AGRI-FOOD
& BIOSCIENCES
INSTITUTE

Leading | Protecting | Enhancing

Environmental Protection

Waste Water Management and Environmental Protection

Chris Johnston

5th March 2020

afbini.gov.uk

Agenda

- Water Quality Pressures (NI)
- Strategy Direction
- Point Source Management
- Diffuse Source Management
- CatchmentCARE

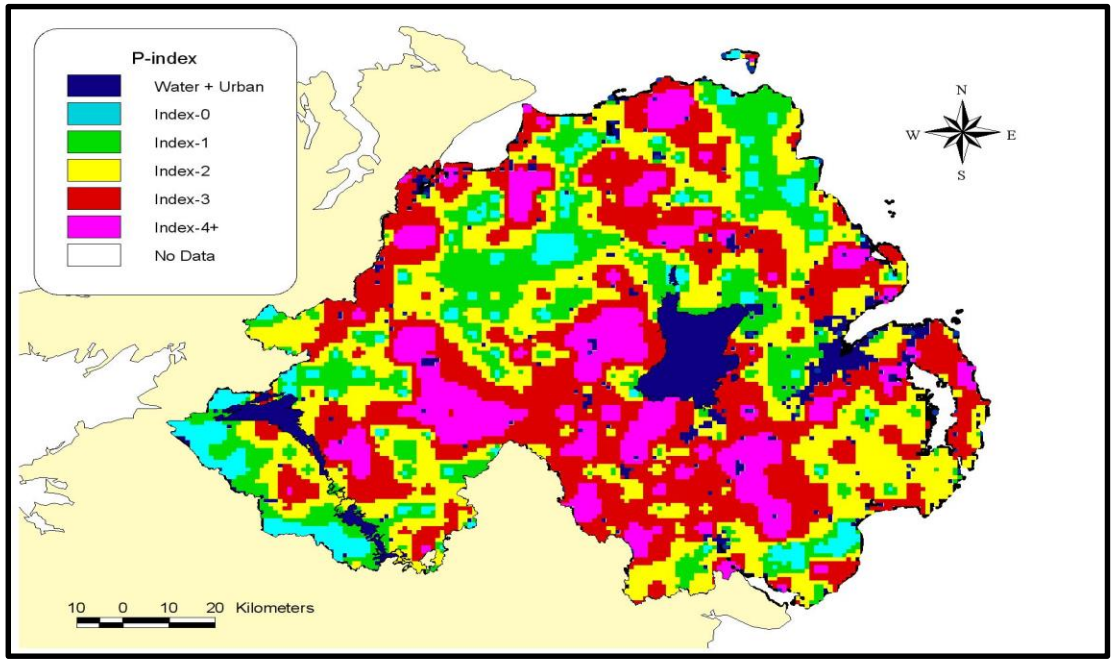
afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

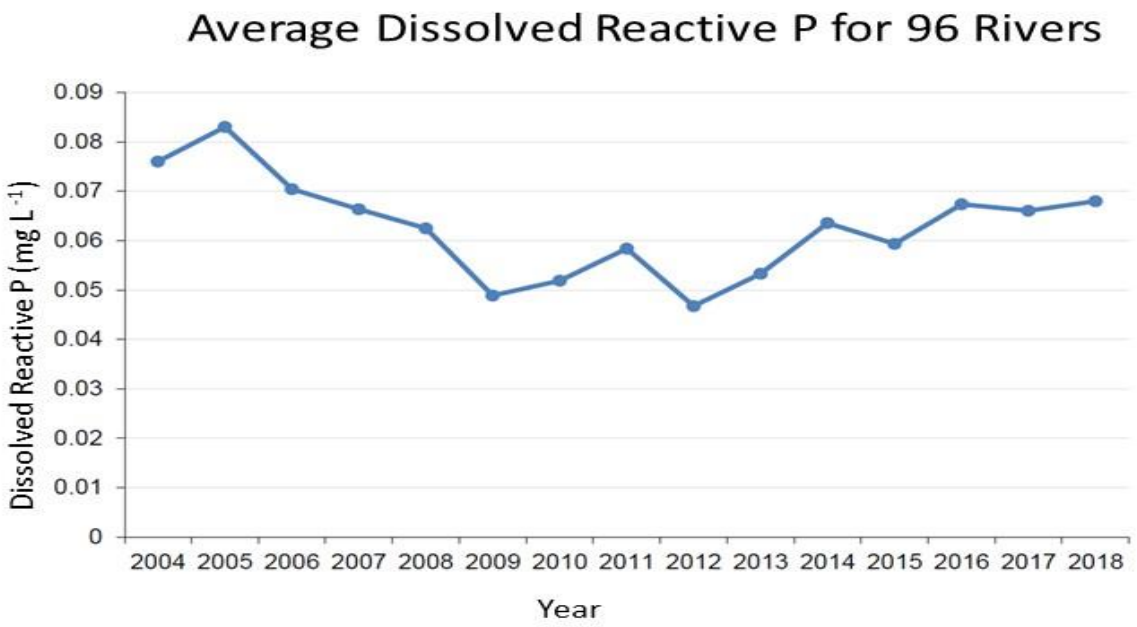
Water Quality Pressure

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Impact of P Loss from Soils

Soluble Reactive Phosphorus (SRP) (127 NI rivers, NIEA)





- Until recently, P concentrations in NI rivers had been declining.
- 'Easier' to justify no further 'tightening' of our Nitrates Action Programme.
- Over the past 10 years there has been a significant increase of 0.31 mg Olsen-P/l/yr identified across NI.
- In the past 5 years, however, P levels appear to have been rising again.
- 55% of waterbodies at 'good' or high status based on DRP only

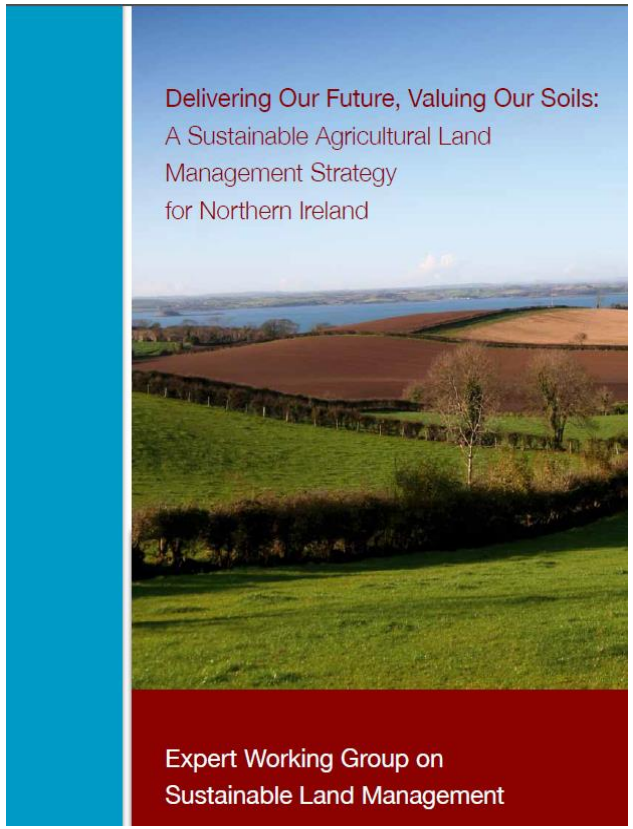
afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Strategy …

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Sustainable Agricultural Land Management Strategy (NI) - Recommendations

- Woody riparian strips in overland water flow pathways
  - populated by plants such as willow
  - which can withstand wet conditions
  - to slow the flow of surface water,
  - collect the sediment and
  - absorb the Phosphorus pre-watercourse
  - Improve permeability, reduce soil %MC
  - can be coppiced regularly (fuel / value chain)
- Carbon sequestration, biodiversity, flood alleviation



afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Recommendation 3c

Target water quality interventions on at least 4,000 ha of land by establishing;

- **woody riparian strips in overland flow pathways and**
- **woody biofiltration blocks downhill of farmyards and at discharges to septic tanks**

Sustainable Biofiltration Blocks

WASTE
to
Bioresources

Interreg
Northern Ireland - Ireland - Scotland
European Regional Development Fund

answer
Agricultural Need for Sustainable Willow Effluent Recycling

Willow Biofiltration plantations
a sustainable solution for waste water management

- Linking of biomass plantations of src willow biomass crop production.
- Sustainable waste management / Environmental protection of water

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Point Source

Hillsborough Farmyard Dirty Water

- Trial to assess SRC plant behaviour and protection of water quality (soil, ground and ditch water)
- Irrigated to a 5ha SRC Willow plantation
- **Farm dirty water** - parlour washings contaminated with cattle faecal matter, urine, cleansing chemicals and nutrients
- 350 cow dairy herd.
- High Nutrient (N & P)
- High BOD
- High Volume

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Results


Contents lists available at ScienceDirect
Biomass and Bioenergy
journal homepage: http://www.elsevier.com/locate/biombioe
Research paper
SRC willow as a bioremediation medium for a dairy farm effluent with high pollution potential
Edward G.A. Forbes, Christopher R. Johnston*, John E. Archer, Alistair R. McCracken
Agri-Food and Biosciences Institute, Northern Ireland, AFBI, Large Park Research Farm, Hillsborough, Co Down, Northern Ireland BT26 6DR, United Kingdom

- Total FDW applied = 3420 m^3/y equivalent to 228 x15m^3 tankers.
- No indication that FDW is negatively affecting soil or surface waters or ditch waters.
- A high degree of water remediation resulting from application.
- Ground waters and ditch waters of irrigated areas had lower concentrations (N,P,K,BOD) compared to areas treated by standard agricultural practice.
- Willow variety choice for inclusion in planting may be primarily focussed on yield and disease resistance and large differences in yields justify this approach
- However nutrient off-take is also a consideration.
  - Selection of high P content varieties could assist reducing P levels in soils
  - There were some increase of soil Phosphorus index in highest FDW application areas.
  - Soil P indexes can remain high even without irrigation

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Results

- Over the years the waste water was fairly constant (pH, Ec, N, P,K, BOD).
- Substantial off-take of N, P, K in stem tissue was recorded at harvest (*nutrient mining*).
- Biomass yields from a 3 year harvest ranged from 8.9 to 14.3 t DM ha/y and showed significant differences ($P<0.05$) between varieties but not treatments.
- Soil and ground water concentrations of minor element not affected between pre- and post irrigation periods.
- *This farm effluent, with a similar range of nutrient concentrations, can be applied at specific rates to these willow varieties without detriment to yield and nutrient off-take, soil and ground water quality.*

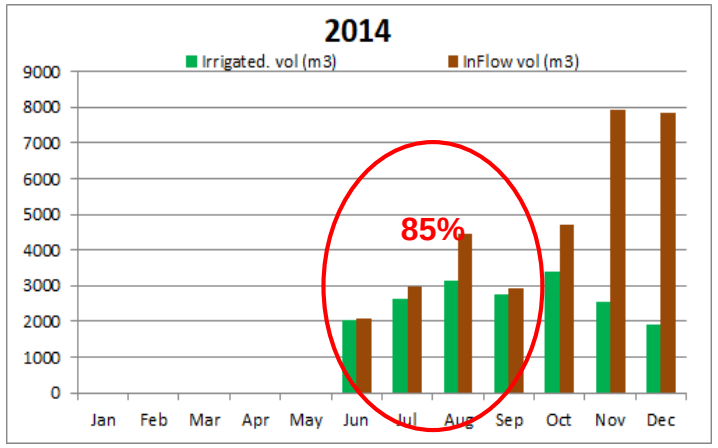
Pumping Main, Valves & Irrigation

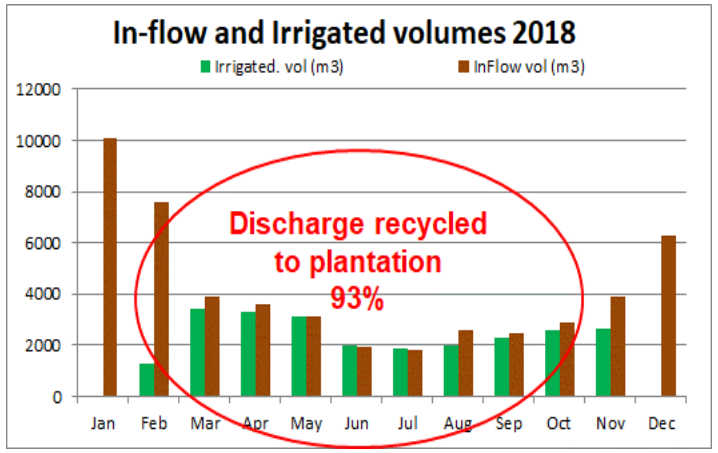

Irrigating

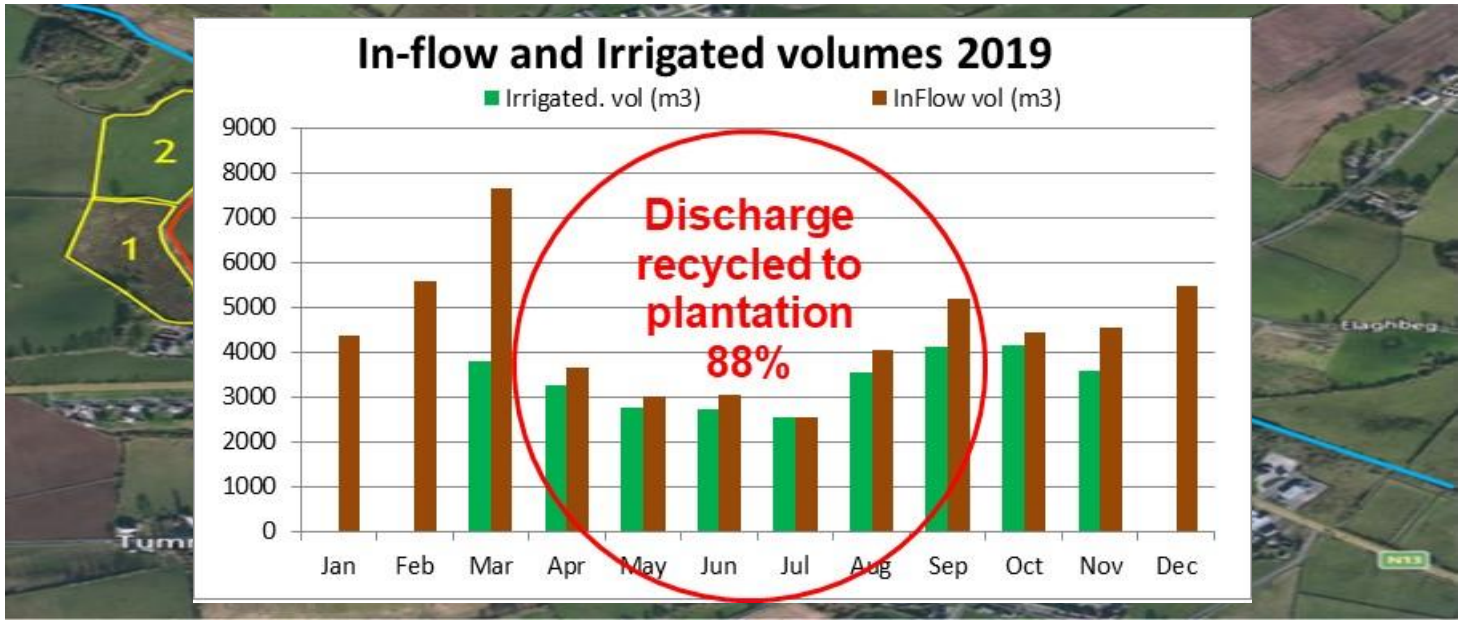

Pre Harvesting

Post Harvesting

Bridgend WWTW – Co Donegal







	Inflow to WWTW	Irrigated to willows	Discharge Environment	Nutrient Loading per ha per y
Volume (m3)	314517	160355	154162	2291
Total N (kg)	9939	5067	4872	72
Total P (kg)	462	236	227	3

- Significant proportion of the yearly WWTW inflow is recycled
- Recycled volumes even higher during the summer during low river flow
- Storm-water reduction work in the inflow will affect the recycling ratio
- This scheme is most certainly reducing this risk as the energy crop receives the majority of the pollution loading as fertiliser during these periods

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Drumkee Treatment Works (50+YO)

- Treating a population of approximately 23 people
- Discharge into a small stream with variable flow rates.
- Baffled reception tank with overflow to a percolating gravel filter
- Adapted to divert the discharge to a collection sump for controlled irrigation to willows.

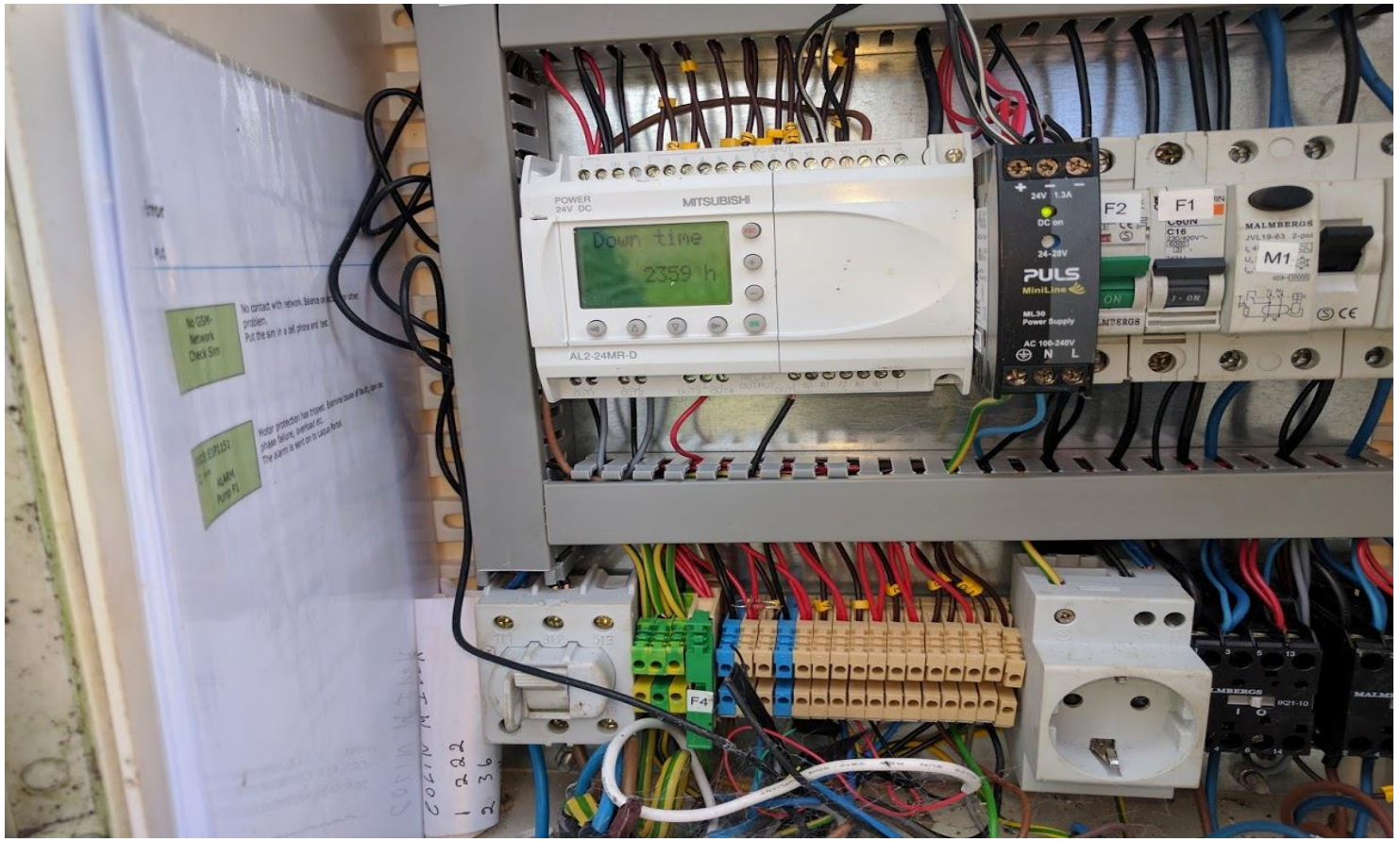
afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

WATERPRO

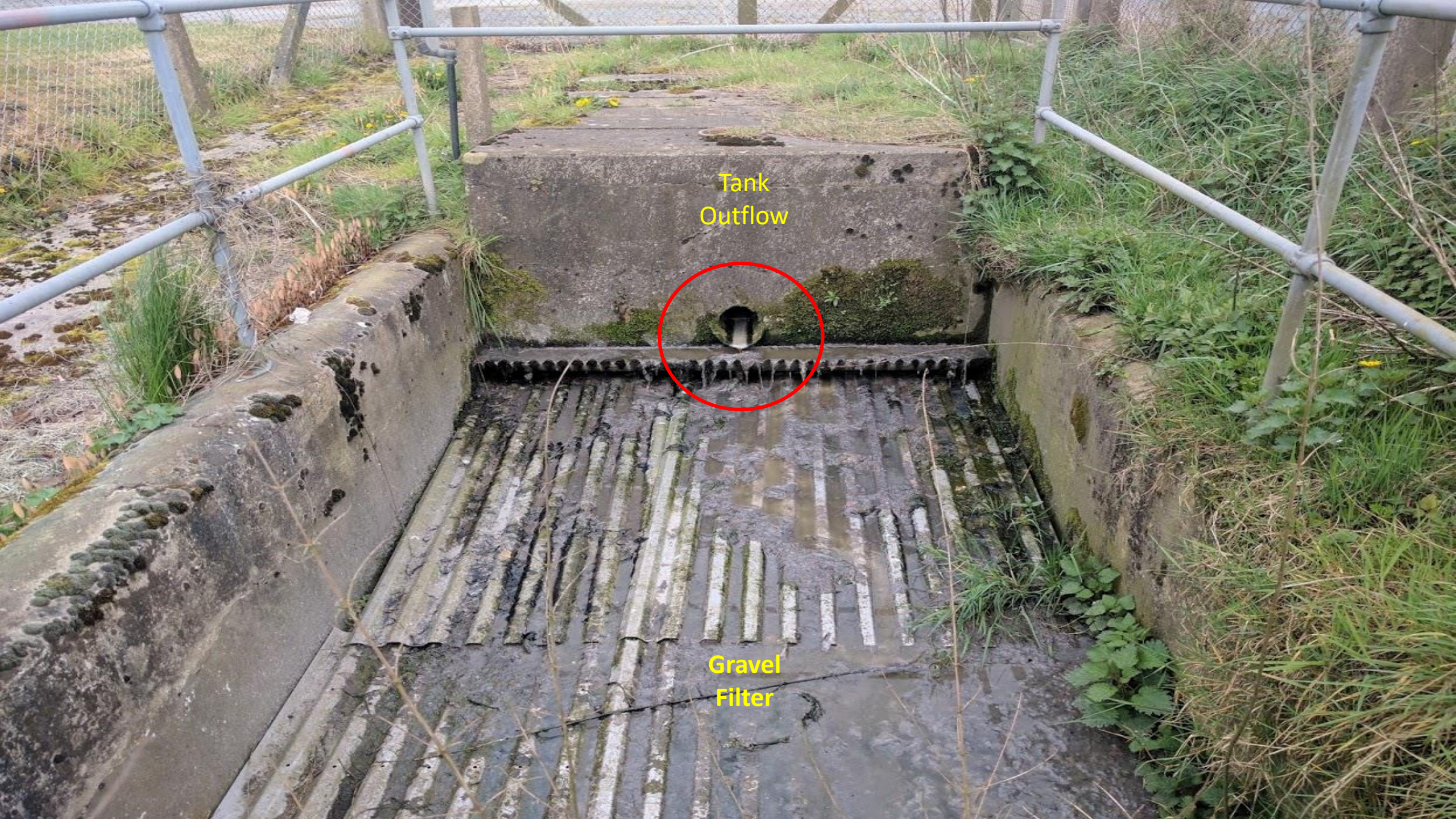
NIWater - Drumkee

Data Collection / system communication

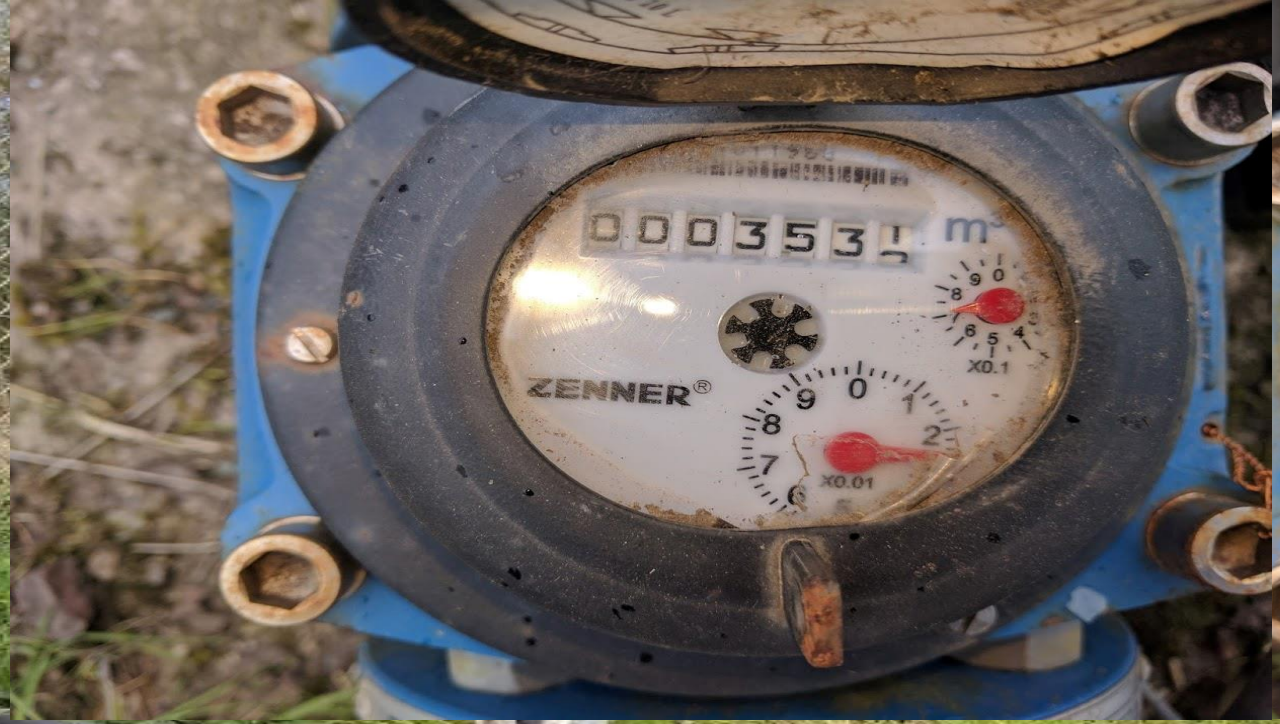
- Data acquisition
  - Frequent SMS
  - Real time SCADA
- Logging, recording
  - Temp
  - Rainfall
  - Volume irrigated
  - Volume in-flow
  - Zones Correlation
  - Web Application.

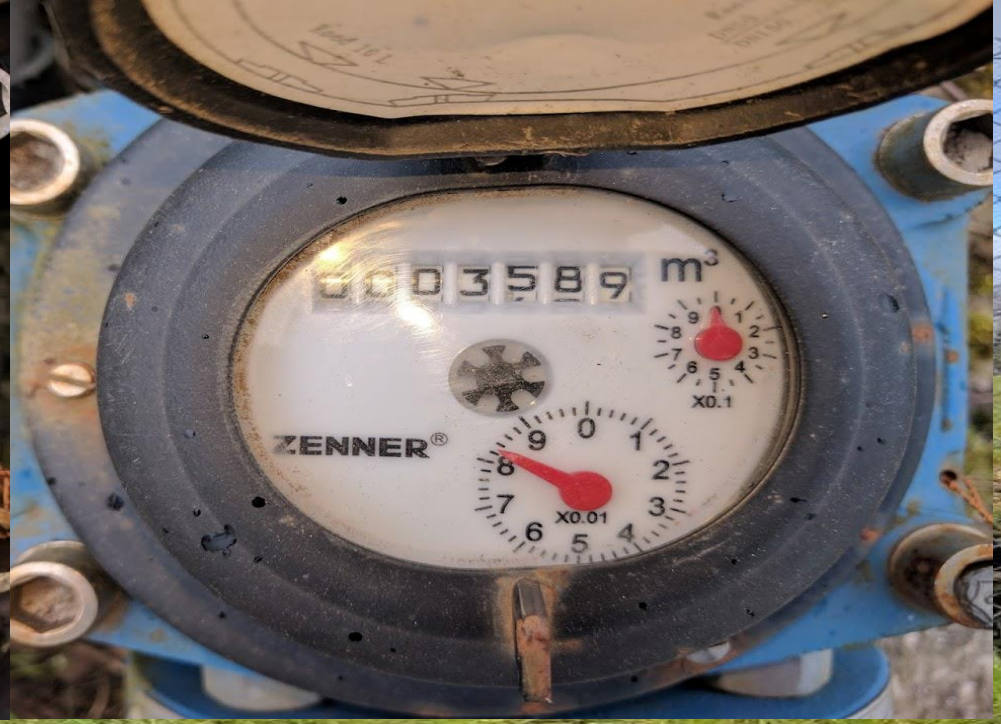


afbi AGRI-FOOD & BIOSCIENCES INSTITUTE


Tank
Outflow
Gravel
Filter


Overflow
To stream
Sump
Inflow
Timer
Float
Switch


ZENNER®
X0.01
X0.1


ZENNER®
X0.01
X0.1


Outflow to
Stream

Scheme - Results

- Running since beginning 2014 (commissioned 2013)
- Volumes pumped – Approx 5.7 m^3 /day irrigated
- Total 43kg phosphorus and 328 kg nitrogen recycled
- Pump & PLC Energy Use Approx (£15/month)
- Stream water and borehole water indicating minimal changes.

Licensed under Variable Discharge

- Downtime 2,359 hours (Soil Temperature, Rainfall) – 8% time
- Estimated Over 95% recycled to biomass crop (sump buffer)
- 53 Tonne harvest = approx £6,000 oil ...

Yearly nutrient recycling approximately

- 91 kg N/ha/y
- 12 kg P/ha/y
- 221 kg ss/ha/y
- 1966 m3 effluent/ha/y

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Overland flow


Northern Periphery and
Arctic Programme
2014-2020
EUROPEAN UNION
Investing in your future
European Regional Development Fund
WATERPRO

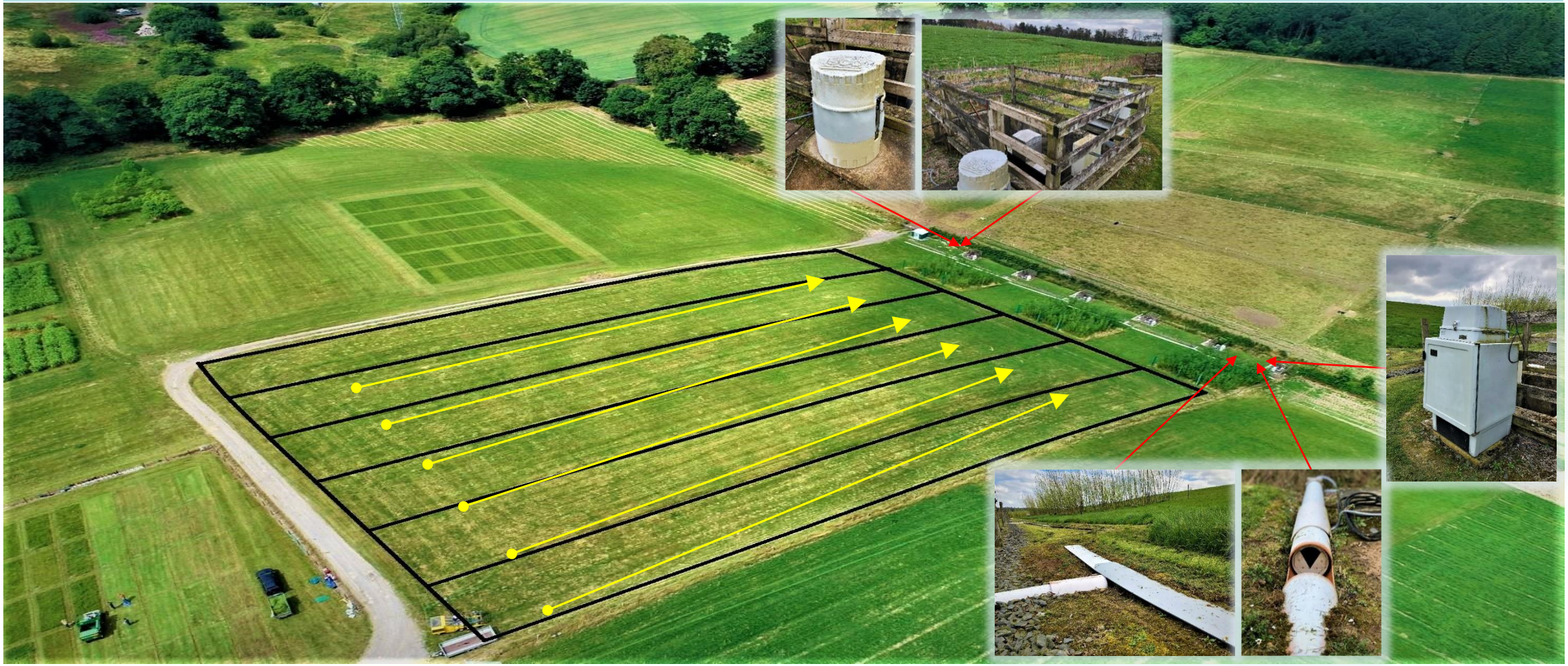
Overland Flow

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

- BACI / Experimental Protocol
- (Before, After, Control, Implementation)

WATERPRO

Operation – Sample collection



afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Physical Parameters

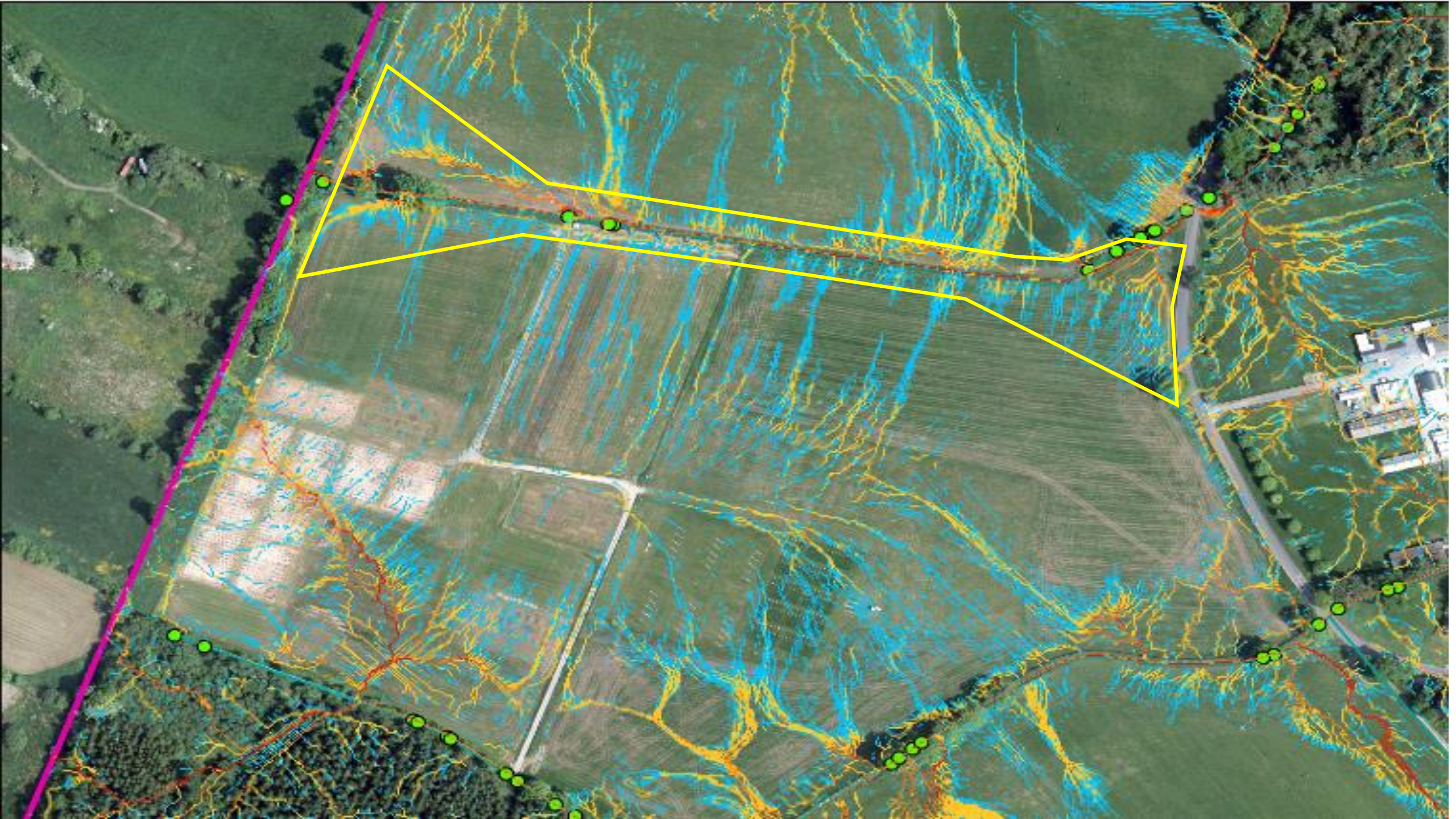
- Commercial willow clones
- Mixed breeding programmes
- Soil Infiltration
- Soil moisture
- Soil penetrability
- Bulk density

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

CatchmentCARE
Community Actions for Resilient Ecosystems

- Potential for mitigation of diffuse pollution - *LiDAR, Biofiltration Blocks*
- Point Source Discharge from WWtWs - *Construction of a number of SRC Willow Waste Water Treatment schemes within sensitive catchments*

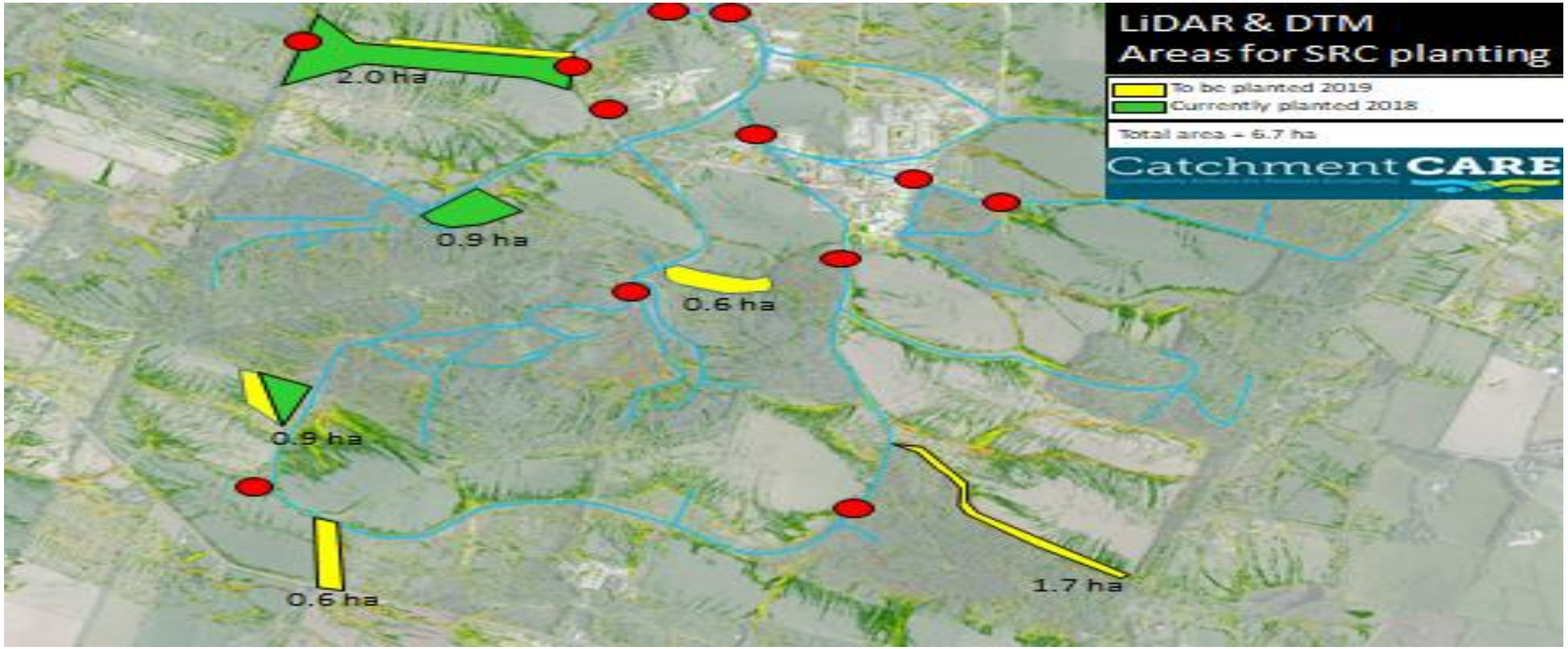
afbi AGRI-FOOD & BIOSCIENCES INSTITUTE



Sub – Catchment approx. 22ha

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Other Farm SRC Plantings



afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Projects


Catchment CARE
Community Actions for Resilient Ecosystems


WATERPRO


UKRI
Engineering and
Physical Sciences
Research Council


Supergen
Bioenergy


Department of
Agriculture, Environment
and Rural Affairs
www.daera-ni.gov.uk


SBRI
Government challenges.
Ideas from business.
Innovative solutions.


NIEA
Northern Ireland
Environment
Agency
www.daera-ni.gov.uk


THE
BRYDEN
CENTRE
ADVANCED MARINE AND BIO-ENERGY RESEARCH


CASE
Centre For Advanced Sustainable Energy


afbi
AGRI-FOOD
& BIOSCIENCES
INSTITUTE


Northern Periphery and
Arctic Programme
2014-2020


EUROPEAN UNION
Investing in your future
European Regional Development Fund


Interreg
Northern Ireland - Ireland - Scotland
European Regional Development Fund

CatchmentCARE

Community Actions for Resilient Ecosystems

afbi AGRI-FOOD & BIOSCIENCES INSTITUTE

Department of Agriculture, Environment and Rural Affairs
www.daera-ni.gov.uk

Interreg
Northern Ireland - Ireland - Scotland
European Regional Development Fund

An Roinn Tithíochta, Pleanála agus Rialtais Áitiúil
Department of Housing, Planning and Local Government