National Development Plan 2007 - 2013

SSTI
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epa
Environmental Protection Agency

Development of a Catchment Management Tool to Assess Environmental Risk from Nutrient Loadings using Open Source GIS

PATHWAYS PROJECT
Environmental Protection Agency, Ireland

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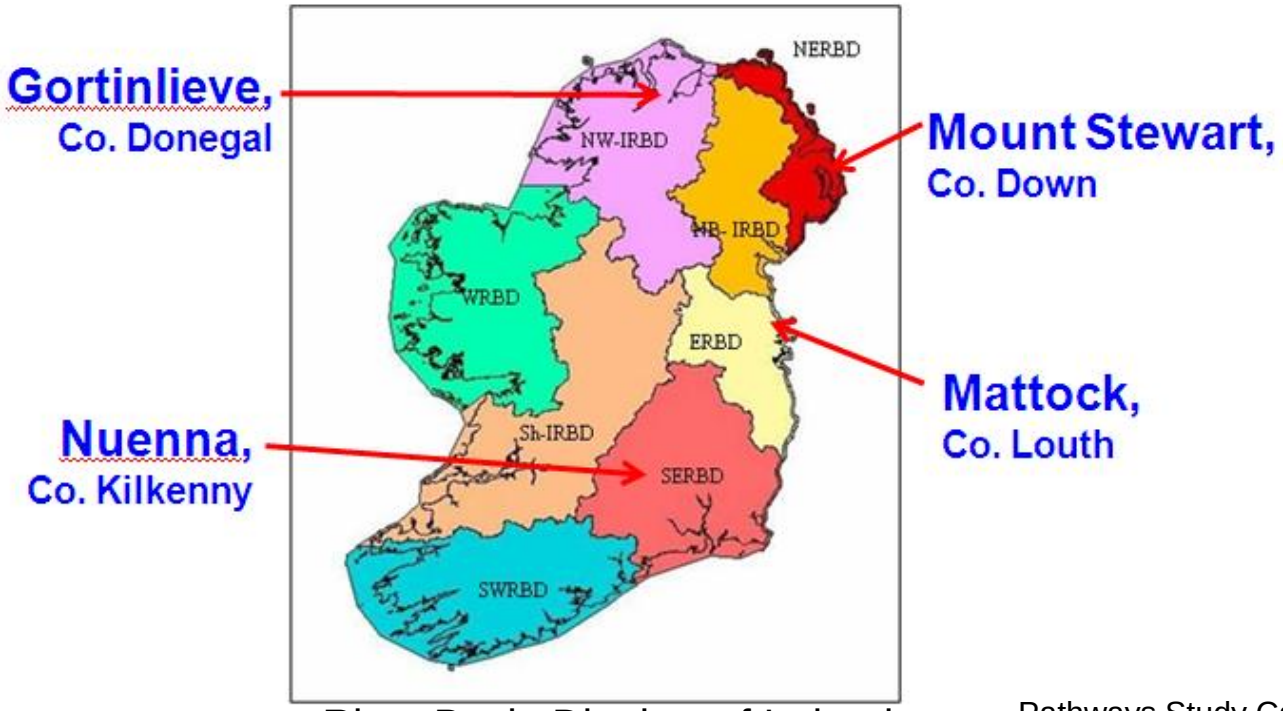
Pathways Project

- Irish EPA funded (2007 – 2013)
- Investigate the influence of flow pathways on contaminant mobilisation, transport and attenuation
- Water quality modelling from management perspective
- Allow River Basin Managers to evaluate Environmental Risk



River Basin Districts of Ireland

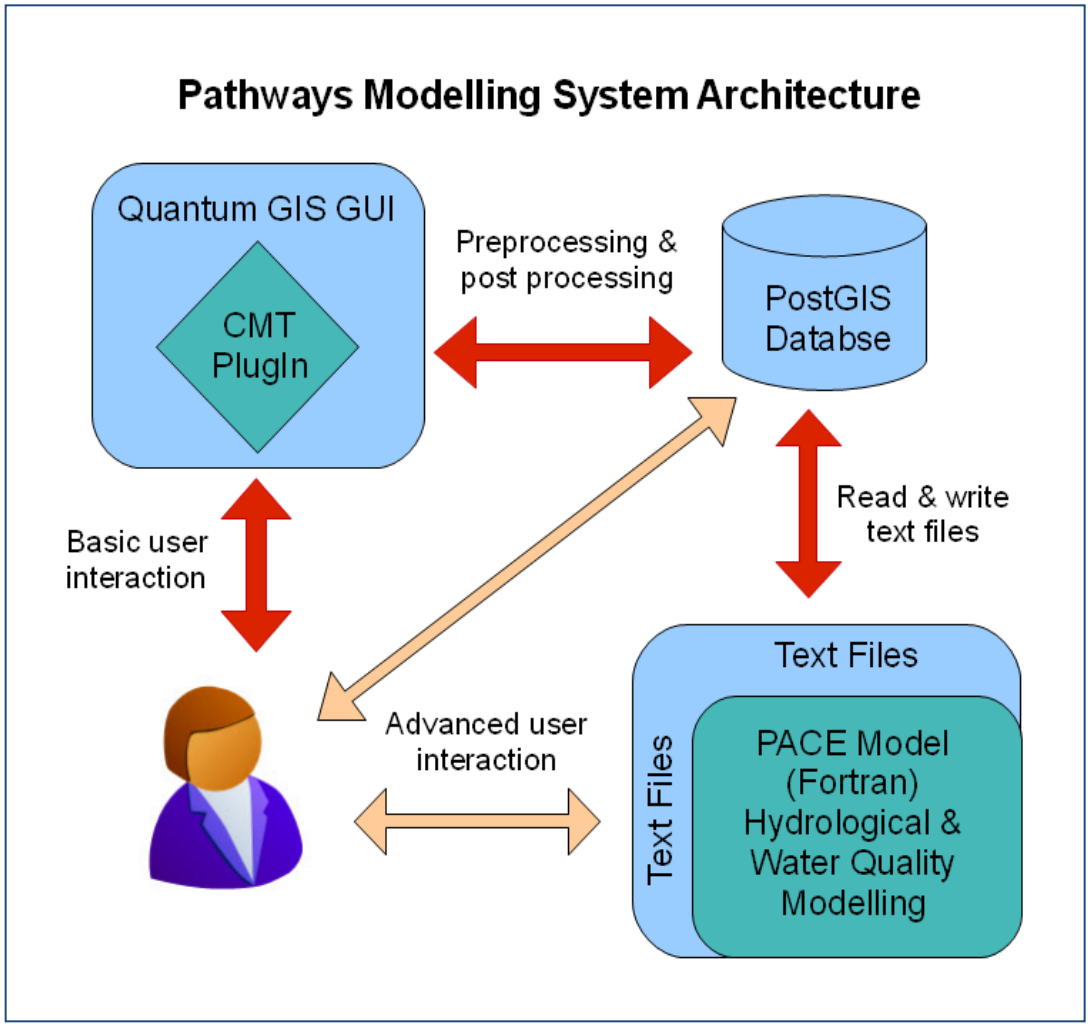
Pathways Study Catchment Locations

Pathways CMT Architecture

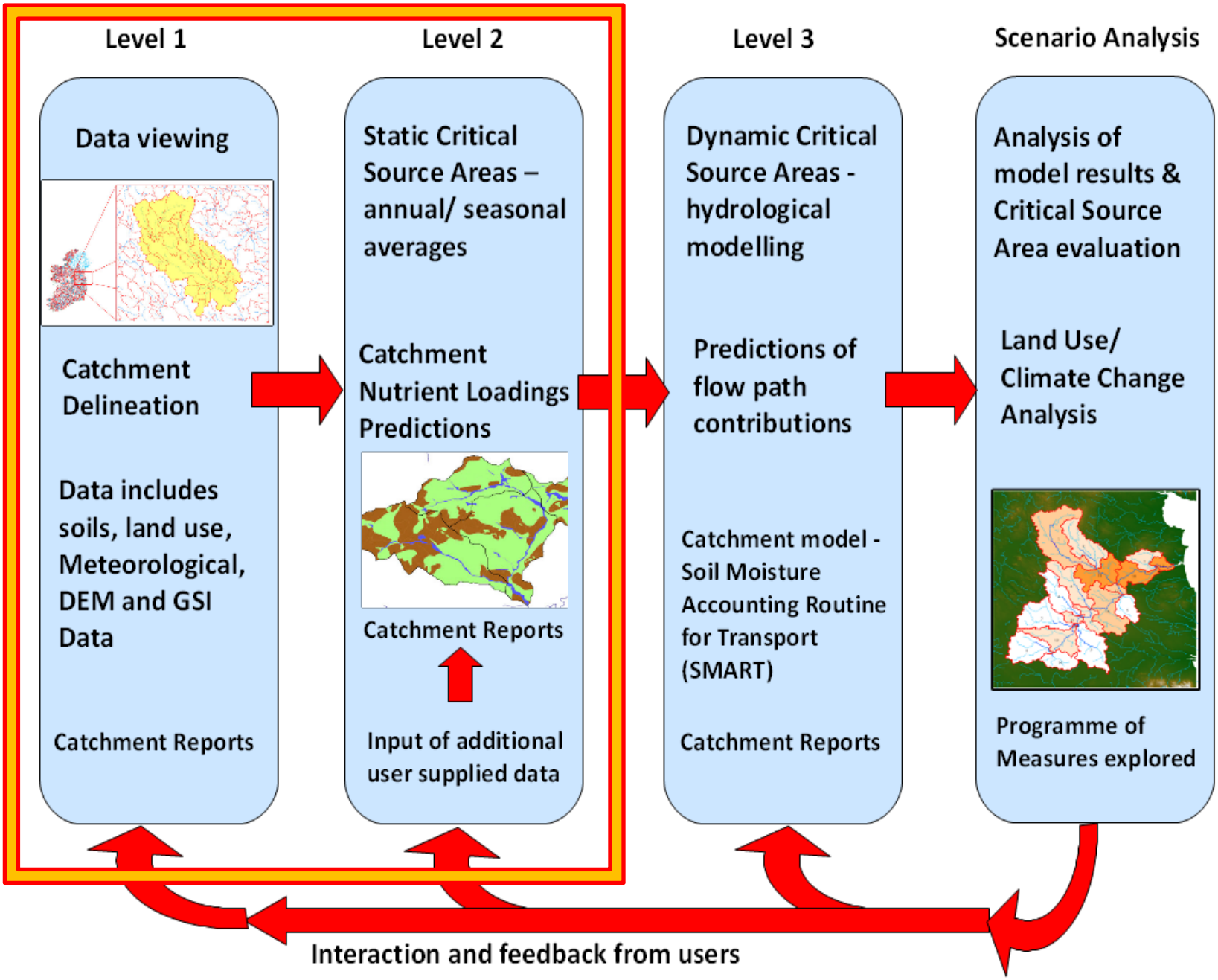
Prototype designed using Open Source Software for:

- Fast software development
- Interaction with other software
- Other research users

- Loosely coupled system
- Quantum GIS
  - User Friendly GUI
- PostGIS/PostgreSQL DB
  - Fast Access to data
- Python Plugin
  - Link between User, QGIS and Database
- Hydrological model (currently Fortran)



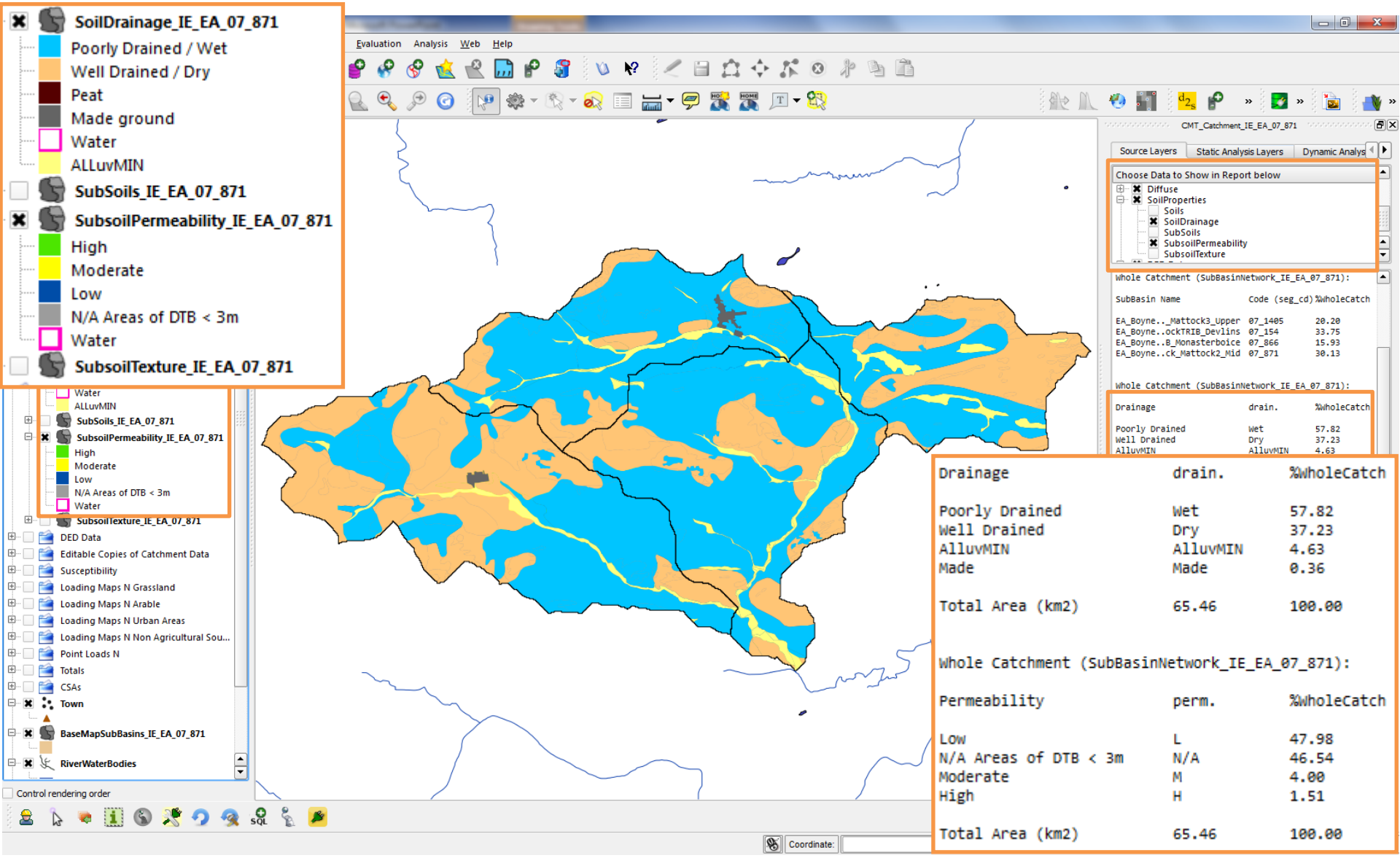
Pathways Catchment Management Tool Overview



Source Layers – Level 1

- User chooses river, upstream catchment defined based on EPA sub-catchments
- GIS layers provided by EPA, GSI available
  - Soils Properties
  - Geological Datasets
  - Point Sources
- Users choose layers to investigate
- Reports include summary statistics of individual sub-catchment or whole catchment

Soils Drainage (and Subsoil Permeability) in Mattock2_Mid

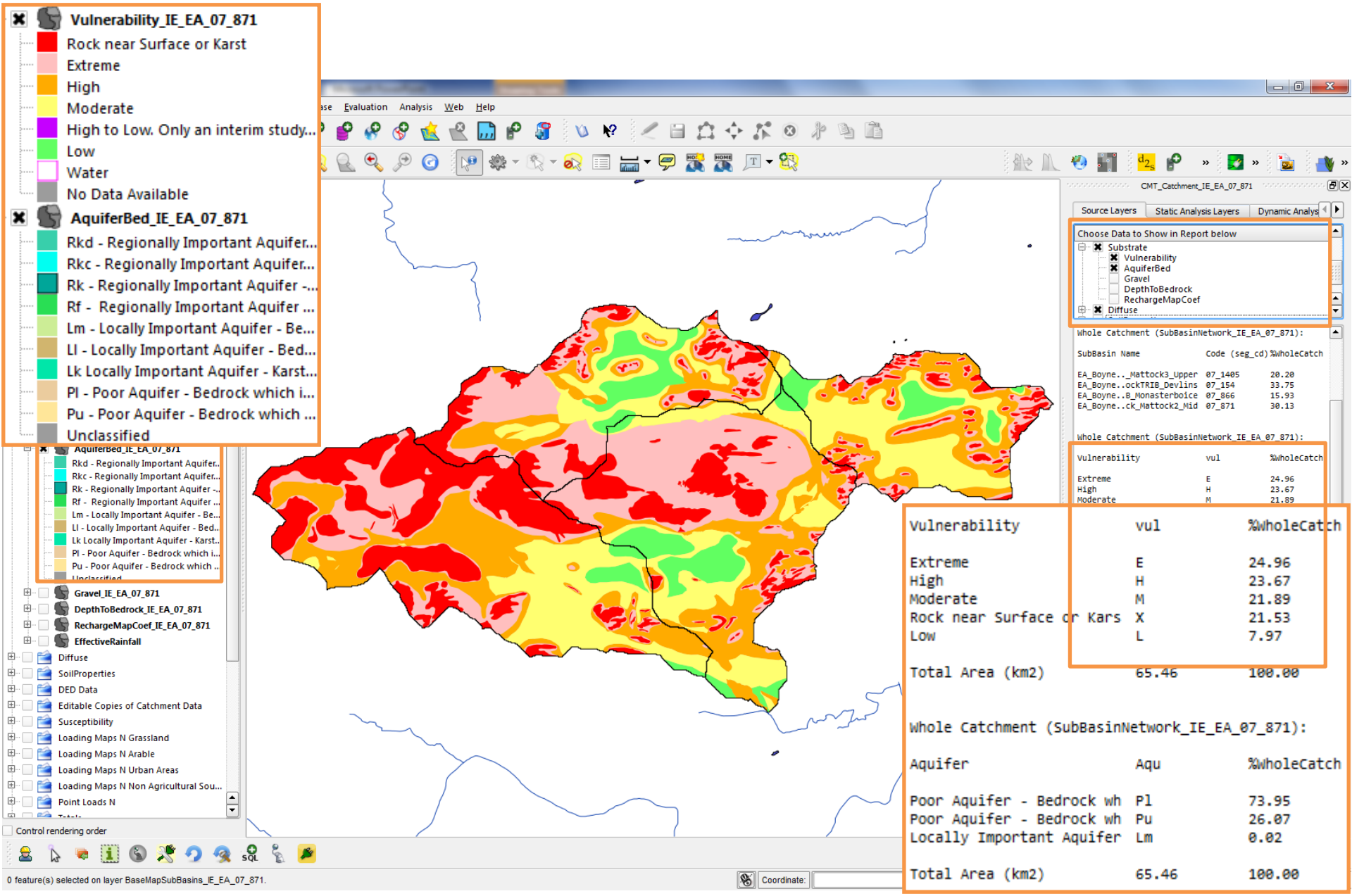


Drainage	drain.	%WholeCatch
Poorly Drained	Wet	57.82
Well Drained	Dry	37.23
AlluvMIN	AlluvMIN	4.63
Made	Made	0.36
Total Area (km2)	65.46	100.00

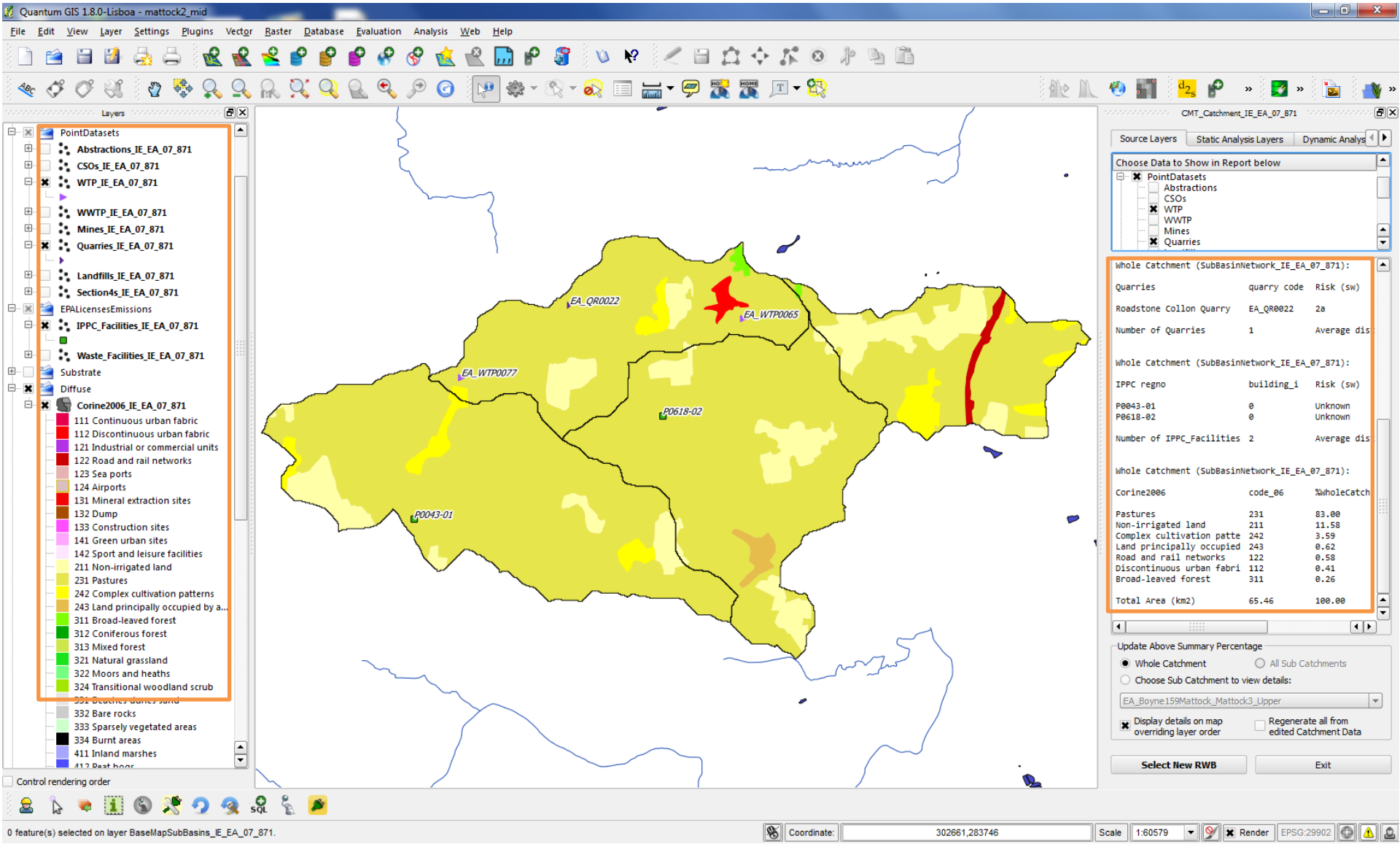
Whole Catchment (SubBasinNetwork_IE_EA_07_871):

Permeability	perm.	%WholeCatch
Low	L	47.98
N/A Areas of DTB < 3m	N/A	46.54
Moderate	M	4.00
High	H	1.51
Total Area (km2)	65.46	100.00

Substrate: Vulnerability (and Bedrock Aquifer)



Switch off other layers and show Corine land use with point pressures



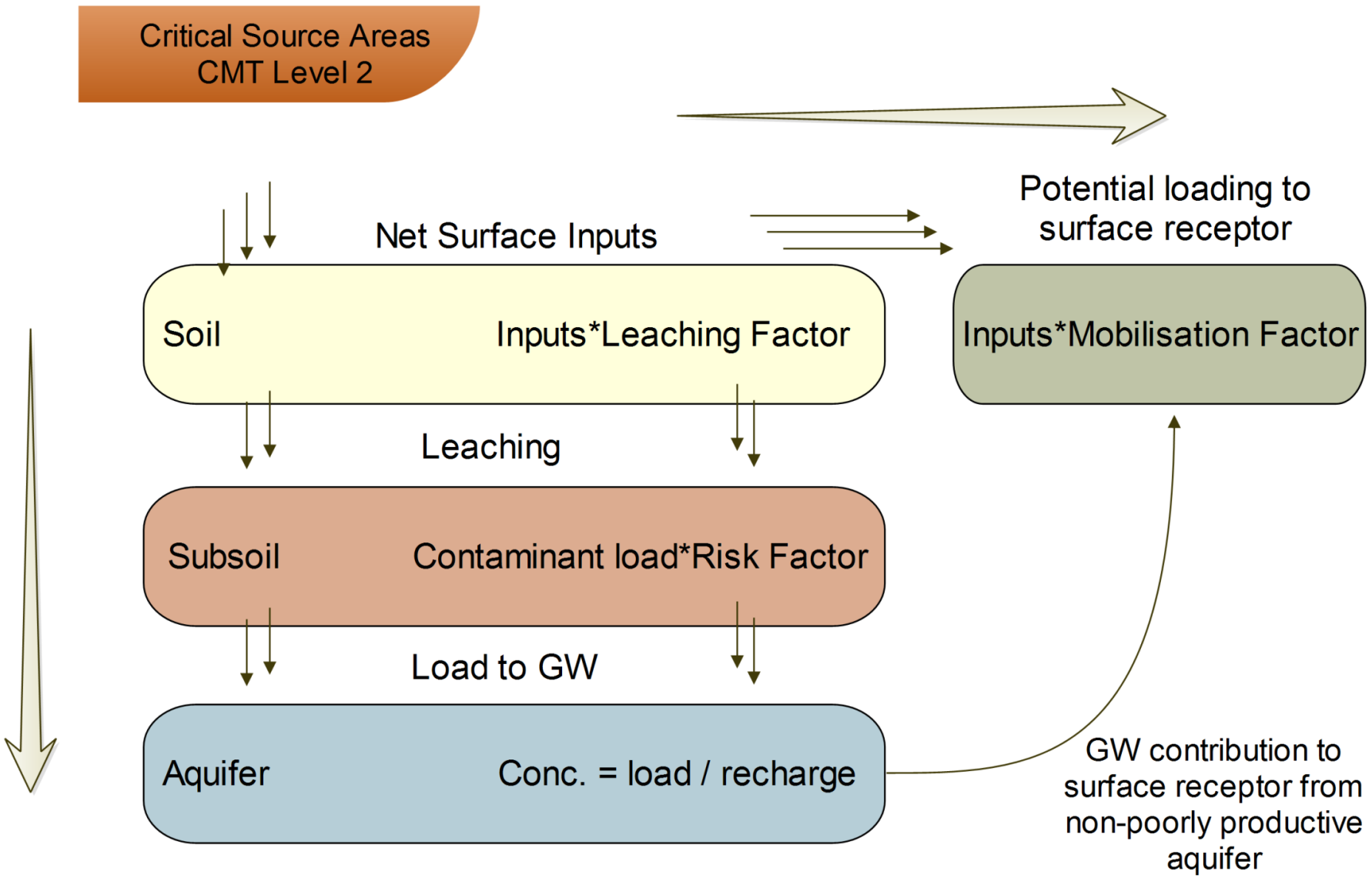
Static Analysis Layers – Level 2

- Combines Source Layer information to form
  - Loadings
  - Static Critical Source Areas (CSAs)
- Groundwater Task Team (GTT) Tool adapted for Ireland provides Loadings for N and P
  - Electoral Division data from Central Statistics Office (2006)
  - Teagasc – Fertiliser Application Rates (2010)
  - Census of Agriculture Detailed Results (2010)
- GTT calculates loads to Groundwater receptor from
  - Grassland and Arable Agriculture
  - Urban Inputs
  - Point Sources and Non Agricultural Diffuse Sources

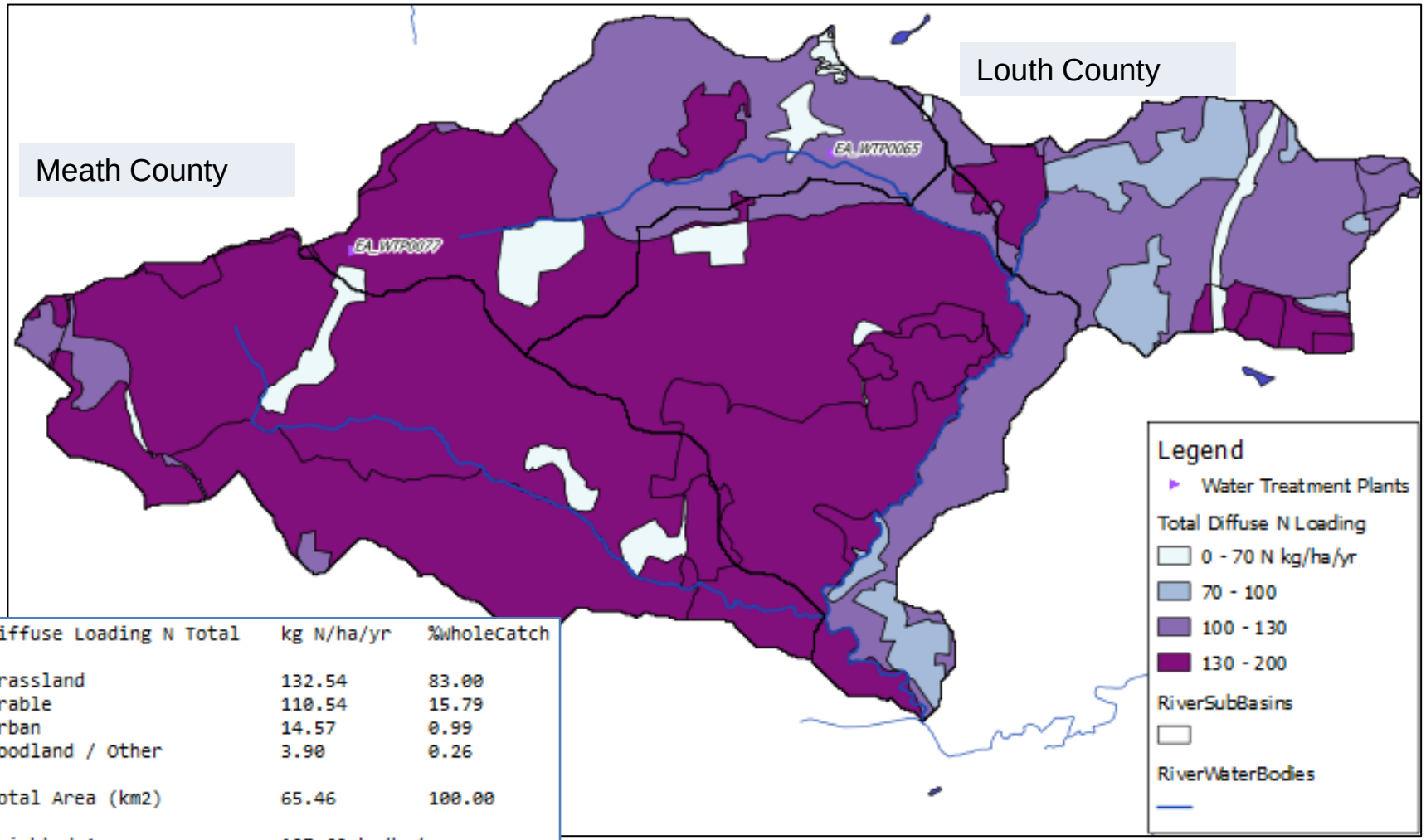
Critical Source Areas for assessing environmental risk

- Areas that contribute a disproportionally high pollutant loading to a receptor because of a coincidence of:
  - High loading
  - Hydro(geo)logically susceptible areas
- Loading is the amount of nutrient applied to the area (kg/ha/yr)
- Hydro(geo)logically susceptible area (HSA) is an area from which a nutrient has a high probability of reaching a receptor of interest

Critical Source Areas – Level 2

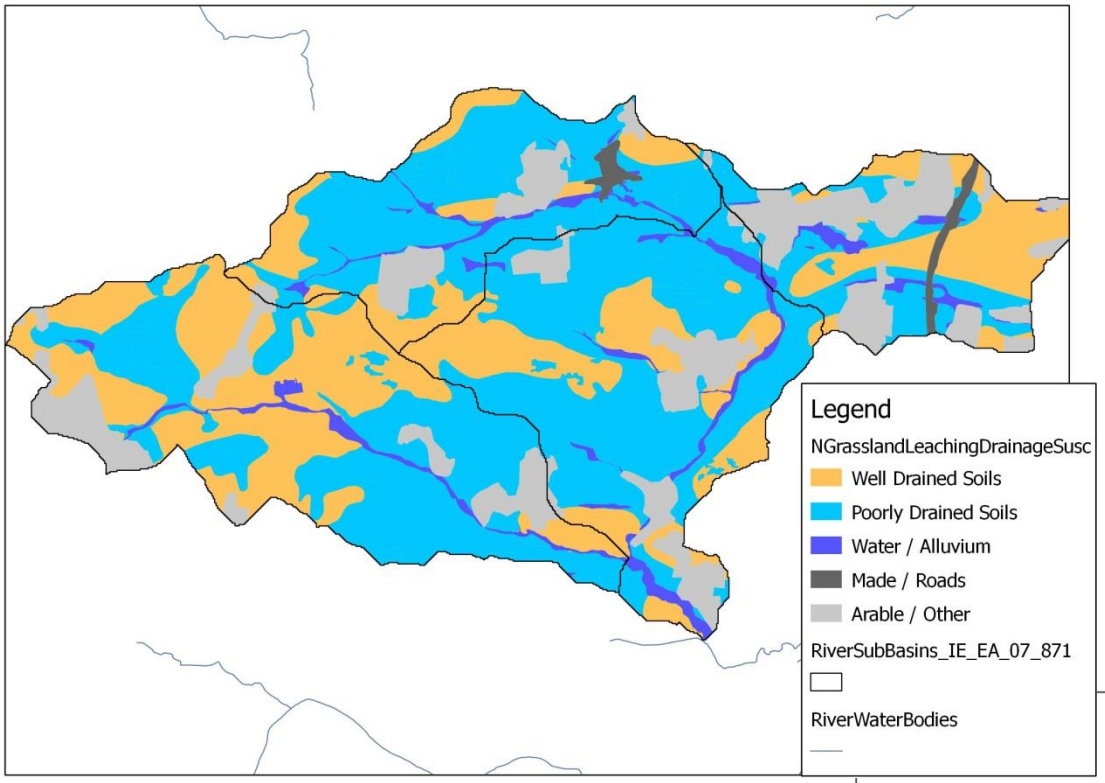


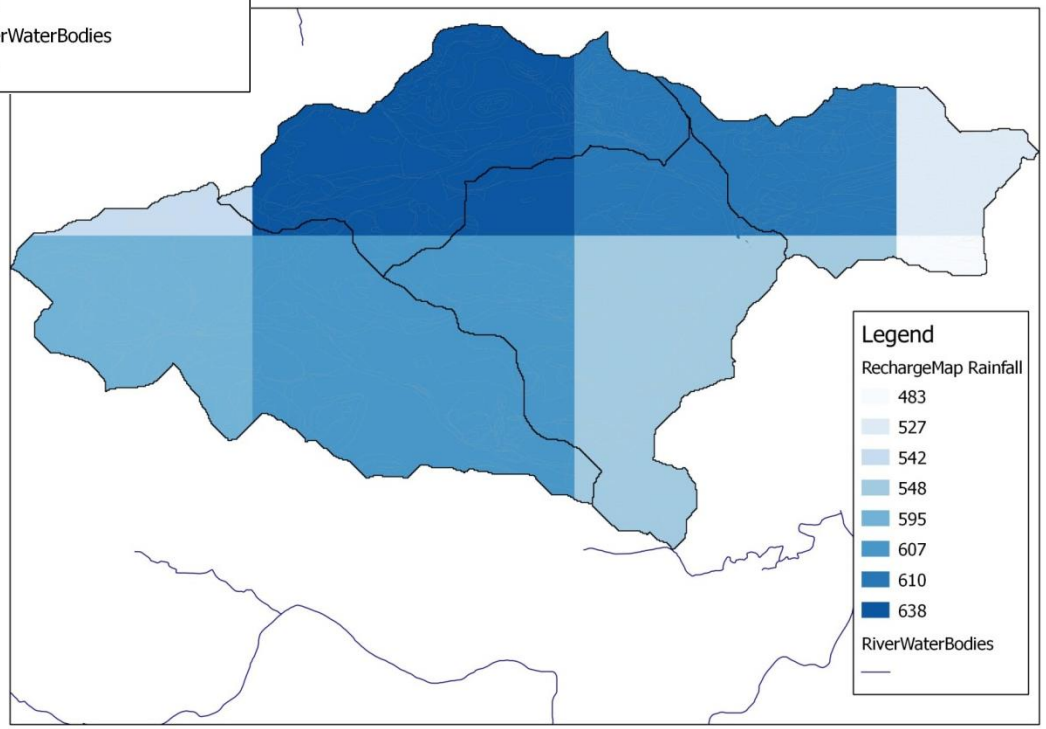
CMT approach uses loading rates from DED data, dependant on fertiliser rates that vary due to Agronomic Zone (by county)



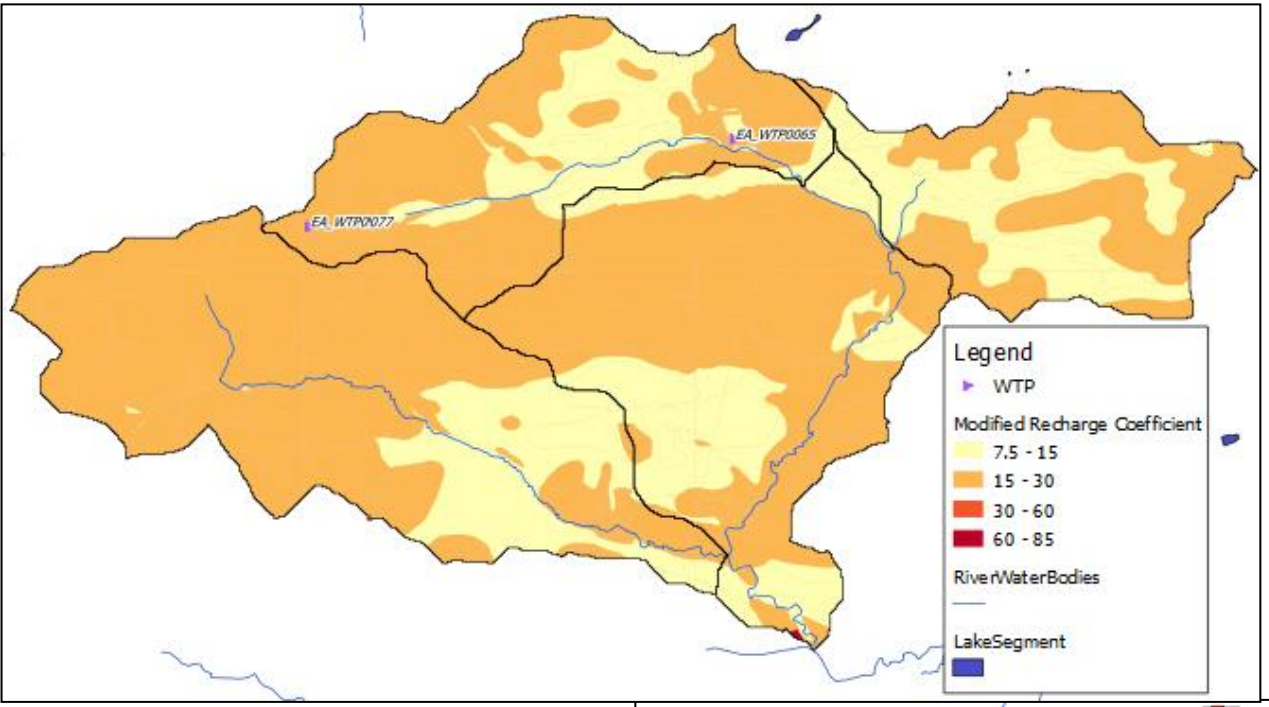
Diffuse Loading N Total	kg N/ha/yr	%WholeCatch
Grassland	132.54	83.00
Arable	110.54	15.79
Urban	14.57	0.99
Woodland / Other	3.90	0.26
Total Area (km2)	65.46	100.00
Weighted Average	127.62 kg/ha/yr	
Total for Area	835,403.1 kg/yr	

Leaching Susceptibility computed through NCYCLE_IRL, depends on Soil Drainage





Also added variable effective rainfall taken from National Recharge Map

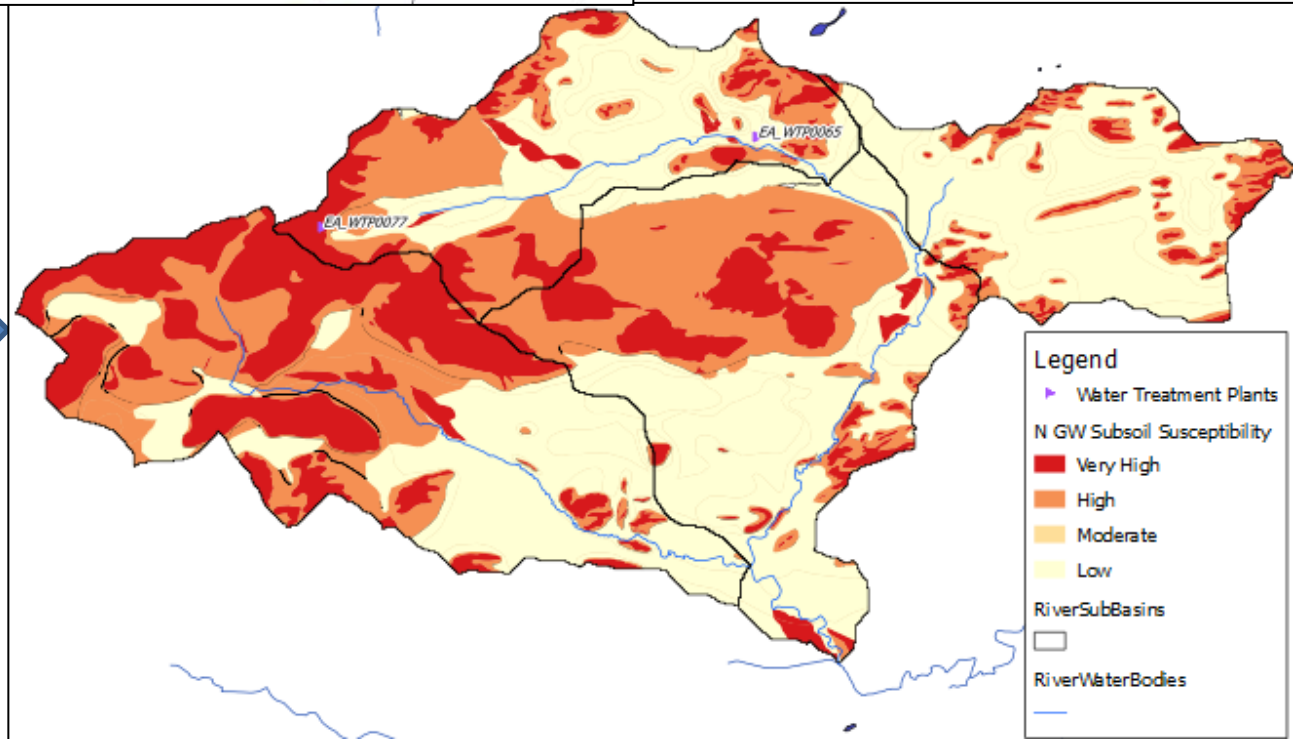


Add Modified Recharge Coefficient (from GSI Recharge Map)

Proportion of effective rainfall to groundwater, for non productive bedrock this includes a cap on the amount accepted

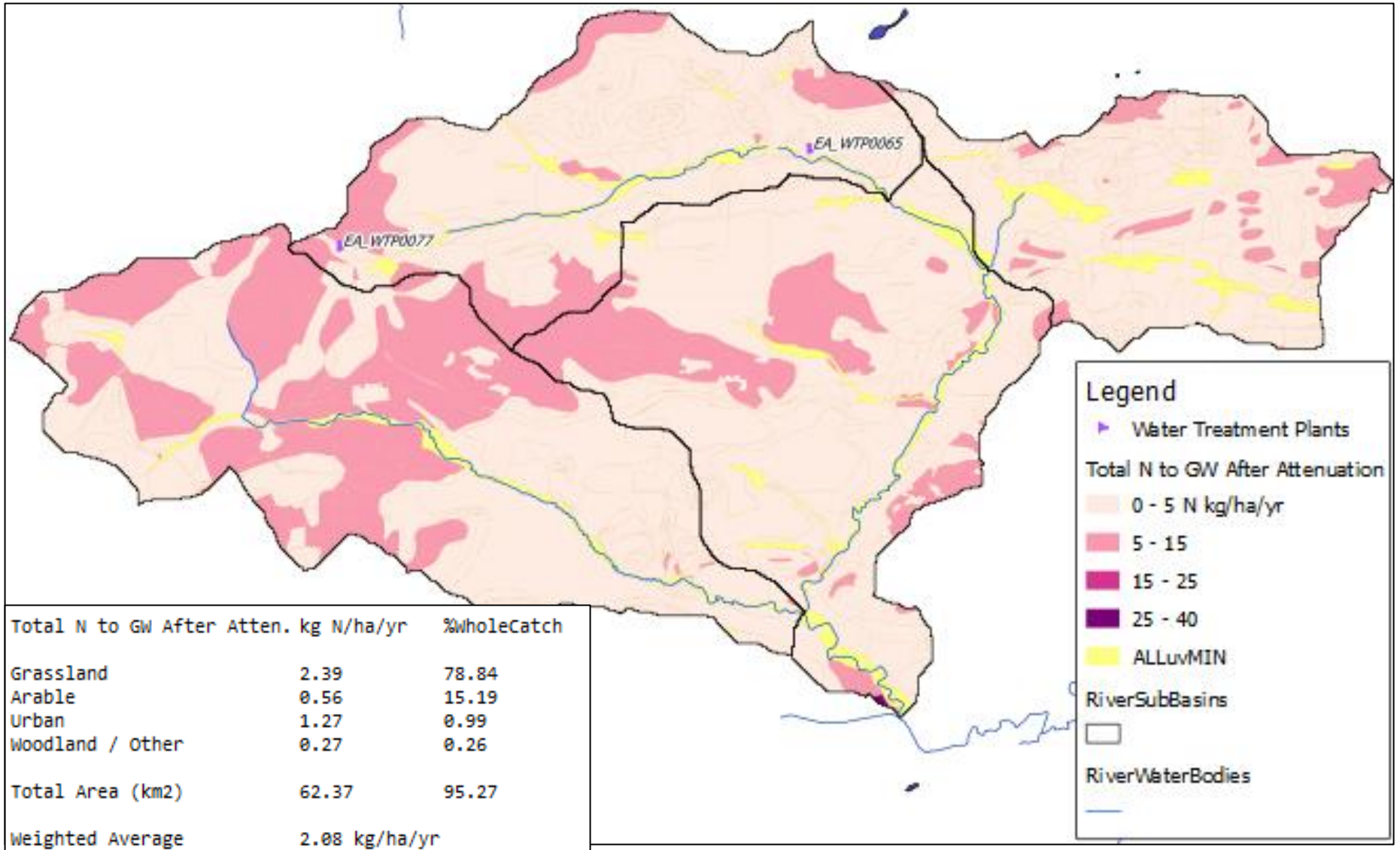
DTB combined with Subsoil Permeability

Resulting Attenuation Map for % Nitrate



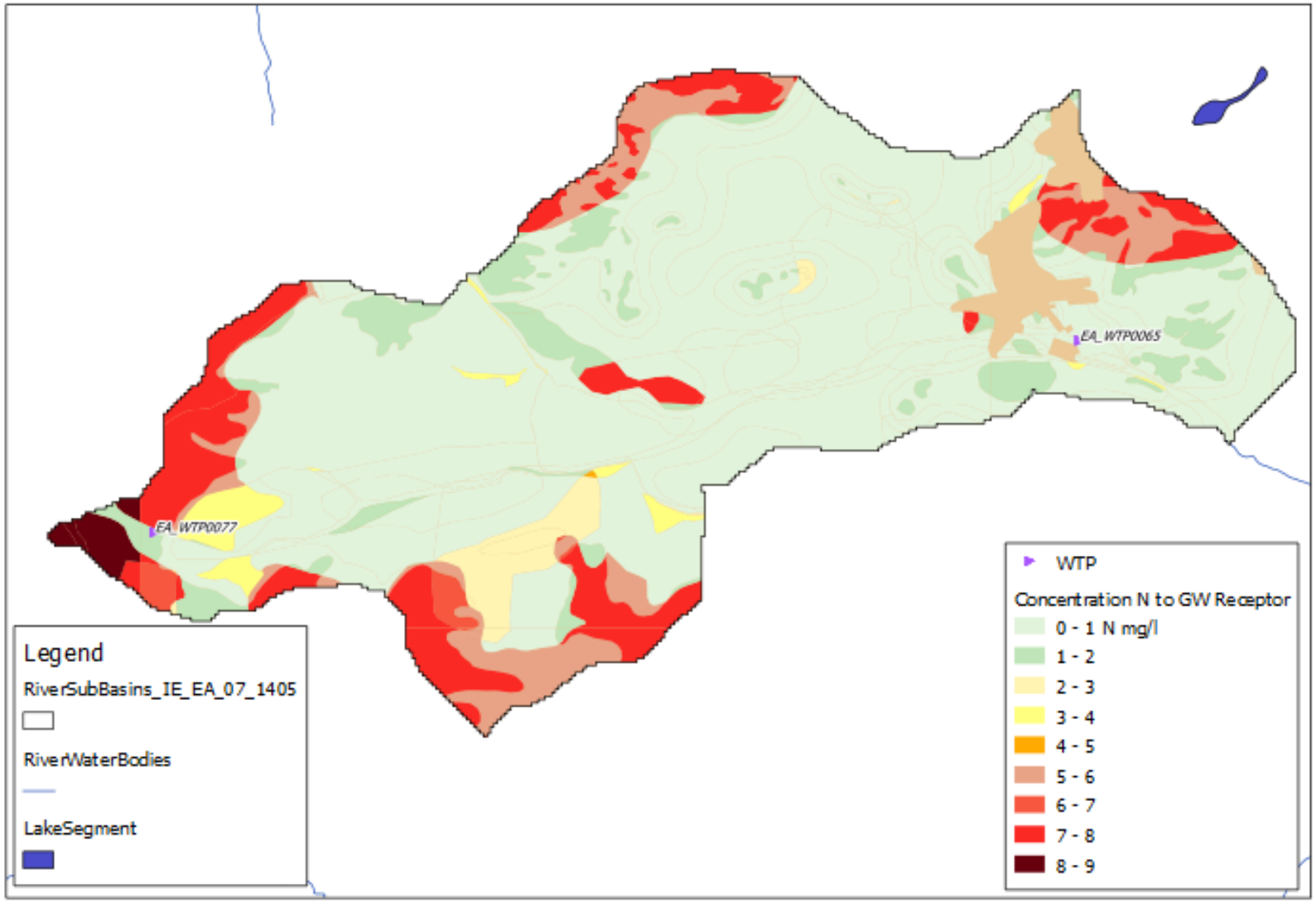
Final N to Groundwater Receptor

Using variable spatial inputs



Total N to GW After Atten.	kg N/ha/yr	%WholeCatch
Grassland	2.39	78.84
Arable	0.56	15.19
Urban	1.27	0.99
Woodland / Other	0.27	0.26
Total Area (km2)	62.37	95.27
Weighted Average	2.08 kg/ha/yr	
Total for Area	12,977.5 kg/yr	

Concentration values = CSAs = Loading / Modified Recharge * 100

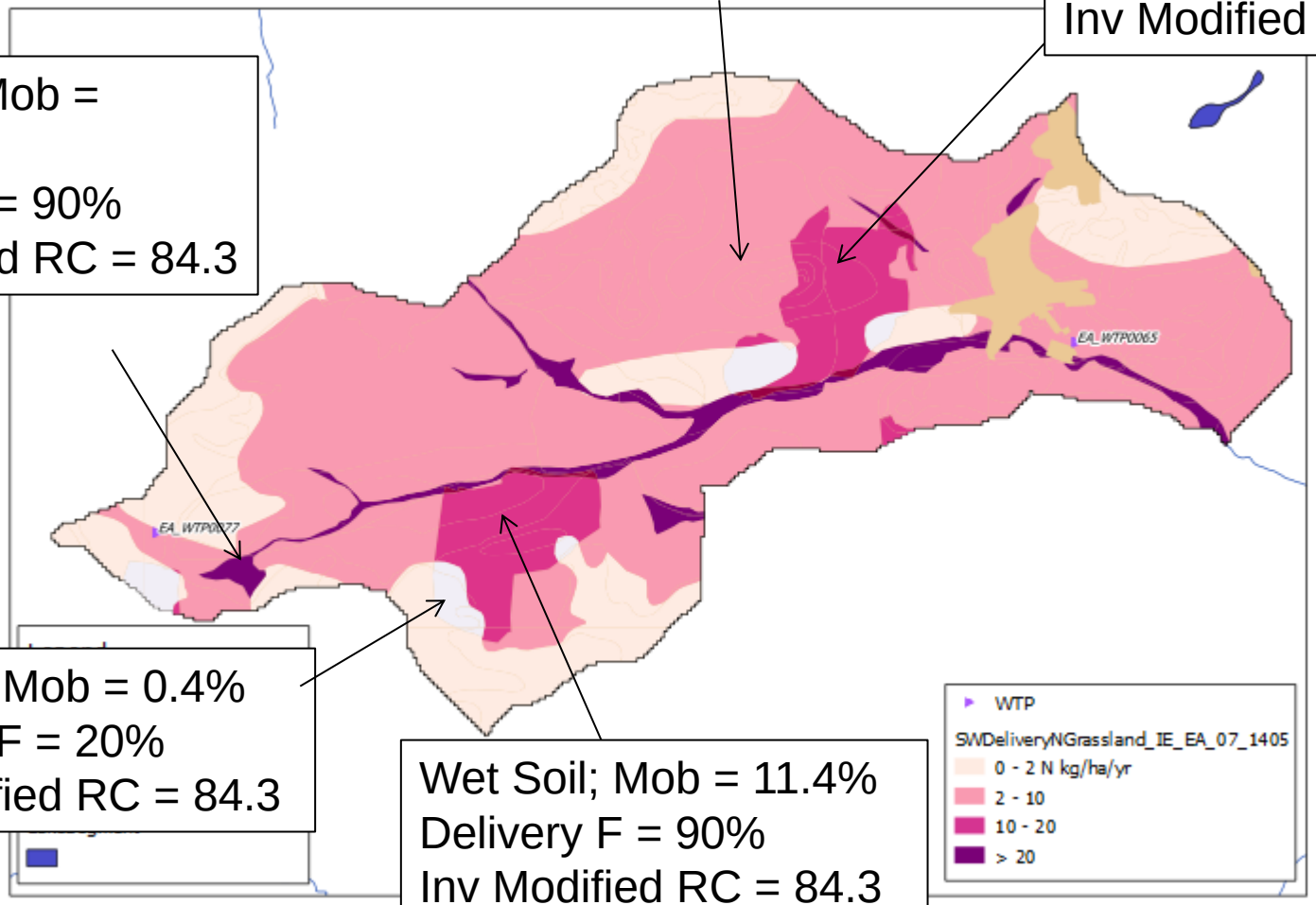


N Delivered via Near Surface Pathway

Wet Soil; Mob = 6.4%
Delivery= 90%
Inv Modified RC = 92.5

Wet Soil; Mob = 9.3%
Delivery = 90%
Inv Modified RC = 85

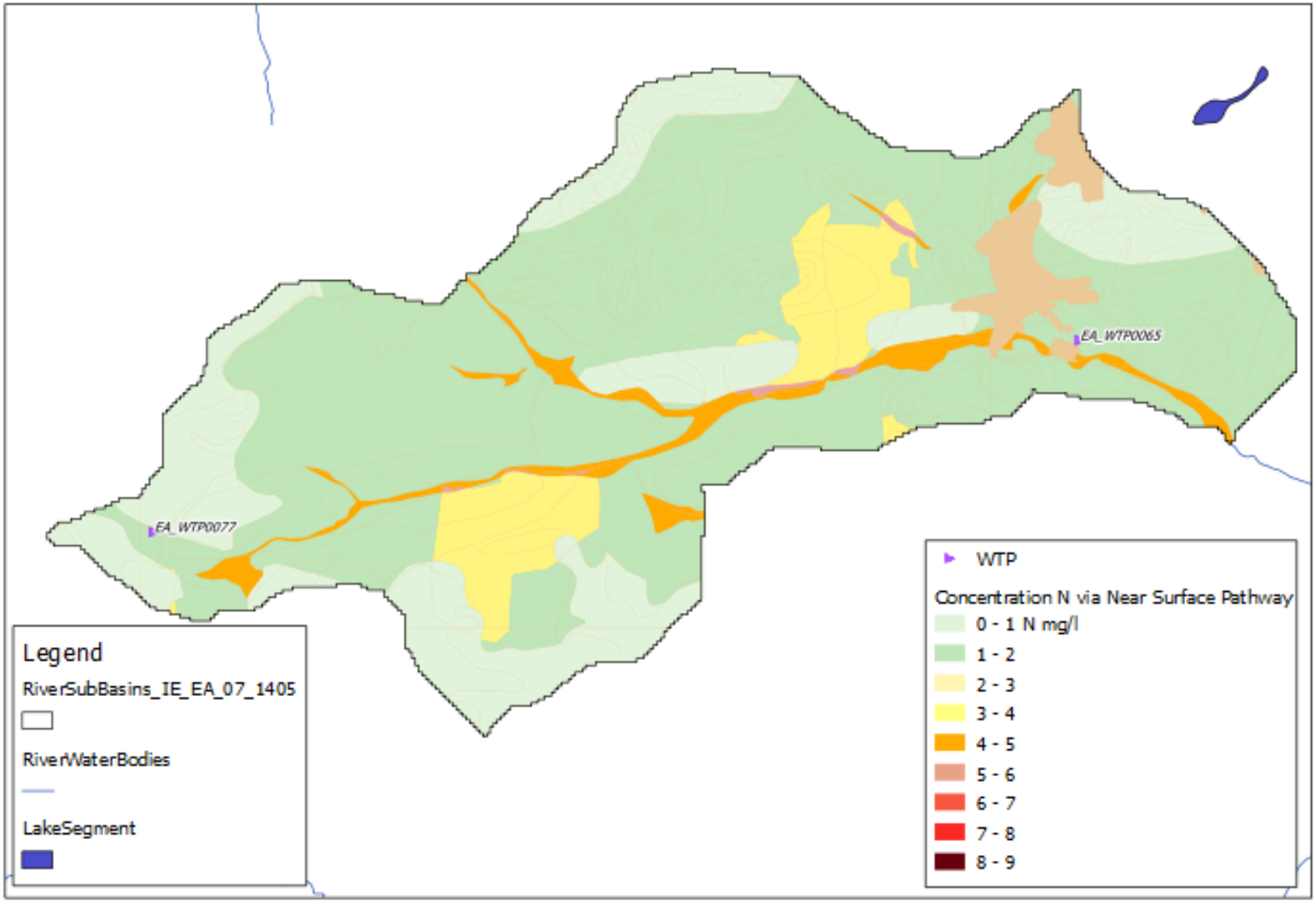
Alluvium; Mob = 22.2%
Delivery F = 90%
Inv Modified RC = 84.3



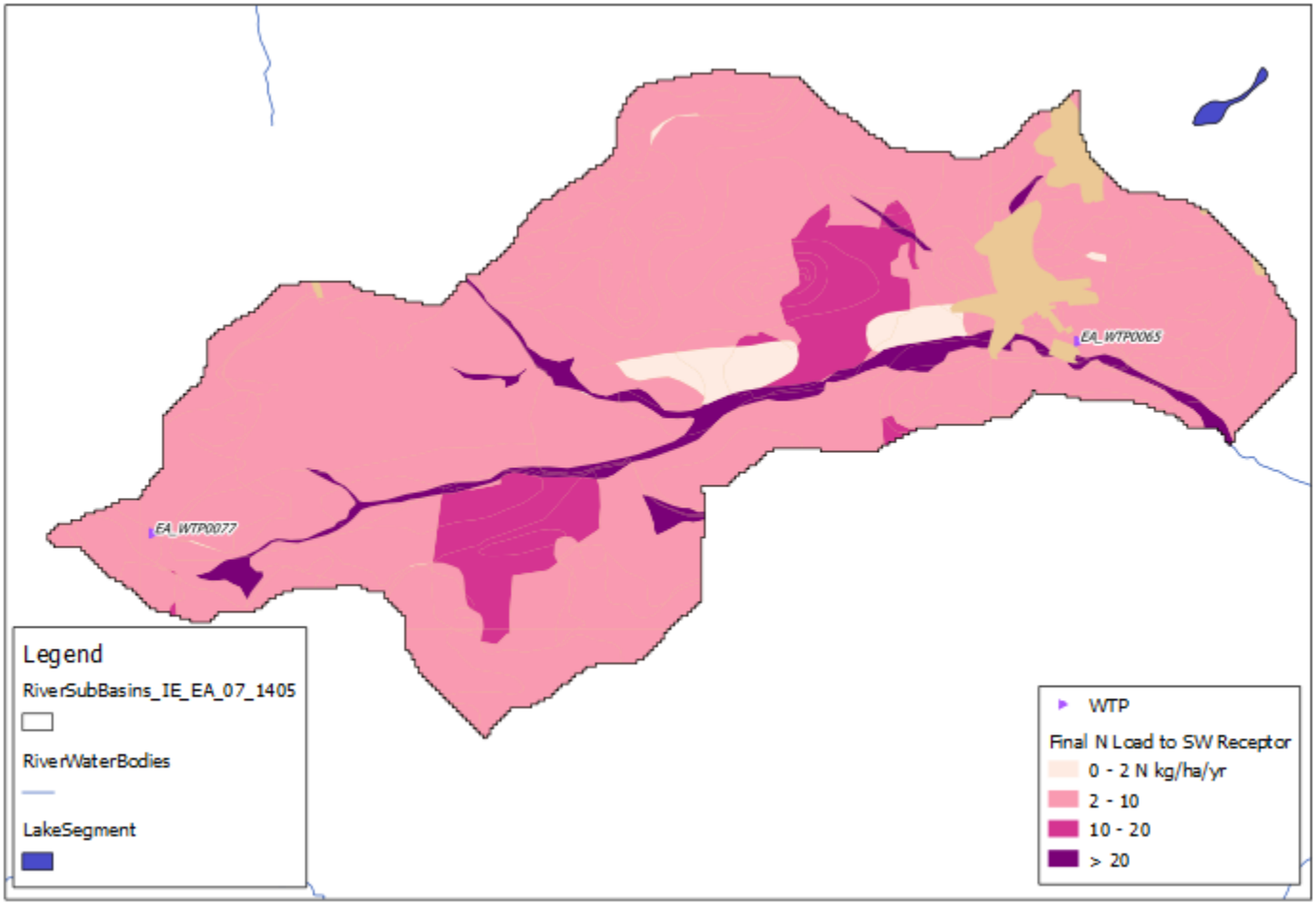
Dry Soil; Mob = 0.4%
Delivery F = 20%
Inv Modified RC = 84.3

Wet Soil; Mob = 11.4%
Delivery F = 90%
Inv Modified RC = 84.3

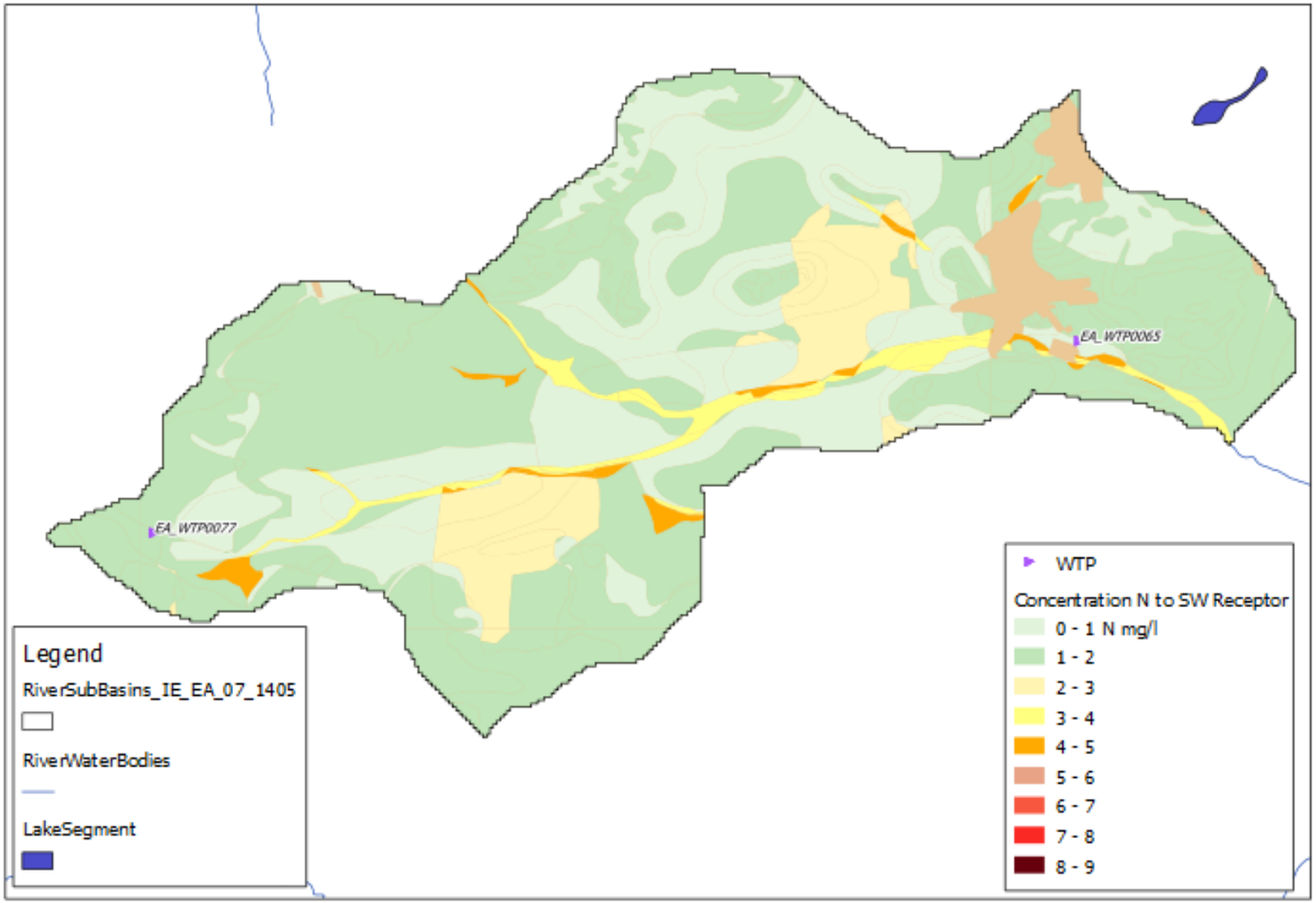
Conc. = Loading / Runoff * 100 = CSAs
Runoff = Eff Rainfall*(1 - Mod RC)



Final Load to Surface Water Receptor = Load from GW + Near Surface Load



Concentration to SW Receptor = CSAs (Loading / Eff Rainfall * 100)



Conclusions

- CMT Levels 1 and 2 demonstrated
  - Multipoint sources (Domestic WWTS) to be added
  - Urban and forestry areas included
- Static Critical Source Areas for GW and SW
  - GTT Tool for Loadings
  - Risk Map produced
  - Nutrient Impact highlighted
- Supports management of River Basin Districts
  - Extensive field work has helped to inform model

Future Work

- Add more detailed landuse data (LPIS)
- What-if scenarios, e.g. Land-use changes…
- CMT Level 3
  - Hydrological model with Transport (SMART)
- Integrate into EPA systems (not Open Source)

Project team

Principle Investigators:

- Michael Bruen - UCD
- Ray Flynn - QUB
- Bruce Misstear - TCD
- Mary Kelly-Quinn - UCD

Team:

UCD - Pamela Maher, Eva Mockler, Ian Packham

TCD - Jenny Deakin, Ronan O'Brien, Laurence Gill, Paul Johnston, Mesfin Desta

AFBI -Donnacha Doody

QUB - Alison Orr, Joshua Thompson, Ulrich Ofterdinger, Marie Archbold.

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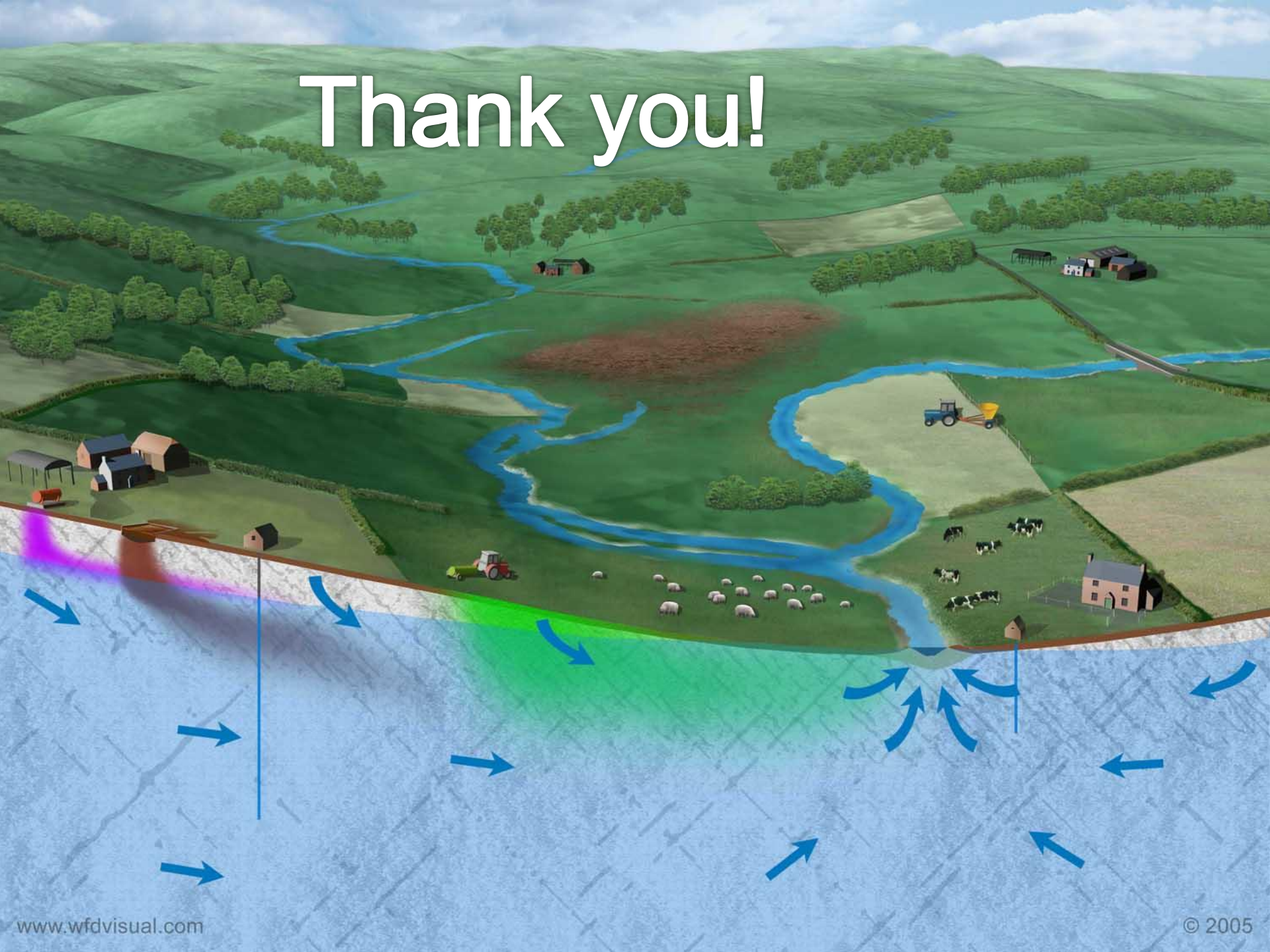
- Steering Committee
  - T. Hunter-Williams, P. Jordan, I. Cluckie, S. Fletcher, V. Fitzsimons, Seppo Rekolainen
- EPA Hydrometric and Groundwater Section
- Landowners in the Study Catchments
- River Basin District managers & Local Authorities
- Collaborating Researchers – Teagasc, DkIT, DCU
- RPS, Geological Survey Ireland, GSNI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