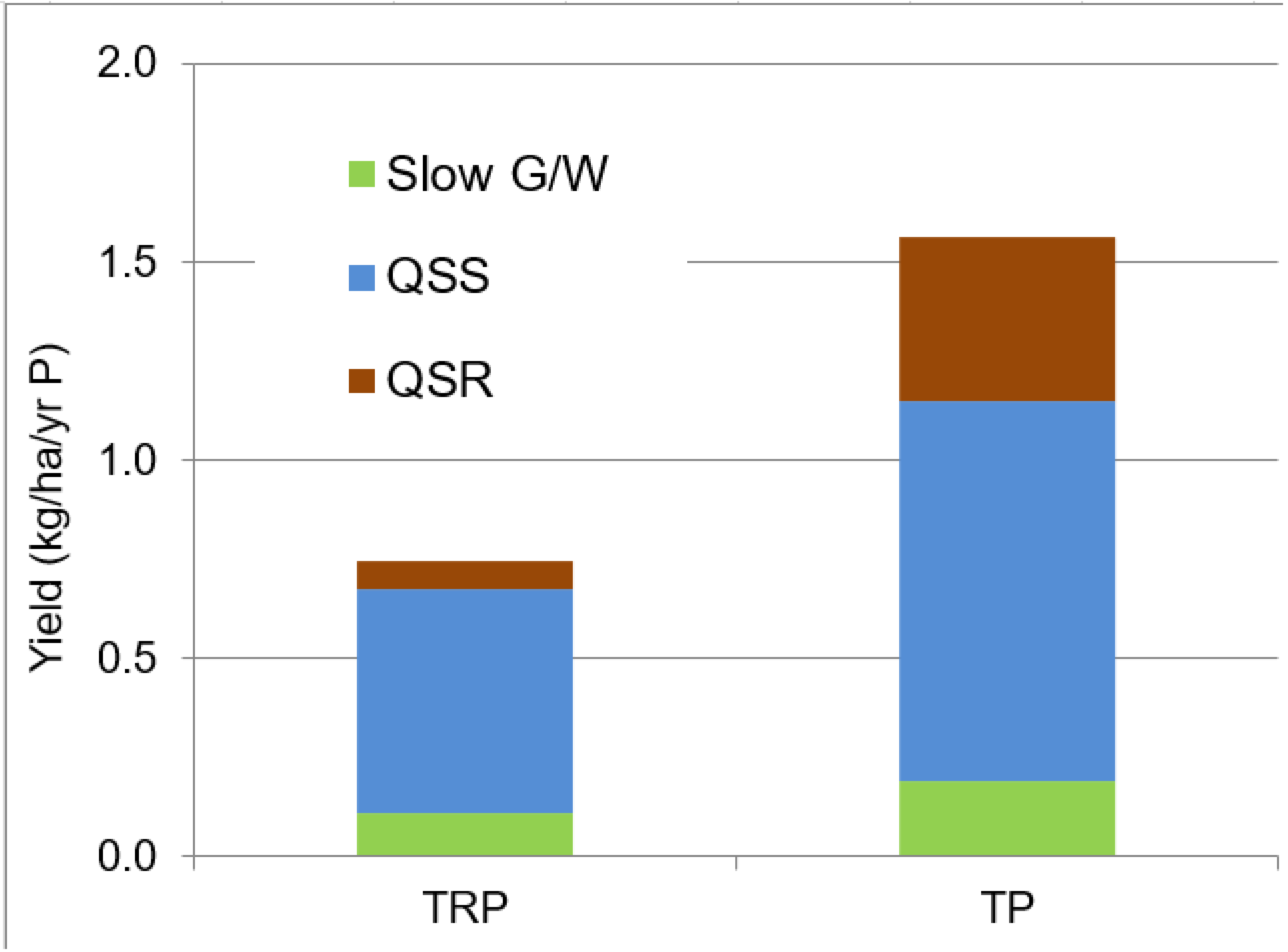




2010/2011 3800 hours

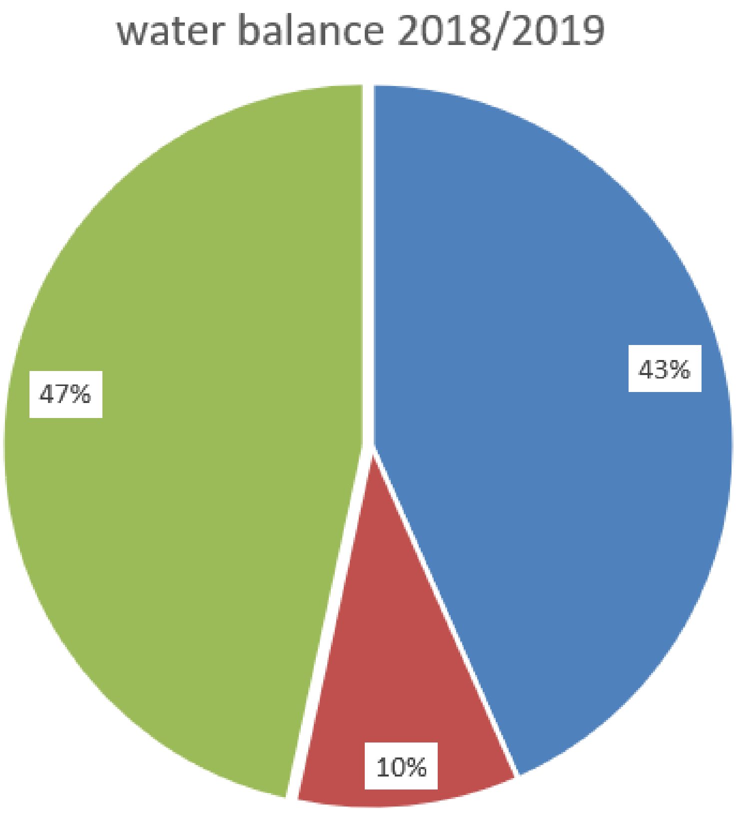
Sum Rain=433mm Sum Flow= 265mm 61%

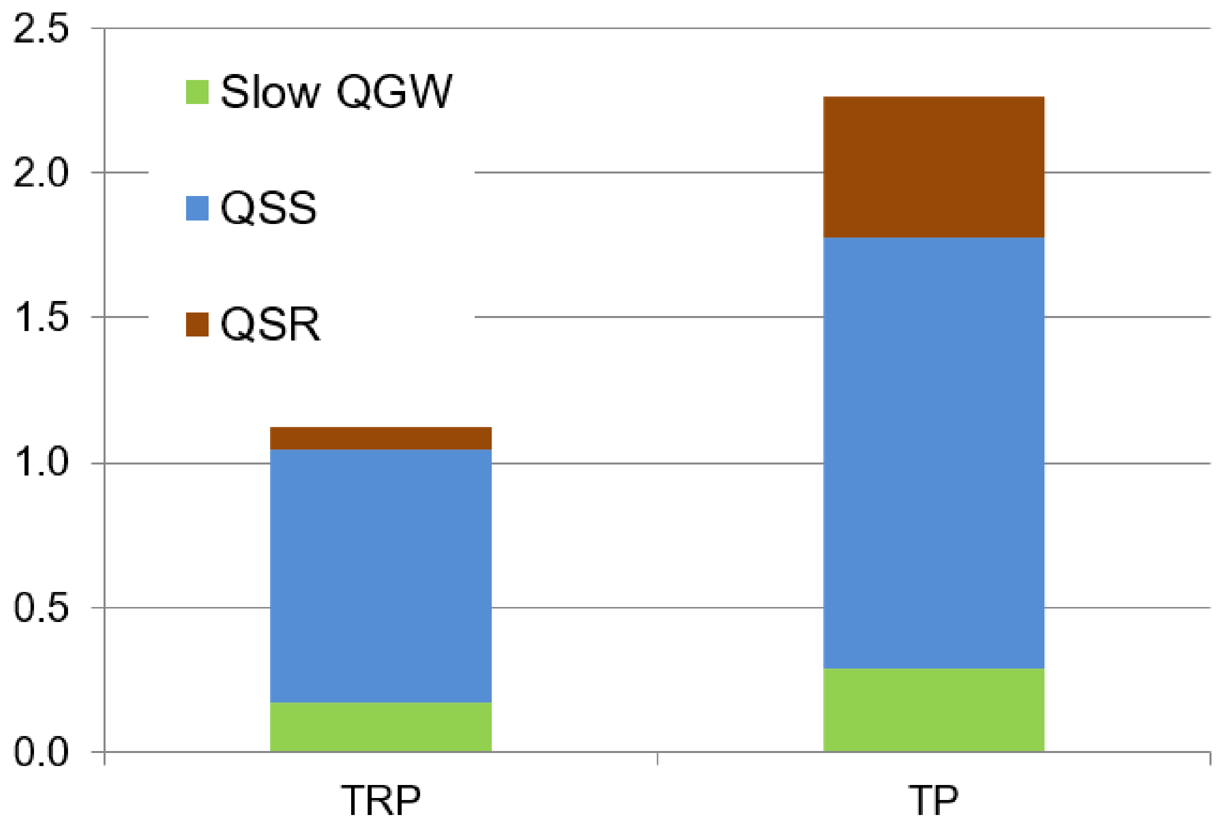




2018/2019 3800 hours

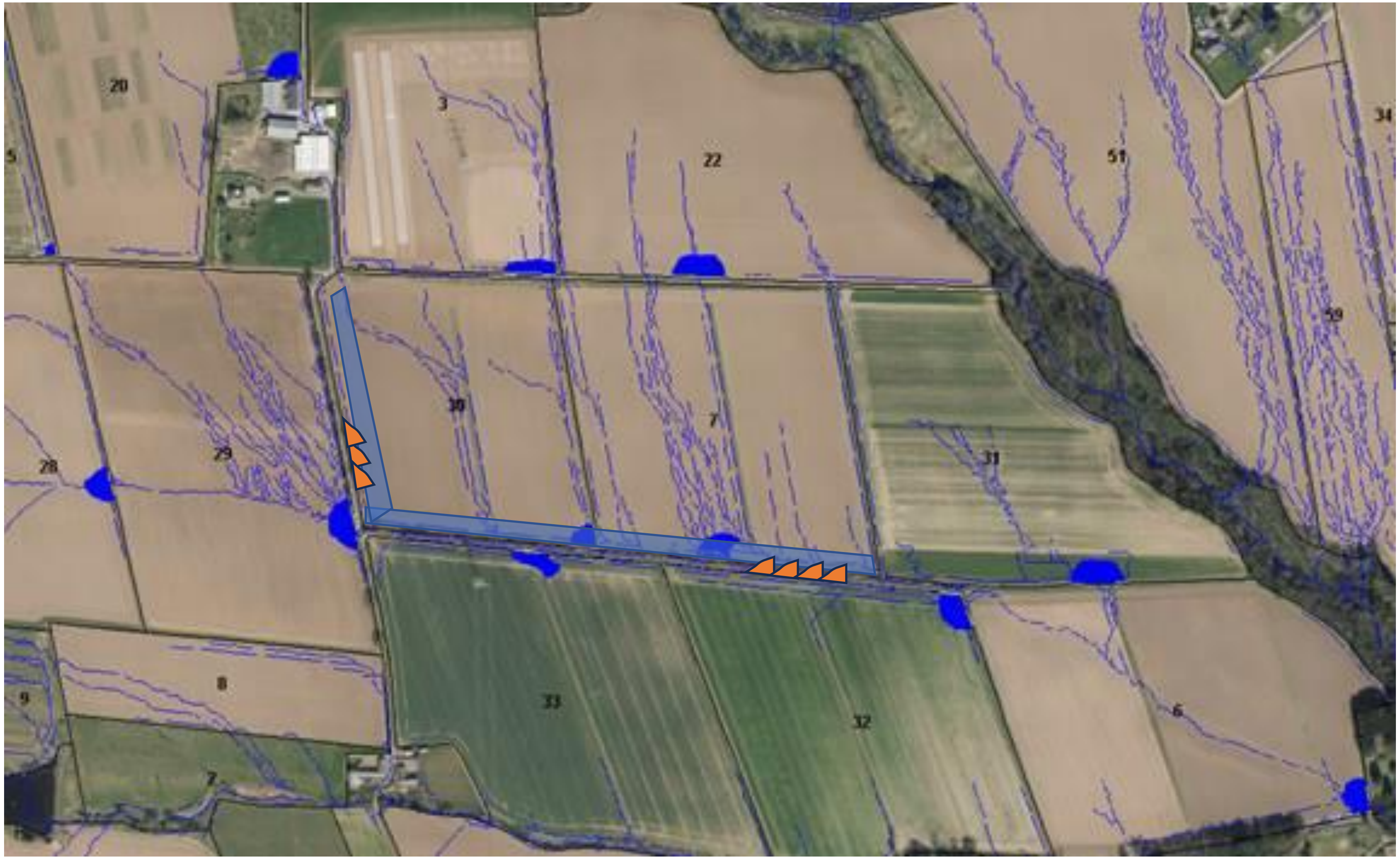
Sum Rain=626mm Sum Flow= 443 mm 71%





Opportunity Mapping with DEMs Using The FRAMETool

Balruddry



Flow pathways and local infrastructure

Metrics: total volume (2752m^3)

ID_Field	Volume m³	Bund length (m)
32	639	64
29	563	60
22	481	48
7	470	33
31	463	48
20	405	53
33	305	31
6	284	46
3	263	50
28	251	36
30	242	53
5	54	38

Magic Margin (Smart Buffer)

Sediment Traps

Field trip

Design Concept

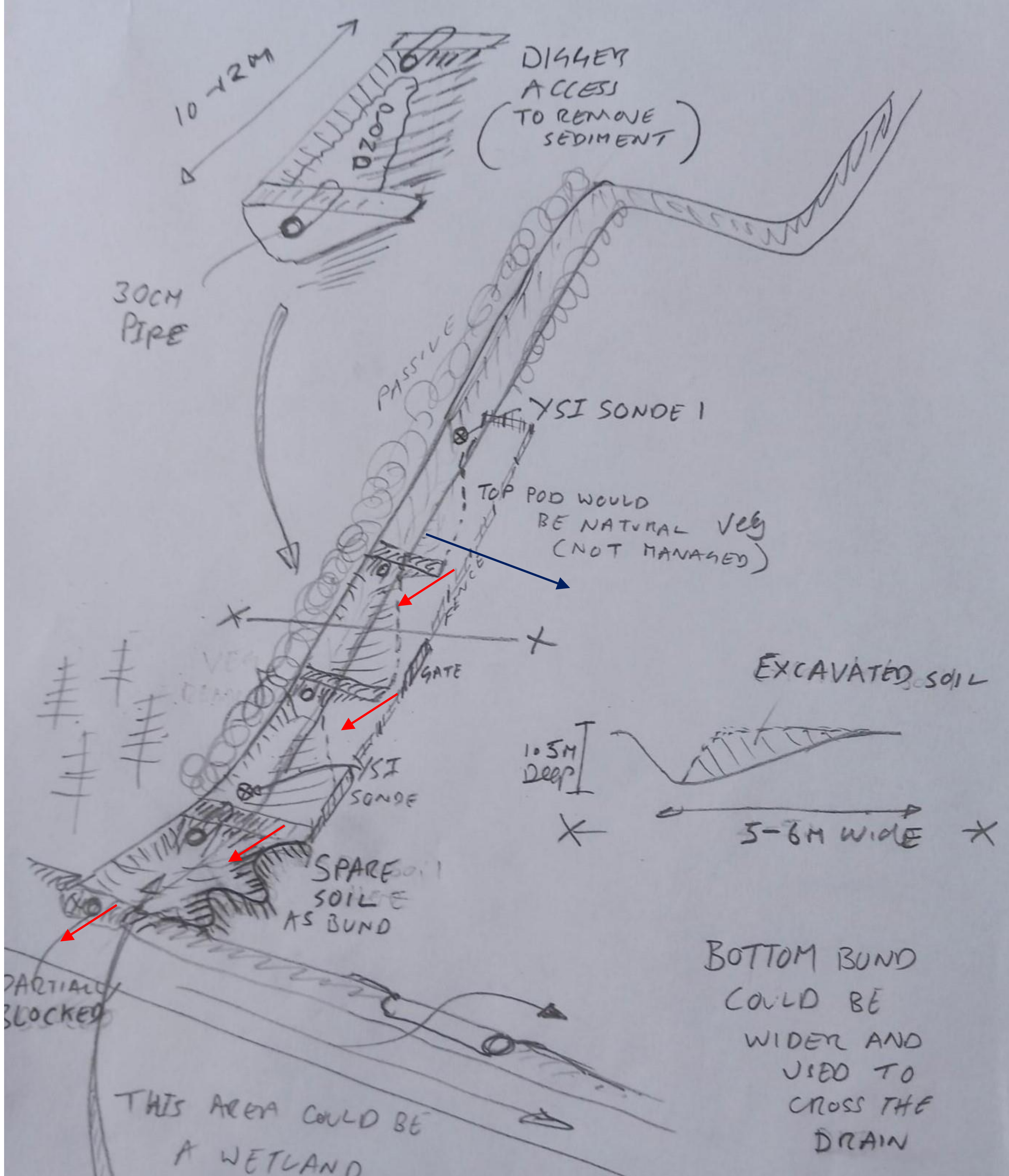
Some veg removed (20m)

excavate soil to make trap and create pond

Easy digger access to remove sediment build up

Optional wetland at bottom … plus a good area to put spare soil.

Overflow from one trap to another during storms



Conclusion

- Lower P application rates?
- Improve soil health at depth?
- Intercept and store flow
- Remove trapped sediment

Use NBS Methods!