Integrated Water Resource Management

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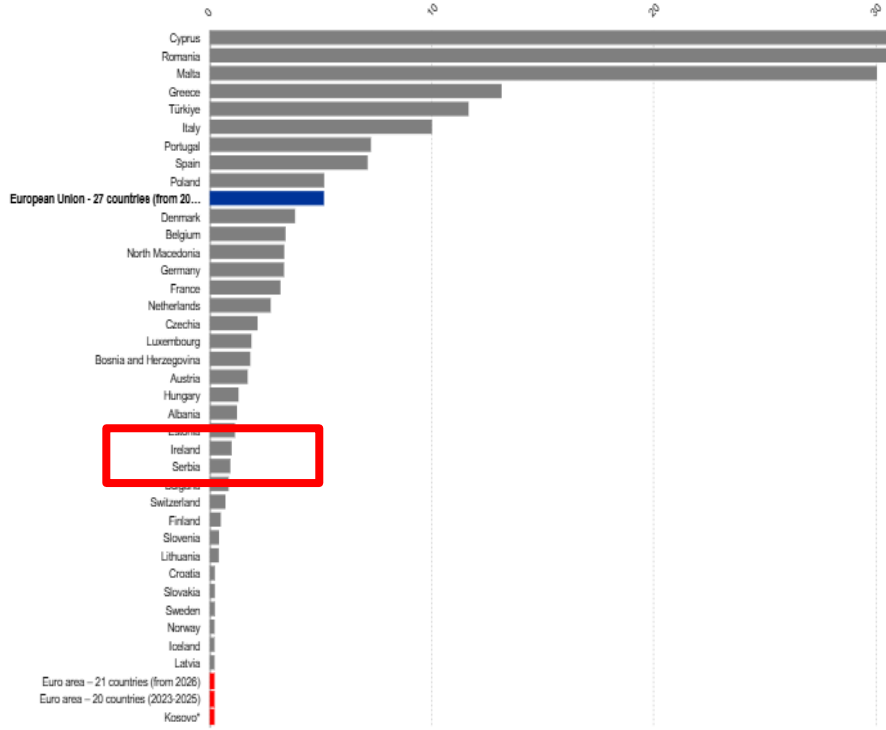
Presentation Overview

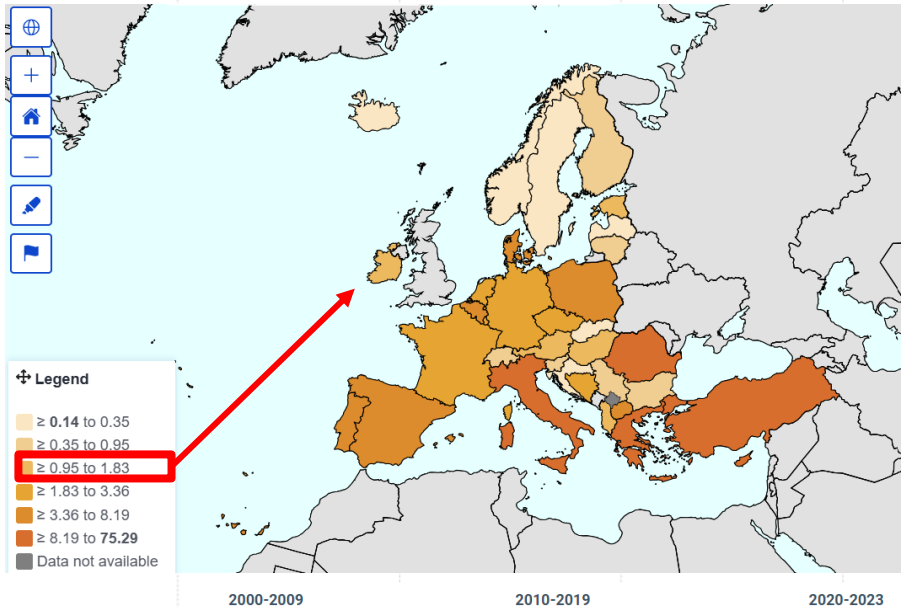
- Context
- Integration water resources – What do we need to consider?
- “Readily” available data
- Assessment Approaches
- Climate influence

Perception – an abundance of water…

…and also no issue in the context European water resources



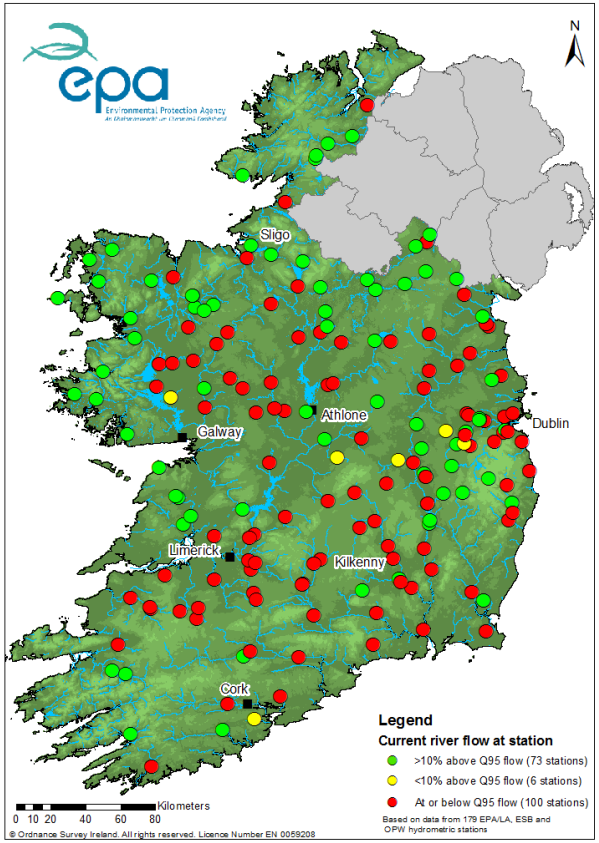
EU Water Exploitation Index (Eurostat, 2023)



EU Abstractions by Source 2000-2023 (EEA)

However: for surface water in 2018 …

National River Flow Estimates (for period 10/8/18 - 15/8/18)



Vartry Res. - Skycam

Owenbrin, Mayo – H. Feeley

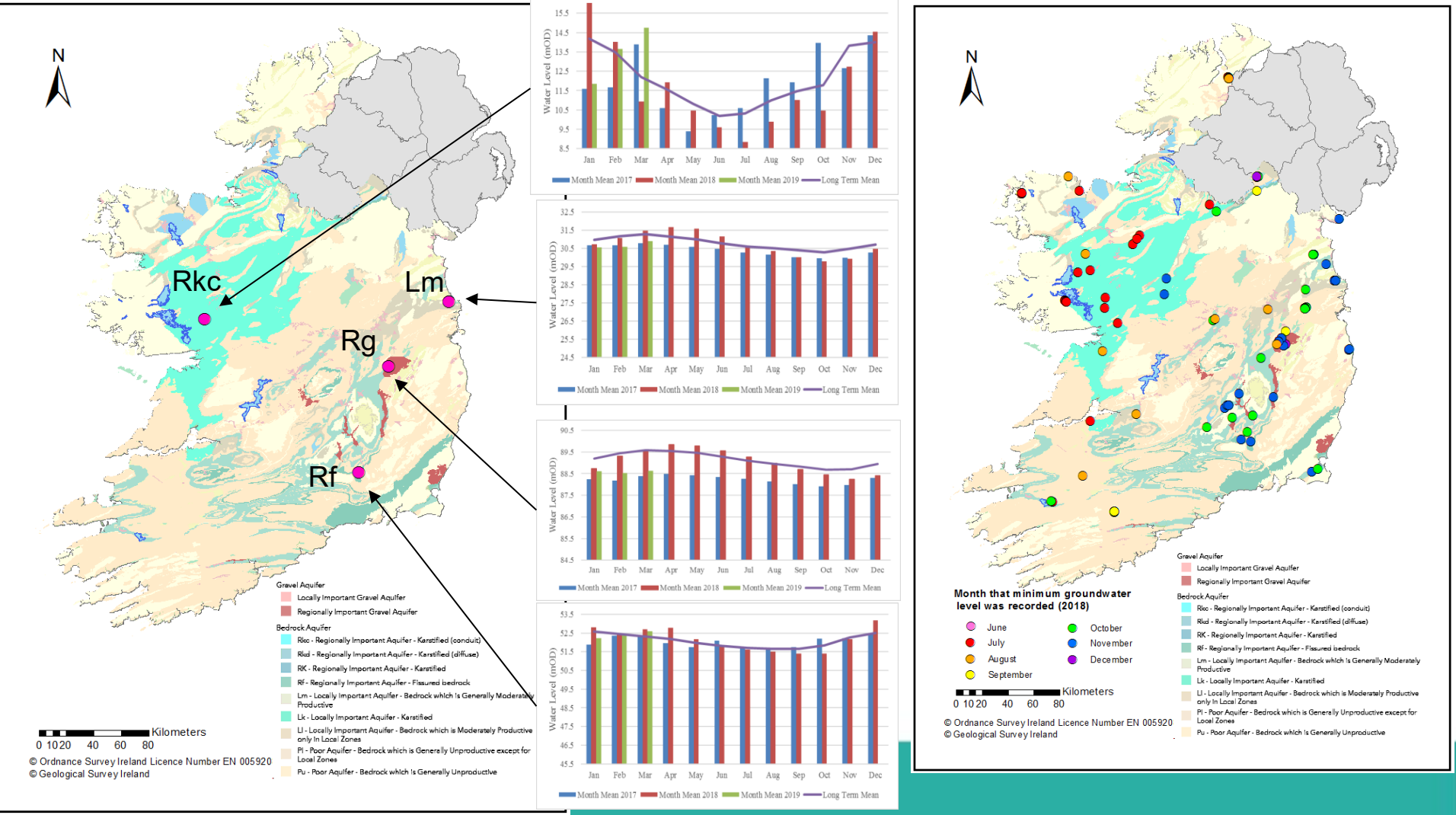
Mountain Water @ Emyvale

© Google

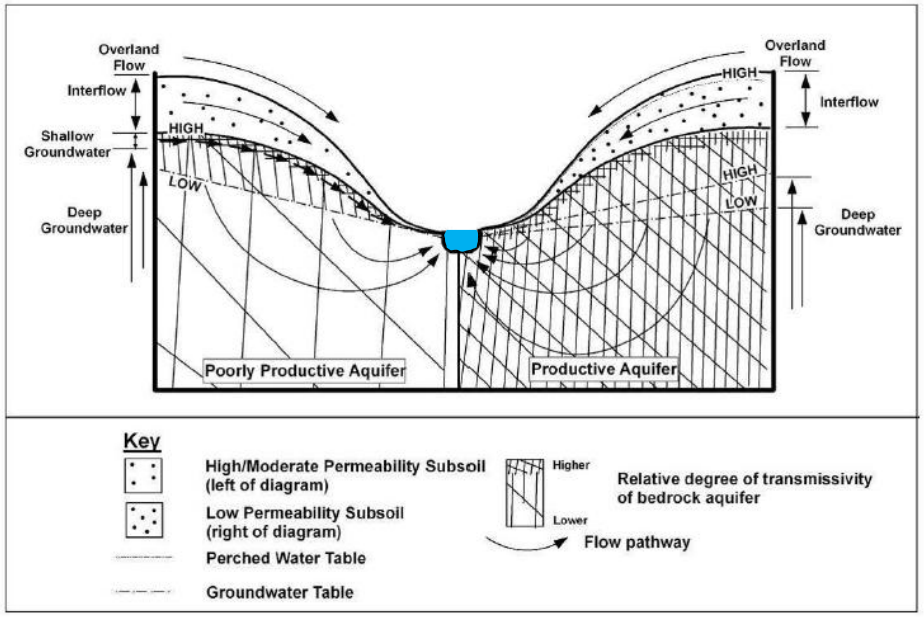
L. Owel – Midlands News Centre

Sandbags @ WS intake – C. Quinlan

… and for groundwater in 2018 …

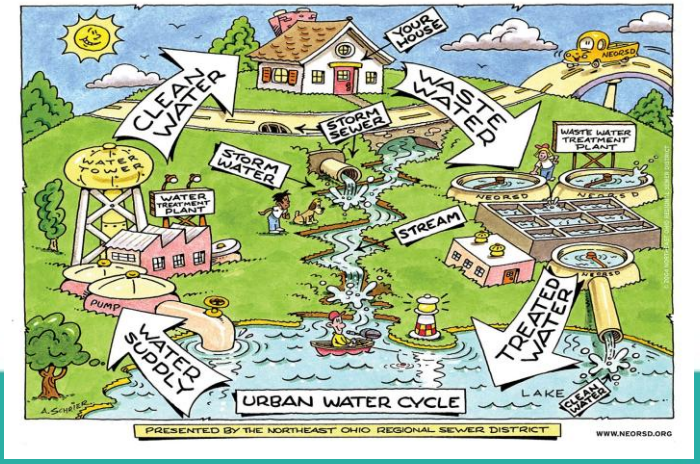


Integrated Water Resource Management needs to:



* https://assets.gov.ie/static/documents/groundwater-recharge-and-its-relationship-to-river-flow-in-ireland-bruce-misstear-dona.pdf

- Balance human needs with environmental needs
- Be holistic, catchment based, integrating surface water and groundwater resources
- Consider the cumulative impact of pressures

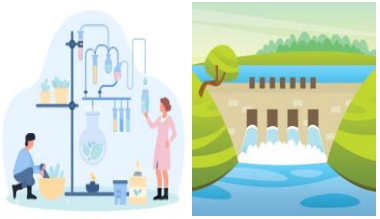


Balancing Water Resources for:

- Human Use
  - Social
  - Economic

Drinking & Cleaning

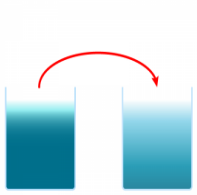

Farming & Food Production


Industry & Energy

- The Environment


Aquatic Life


Nature

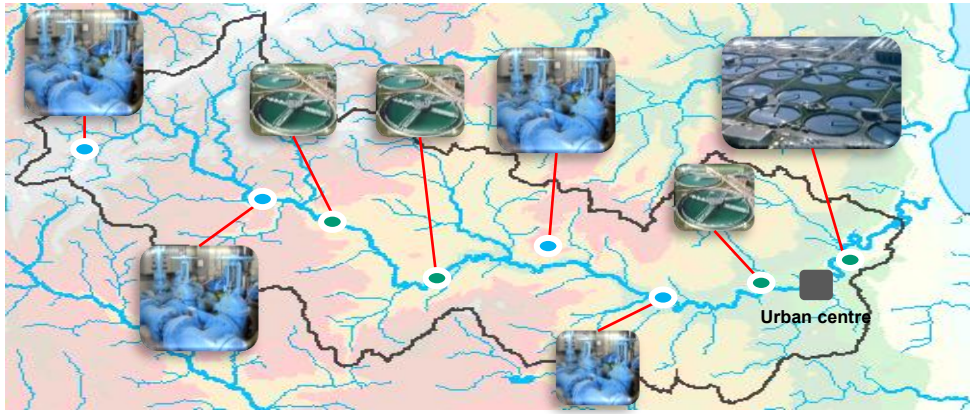

Dilute Pollutants

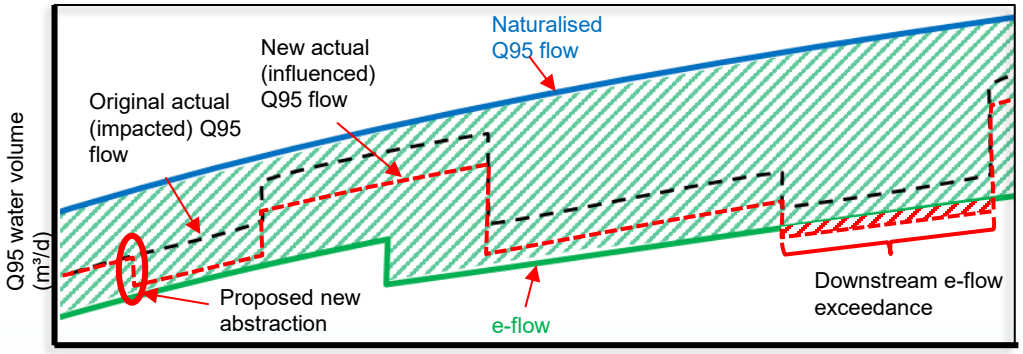

Recreation

To manage water resources what do we need to know?

- Estimates of the “Natural” Water Resources
  - Groundwater Recharge & Aquifer Storage
  - River Flow / Water Levels
  - Lake Volume / Water Levels
- Knowledge of activities that alter water resources
  - Abstractions
  - Dams / reservoirs with controlled water releases
  - Water transfers / diversions (feeder channels, mill races, piped)
  - Wastewater discharges
- Environmental needs for:
  - Ecological flow / level to support healthy aquatic ecology - temperature, species spawning / migration, oxygen content / WQ
  - Functioning ecosystems (e.g., to transport sediment, maintain riparian habitats)

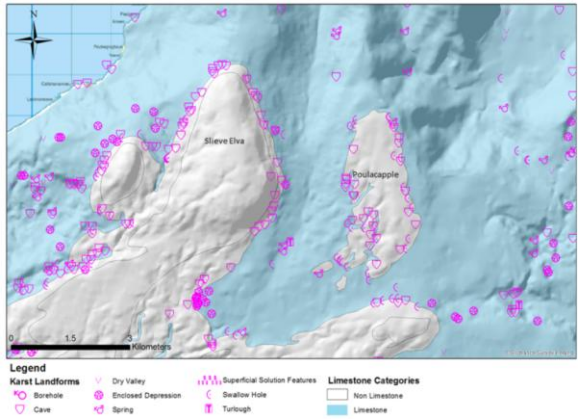
Applying Integrated Water Resource Management to a Catchment

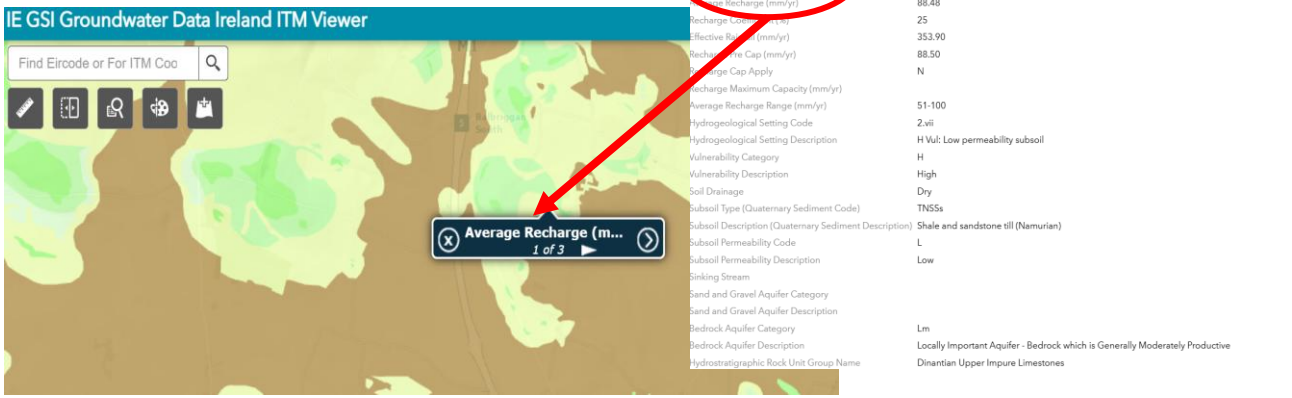




“Natural” Water Resources: Groundwater

- Groundwater Recharge Map – download from GSI
- Recharge principles - Misstear & Brown, 2008
  - https://www.gsi.ie/en-ie/data-and-maps/Pages/Groundwater.aspx#Recharge
  - https://www.epa.ie/publications/research/water/Strive_6_Misstear_GWVulnerability_syn_web.pdf
  - Calculate for your assessment unit e.g., GWB, ZOC

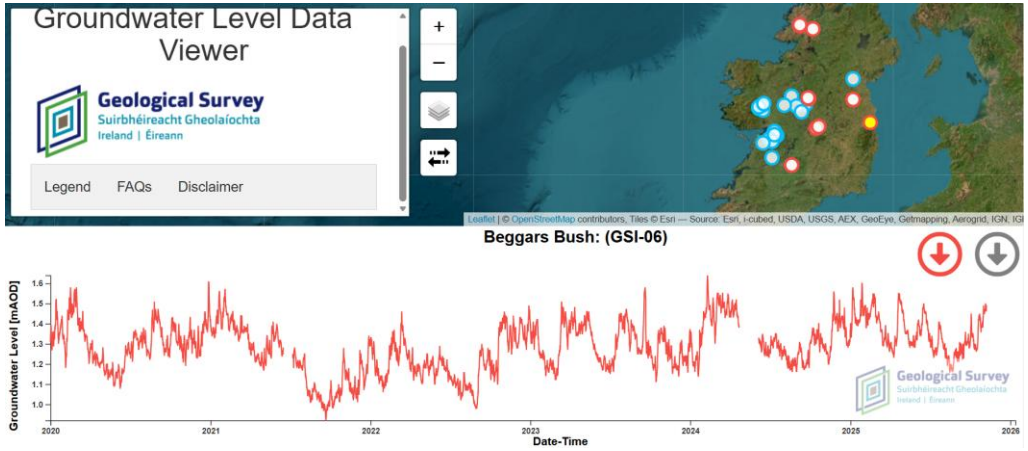




- Karst Data and Turloughs (GSI) - https://www.gsi.ie/ga-ie/programmes-and-projects/groundwater/activities/understanding-irish-karst/pages/karst-databases.aspx
- Aquifer Parameters – GW vulnerability, subsoil, depth to bedrock…
  - Estimates of aquifer parameter values (GSI-EPA) - https://www.gsi.ie/documents/IrishAquifersPropertiesAreferencemanualandguideVersion10March2015.pdf

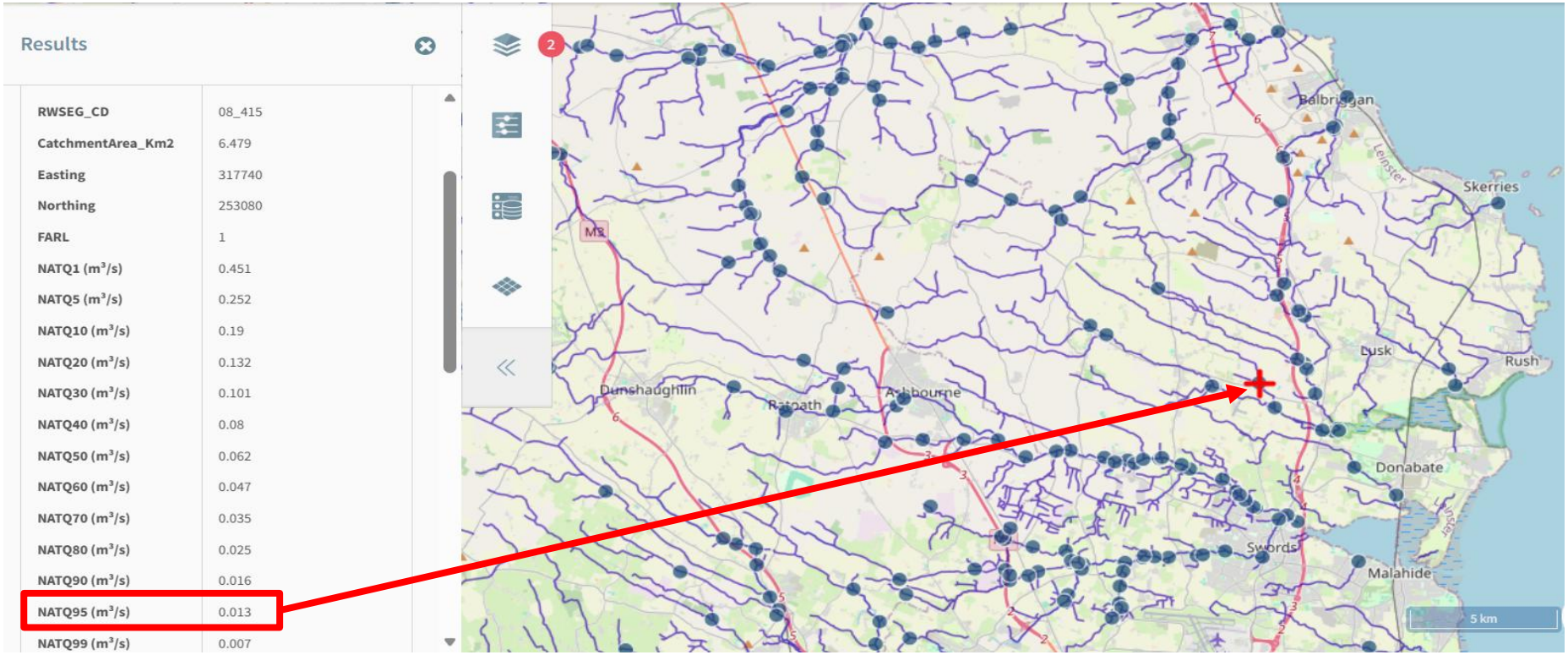
“Natural” Water Resources: Groundwater

- Groundwater Level – download from EPA & GSI
  - EPA - https://epawebapp.epa.ie/hydronet/ - raw data, summary stats
  - GSI - https://gwlevel.ie/ - raw data



- Hydrogeological reports (GSI, EPA, Consultants) – includes hydraulic testing summaries
  - GSI (Source Reports) - https://www.gsi.ie/en-ie/programmes-and-projects/groundwater/projects/protecting-drinking-water/what-is-drinking-water-protection/county-groundwater-protection-schemes/Pages/Source-Protection-Zone-Reports.aspx
  - EPA (Poorly Productive) - https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/EPA-Poorly-Productive-Aquifers-Summary-Report.pdf

“Natural” Water Resources: Rivers



- Hydrometric data (modelled flow - HydroTool)
  - EPA - https://gis.epa.ie/EPAMaps/Water - flow percentile estimates for ~19,000 locations

“Natural” Water Resources: Lakes

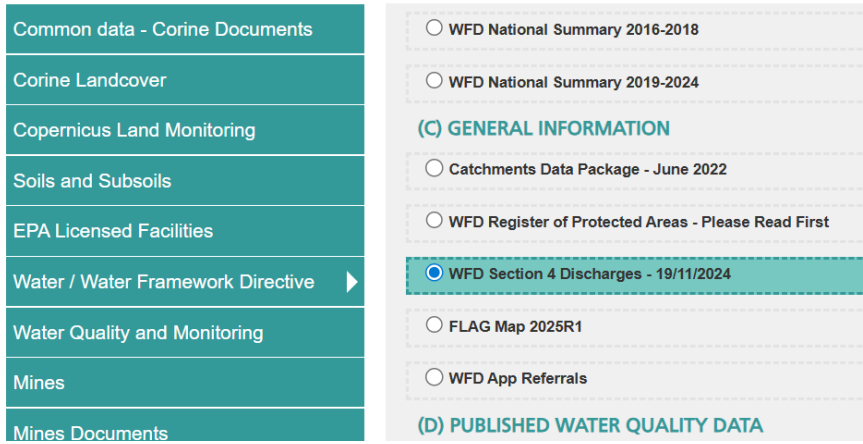
- Lake characteristics
  - Lake area extent
    - Current extent (OSI, OPW, EPA)
    - Seasonal extent - Satellite / remote sensing
    - Historic extent - 6” & 25” maps
  - Bathymetry (OPW, EPA, UÉ, Academia)
- River inflow – outflow (see slides on rivers)
- Lake Levels
  - EPA - https://epawebapp.epa.ie/hydronet/ - raw data, summary stats
  - GSI – Turloughs https://gwlevel.ie/ - raw data
  - ESB – (Level & Flow) Shannon, Liffey, Lee & Erne https://esb.ie/what-we-do/generation-and-trading/hydrometric-information

“Pressures” data

- EPA register of abstractions
  - Currently 2,043 Registrations (2,890 Abstraction Points)
  - https://leap.epa.ie/abstractions/

  (note coordinates for drinking water abstractions are not in the public domain)
- Discharge datasets e.g. Section 4s, EPA licensed discharges
  - EPA geoportal (S4s) - https://gis.epa.ie/GetData/Download

  (dataset was last updated in 2023)
  - EPA license files - https://leap.epa.ie/
- IFI Barriers dashboard
  - https://opendata-ifigeo.hub.arcgis.com/apps/f9322c21d8124cc7aa54375901e6b967/explore



2024 Abstraction Regulations (S.I. 419 of 2024)

- General Binding Rules (currently being developed by EPA – aiming to publish in April 2026)
  - applicable to all abstractions: will contain the environmental criteria governing abstractions not licensed by the EPA
- Significant abstractions assessment (2025 EPA guidance) –
  - assessment identifies abstractions between 25 – 1,999 m^3/d that are, or may be, impacting on a water bodies WFD environmental objectives and need an EPA licence.
  - If they are not impacting on a water bodies environmental objectives, then they must adhere to the General Binding Rules

  https://www.epa.ie/publications/licensing--permitting/freshwater--marine/Significant-Abstraction-Guidance-V1.15.pdf
- Licensing
  - for significant abstractions and **all** abstractions >2,000 m^3/d: to include, where relevant, licence conditions to ensure a water bodies WFD environmental objectives will be met

River abstraction assessment

Step 1: Hydrological limits

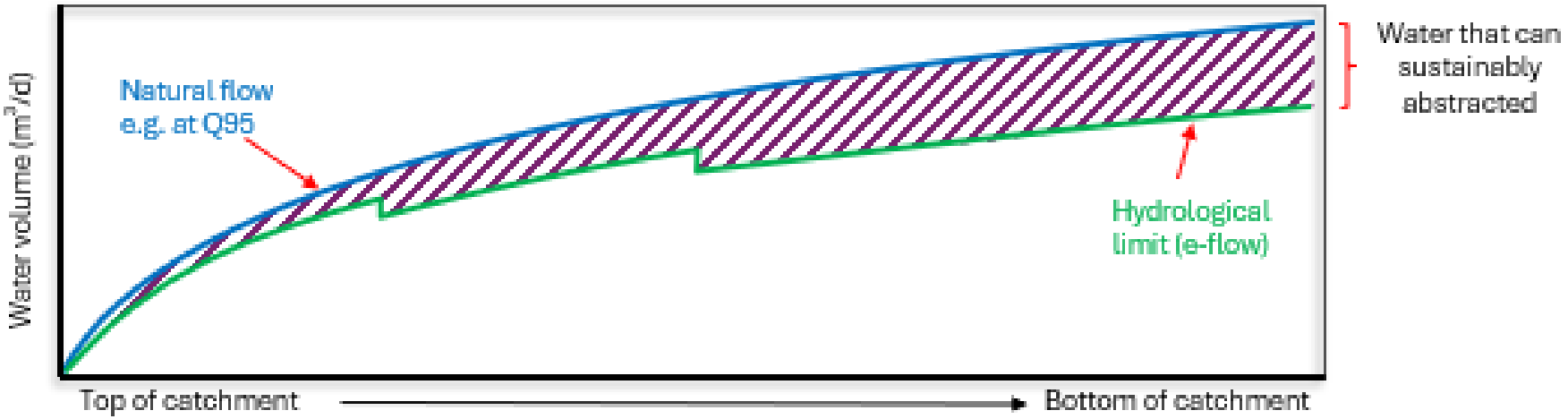
Assess if the cumulative impact of all abstractions causes a breach of hydrological limits.

Step 2: Spatial analysis

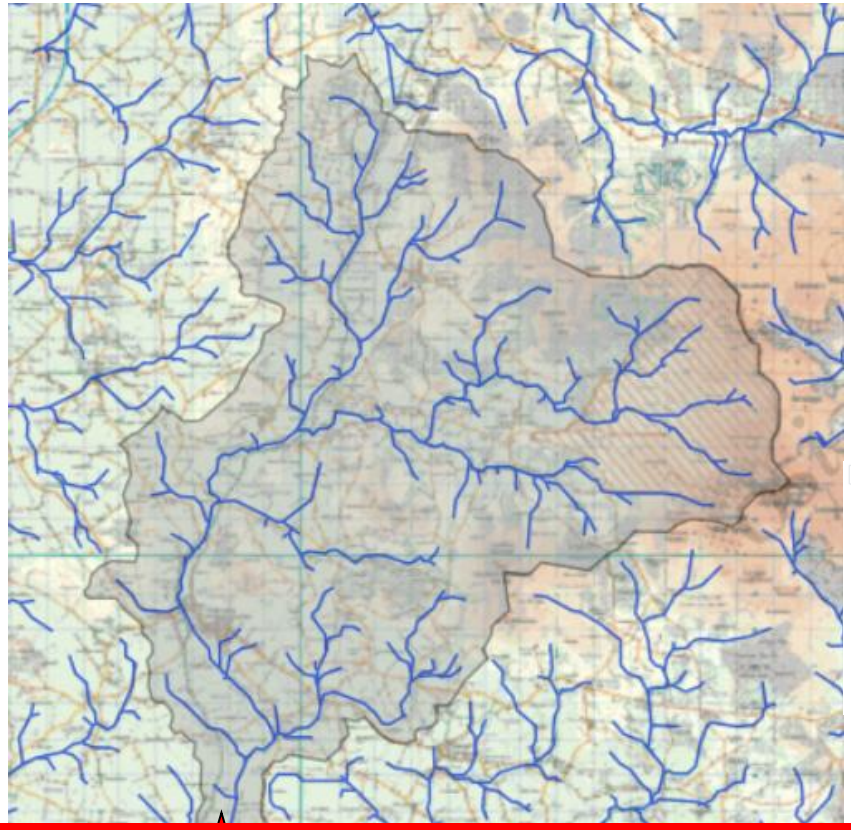
Assess if the breach is for more than 5 % or 15 % (High or Good Status objective respectively) of the river water body length.

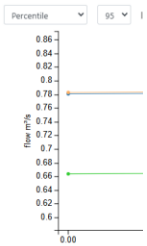
Step 3: 1% Rule

Assess if the abstraction is >1% of the volume of water which can be sustainably abstracted from an individual river water body.



River Assessment Example





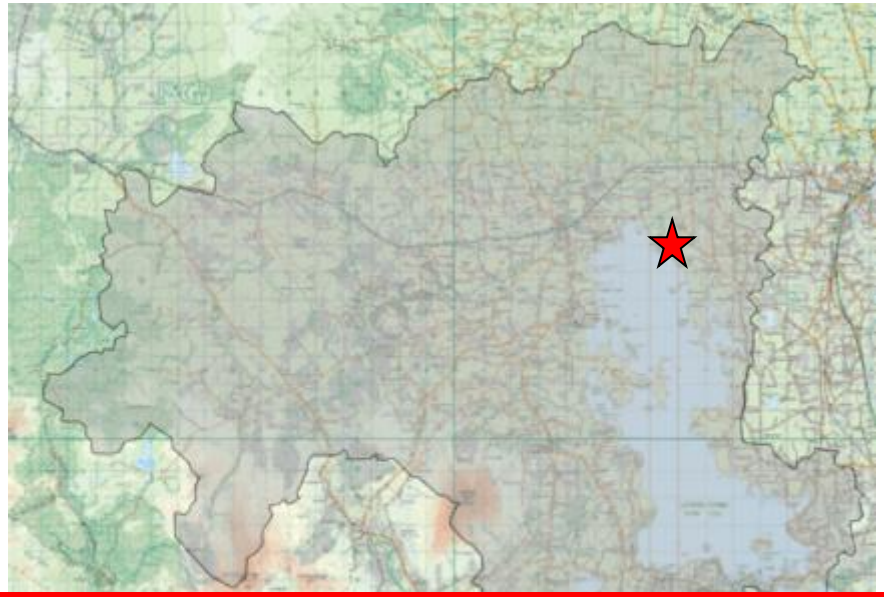
River Abstraction	
Max daily vol (m^3/day)	10,800
River Water Body 1 (abstracted)	
WFD environmental objective	Good
Number of known abstractions from waterbody and/or upstream in catchment	11
Number of known discharges to waterbody and/or upstream in catchment	4
River typology	B1
Step 1: Hydrological limits	
Q60 assessment	Pass
Q70 assessment	Pass
Q95 assessment	Fail
Step 2: Spatial analysis	
Total river channel length (km)	39.59
Impacted river channel length (km)	0.91
Percentage of river channel impacted	<15%
River waterbody 1 assessment outcome (final)	Pass
River Water Body 2 (downstream)	
WFD environmental objective	Good
Number of known abstractions from waterbody and/or upstream in catchment	12
Number of known discharges to waterbody and/or upstream in catchment	4
River typology	B1
Step 1: Hydrological limits	
Q60 assessment	Pass
Q70 assessment	Pass
Q95 assessment	Fail
Step 2: Spatial analysis	
Total river channel length (km)	22.23
River waterbody assessment outcome (modelled)	Fail
Further assessment / expert judgement	
Additional hydrometric monitoring data informs the final assessment outcome	Yes
River waterbody assessment outcome (final)	Pass

Highlights the importance of actual flow data

Lake abstraction assessment

- Shallow lake margin / littoral zone is important ecologically
- Hydrological Assessment:
  - Do abstractions reduce a lakes habitable zone by more than 1% (High Status) or 5% (Good Status) for more than 1% of the time (4 days) per year?
  - Is the volume abstracted greater than 10% of the Q50 lake outflow?
- Data needs
  - Lake water levels
  - Lake extent (natural)
  - Lake outflows

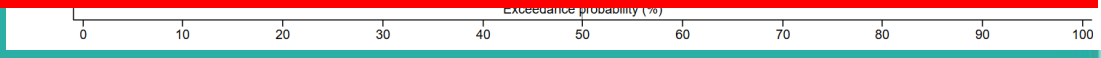
Lake Assessment Example



Lake Abstraction	
Max daily vol (m^3/day)	20,099
Lake Water Body (abstracted)	
WFD environmental objective	Good
Number of known abstractions from waterbody and/or upstream in catchment	5
Number of known discharges to waterbody and/or upstream in catchment	3
Assessment of lake hydrological limits	
Modelled catchment area (km^2)	424
Estimated naturalised Q50 outflow (m^3/s)	9.346
Ratio of the Q50 outflow to the net influence	0.03
Assessment of the % allowable change in natural Q50 lake outflow	Pass
Lake waterbody assessment outcome	Pass
River Water Body 1 (downstream)	
WFD environmental objective	Good
Number of known abstractions from waterbody and/or upstream in catchment	28
Number of known discharges to waterbody and/or upstream in catchment	28
River typology	C2
Step 1: Hydrological limits	
Q60 assessment	Pass

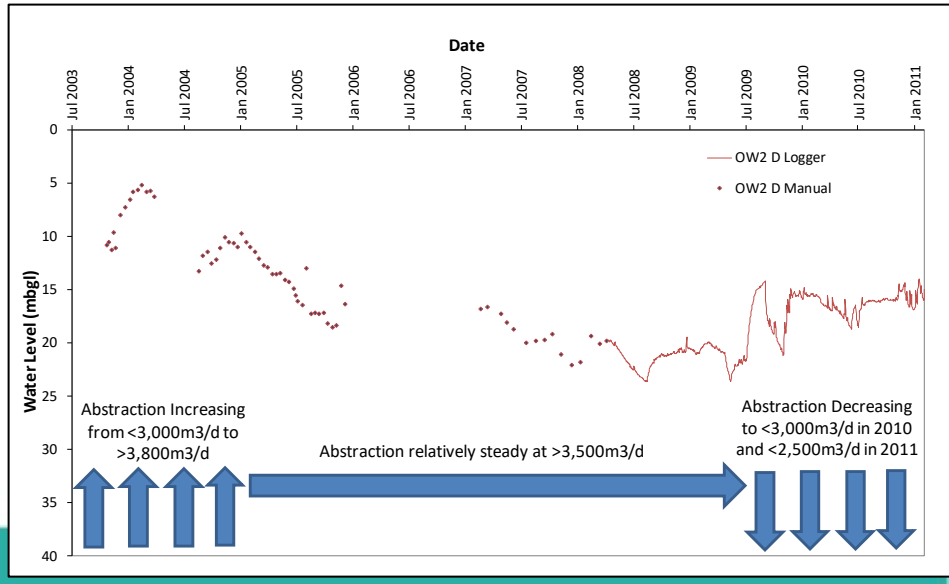
3%

1. Where available, use lake levels to estimate extent of lake margins impacted.
2. Use the above approach if lake levels are unavailable.



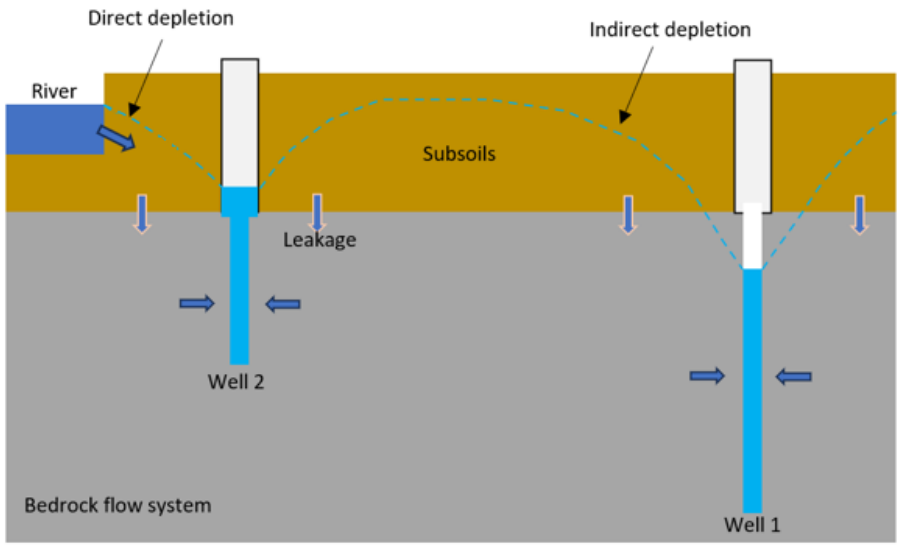
Groundwater abstraction assessment – Water Balance

- Long-term ratio of GW abstraction to recharge?
  - Ratio > 0.8 (i.e., 80%)
  - Ratio > 0.3 in gravel aquifers & falling GW level
  - Ratio > 0.2 in bedrock aquifers & falling GW level
  - Ratio > 0.05 in aquifers supporting GW dependent wetland & falling GW level
- GWB Abs/Recharge ratio: 0.64
  - Recharge 103 mm/yr
  - Area 233 km^2
  - GWB Abstraction Vol. 15,430 m^3/d
- GW Level Data
  - GWL since 2010 relatively stable
  - Sustainable Abstraction 2,500 – 3,000 m^3/d

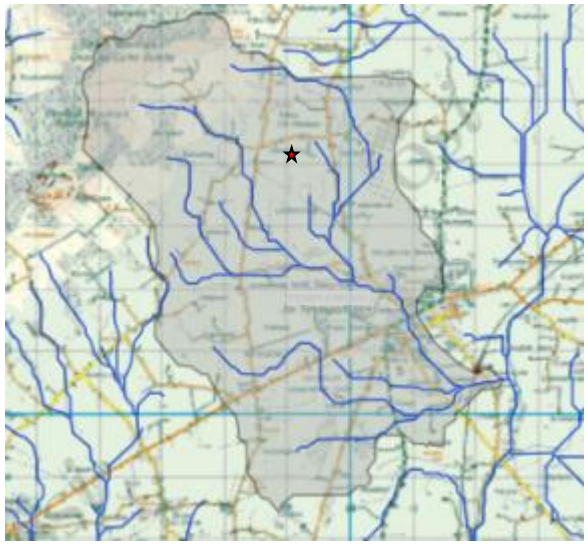


Groundwater abstraction assessment - Surface Water

- EPA Significant Abstractions Guidance (2025)
  - Groundwater abstractions are unlikely to pose a risk to rivers when they are:
    1. <100 m^3/day from PP aquifers, with low-moderate vulnerability.
    2. <250 m^3/day & >150 m from streams, irrespective of GW vulnerability.
    3. <250 m^3/day from streams in karst & are outside the ZoC to springs.
- Rate of streamflow depletion from groundwater abstraction is a factor of aquifer / subsoil properties, distance and abstraction volume.



Groundwater Assessment Example



- GWB Abs/Recharge ratio: 0.05
  - Recharge 140 mm/yr
  - Area 930 km^2
  - GWB Abstraction Vol. 16,570 m^3/d

Max daily vol (m^3/day)	2,409
Groundwater Body (abstracted)	
WFD environmental objective	Good
Number of known groundwater abstractions from groundwater body	30
Groundwater body assessment	
Groundwater body water balance	Pass
Cumulative abstraction from groundwater body as a % of groundwater body recharge	5
Evidence of falling groundwater levels	n/a
Presence of saline (or other) intrusions	n/a
Impact on surface waterbodies	?
Impacting on supporting conditions of groundwater dependent terrestrial ecosystem(s)	n/a
Groundwater abstraction assessment outcome	?

Any local impact on stream?

Groundwater Assessment Example

- GW Abstraction 2,409 m^3/d
- Stream Flow Depletion at river calc.
  - Calculation Tool used (Hunt, 2003)

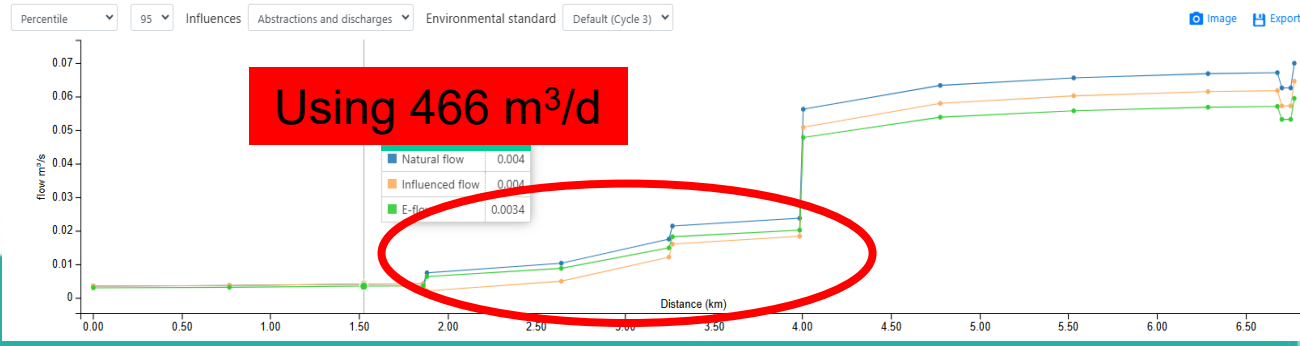
https://mi.water.usgs.gov/software/groundwater/CalculateWell/index.html

	SI units	SI Values	Data Source
Distance of pumping well to SW body	m	600	Google Maps
Transmissivity of aquifer (T)	m^2/day	233	GSI Source Protection Report
Storativity (storage coefficient) of aquifer	-	0.011	GSI Aquifer Properties (2015)
Specific yield of aquitard	-	0.06	GSI Aquifer Properties (2015)
Hydraulic Conductivity of "Aquitard" (K)	m/day	0.0864	Misstear & Brown (2008)
Stream (SW body) width	m	1.5	Google Maps
Thickness of Aquitard	m	5	GSI Source Protection Report
Distance of streambed from bottom of Aquitard	m	4	Estimate from Google Streetview
Pumping rate	m^3/day	2409	Registered Abstraction Volume
Days of pumping	day	3650	10 year model run
Stream Flow Depletion	m^3/day	**466**	Estimated SFD at river

Max daily vol (m^3/day)	2,409
Groundwater Body (abstracted)	
WFD environmental objective	Good
Number of known groundwater abstractions from groundwater body	30
Groundwater body assessment	
Groundwater body water balance	Pass
Cumulative abstraction from groundwater body as a % of groundwater body recharge	5
Evidence of falling groundwater levels	n/a
Presence of saline (or other) intrusions	n/a
Impact on surface waterbodies	Pass
Impacting on supporting conditions of groundwater dependent terrestrial ecosystem(s)	n/a
Groundwater abstraction assessment outcome	Pass
River Water Body 1 (stream flow depletion)	
WFD environmental objective	Good
Number of known abstractions from waterbody and/or upstream in catchment	3
Number of known discharges to waterbody and/or upstream in catchment	3
River typology	B1
Step 1: Hydrological limits	
Q60 assessment	Pass
Q70 assessment	Fail
Q95 assessment	Fail
Step 2: Spatial analysis	
Total river channel length (km)	29.78
Impacted river channel length (km)	2.51
Percentage of river channel impacted	<15%
River waterbody assessment outcome (final)	Pass

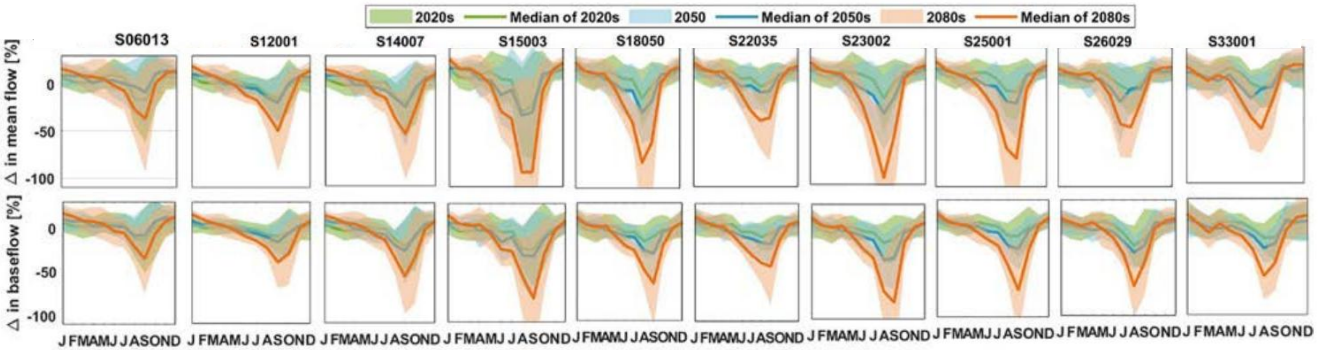
Using 466 m^3/d

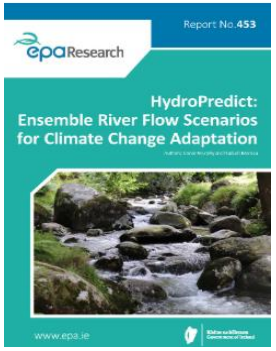
Abstraction not causing river to fail its environmental objective **(Step 2)**



What about climate change?

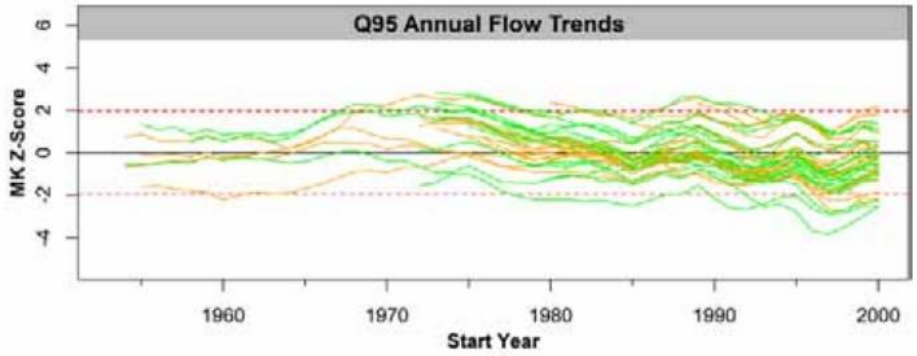
- Research 453: HydroPredict

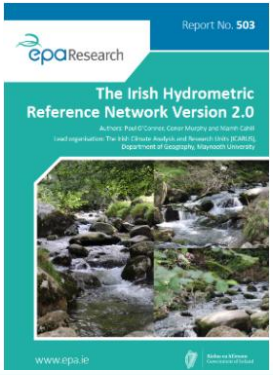




https://www.epa.ie/publications/research/climate-change/research-453-hydropredict-ensemble-river-flow-scenarios-for-climate-change-adaptation.php

- Research 503: The Irish Hydrometric Reference Network V. 2

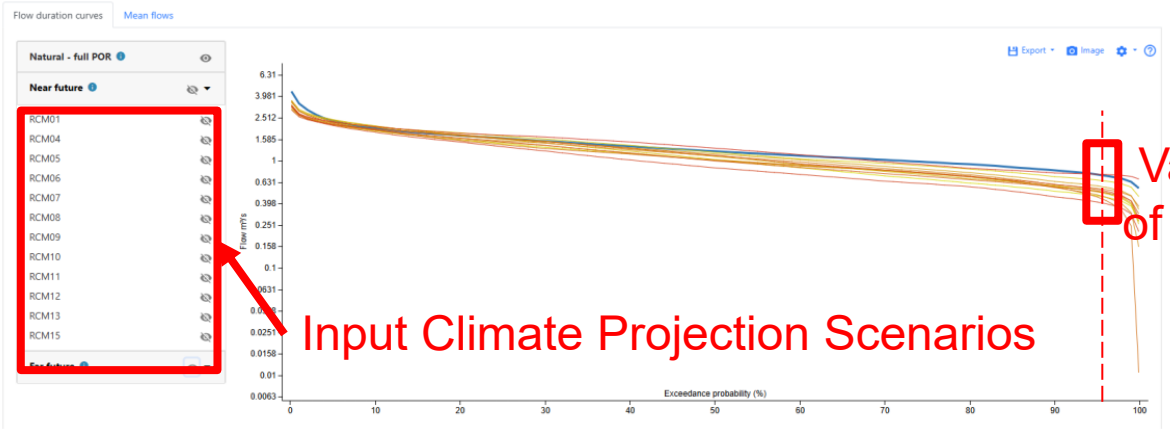


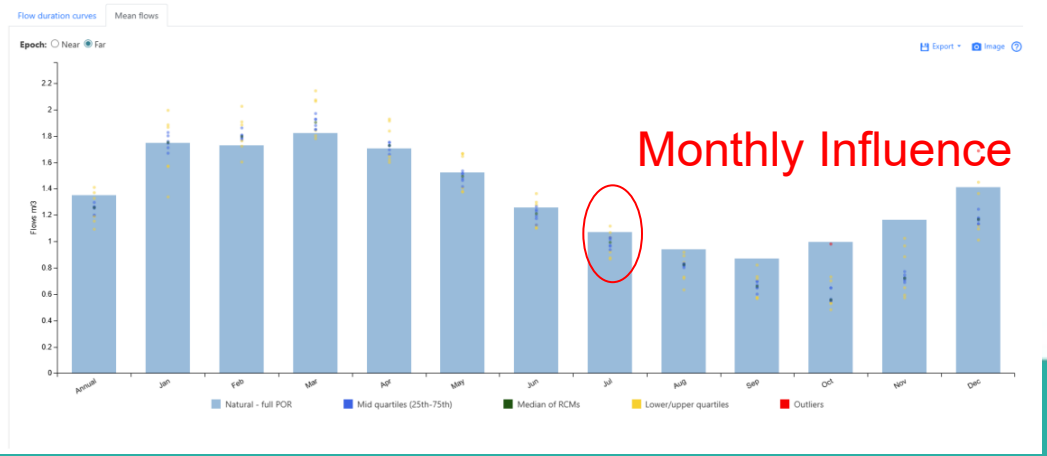


https://www.epa.ie/publications/research/climate-change/Research_Report-503.pdf

Incorporate climate knowledge in Integrated Water Resource Management

- Applying Climate Factors to Flow datasets (HydroTool / Qube model) – Due to complete Q4 2026.





Projected percentile flow (e.g. Q_{10}) for each Climate Projection Scenario

10 %	
Natural - full POR	1.999 m³/s
Far future - RCM01	1.887 m³/s
Far future - RCM04	2.059 m³/s
Far future - RCM05	2.107 m³/s
Far future - RCM06	2.097 m³/s
Far future - RCM07	2.047 m³/s
Far future - RCM08	1.911 m³/s
Far future - RCM09	1.948 m³/s
Far future - RCM10	1.933 m³/s
Far future - RCM11	1.924 m³/s
Far future - RCM12	1.975 m³/s
Far future - RCM13	1.84 m³/s
Far future - RCM15	2.072 m³/s

Photo: M. Craig