Sustainability and Groundwater

Implications of Implementation of the EU Water Framework (2000) and Groundwater (2006) Directives

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Arabic Proverb

Literally

"Into the well from which you drink do not throw stones"

[Care for the water upon which you depend]

"Sustainable Development"

- Is it an over-used, devalued term????
- Is it associated with prevention of development – a word of abuse for some!
- Hard to avoid the conclusion that there will be some sectoral pain if implemented
- What can we do?
  - Change the term? Not a practical option.
  - Communicate it's relevance and importance better? Yes.
  - But, are we in a position to do that convincingly????
  - If it means some pain, can you and I take the pain to start with and then convince others to do so?
- What is the role of the WFD and GWD?

Sustainability – a nice intellectual concept or one that applies to us personally??

- Recent past and now
  - Most of us are "comfortable".
  - We can fly away on holidays in beautiful, sunny areas – many of which have water problems.
  - We use our cars to go to the shop a few 10s to 100ms away.
  - We want cheap food.
  - We invariably flush the toilet after a pee.
  - Etc, etc.
  - So, how much has the concept impinged on us in our home/personal life?

Sustainability – a nice intellectual concept or one that applies to us personally??

- Now and immediate future
  - Sustainability as a concept/policy is "common sense" now at a time that we have the potential to damage and destroy the planet, and are causing damage, e.g climate change.
  - Let us not just sit here and discuss this as an intellectual exercise!
  - Or, regard it just as an opportunity for us and our organisations to get money/work.
  - We, as scientists/geologists/engineers, can look to and predict the future in a way others cannot.
  - My suggestion:
    - Let us all ask ourselves are we personally and our organisations doing enough?
    - Let us all not leave here later today without asking ourselves personally what we can do and what changes we might make, even though it might make us a bit less "comfortable".

Back to my comfort zone!!

- Will implementation of the WFD and GWD help in progressing sustainable development?
  - Undoubtedly, YES, YES, YES ……!
- Will it mean months and years of enjoyable, stimulating work for staff in public bodies and in consultancies?
  - Absolutely,
  - but also some "blood, sweat and tears".

The Two WFD and GWD Core Concepts

- Sustainability

- Integrated catchment management

Successful Implementation WFD & GWD

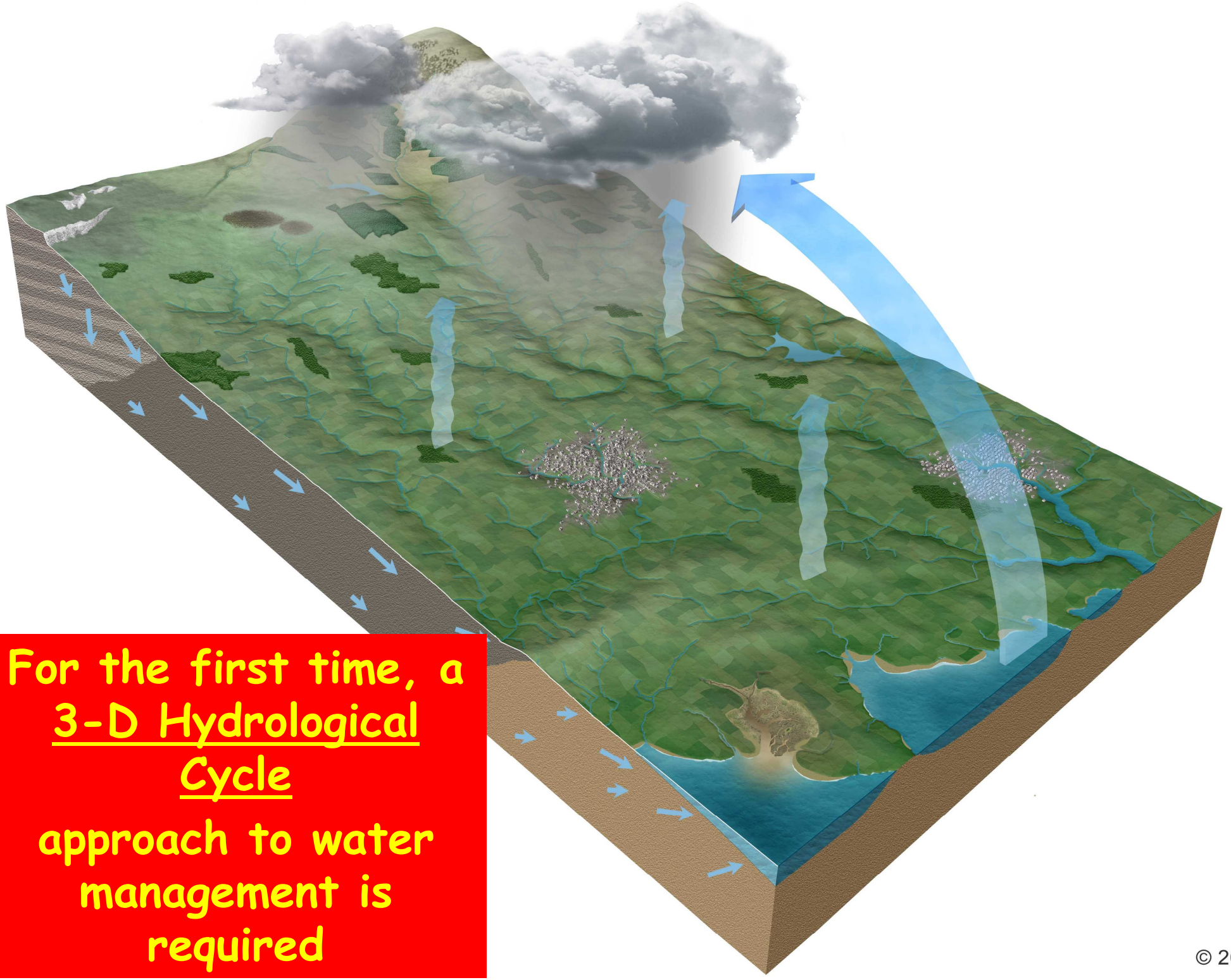
- Traditionally, study and management of water resources focussed on surface water & groundwater as separate entities

- Overall, this has been and is a recipe for failure!

Integration: a key concept underlying the Water Framework Directive

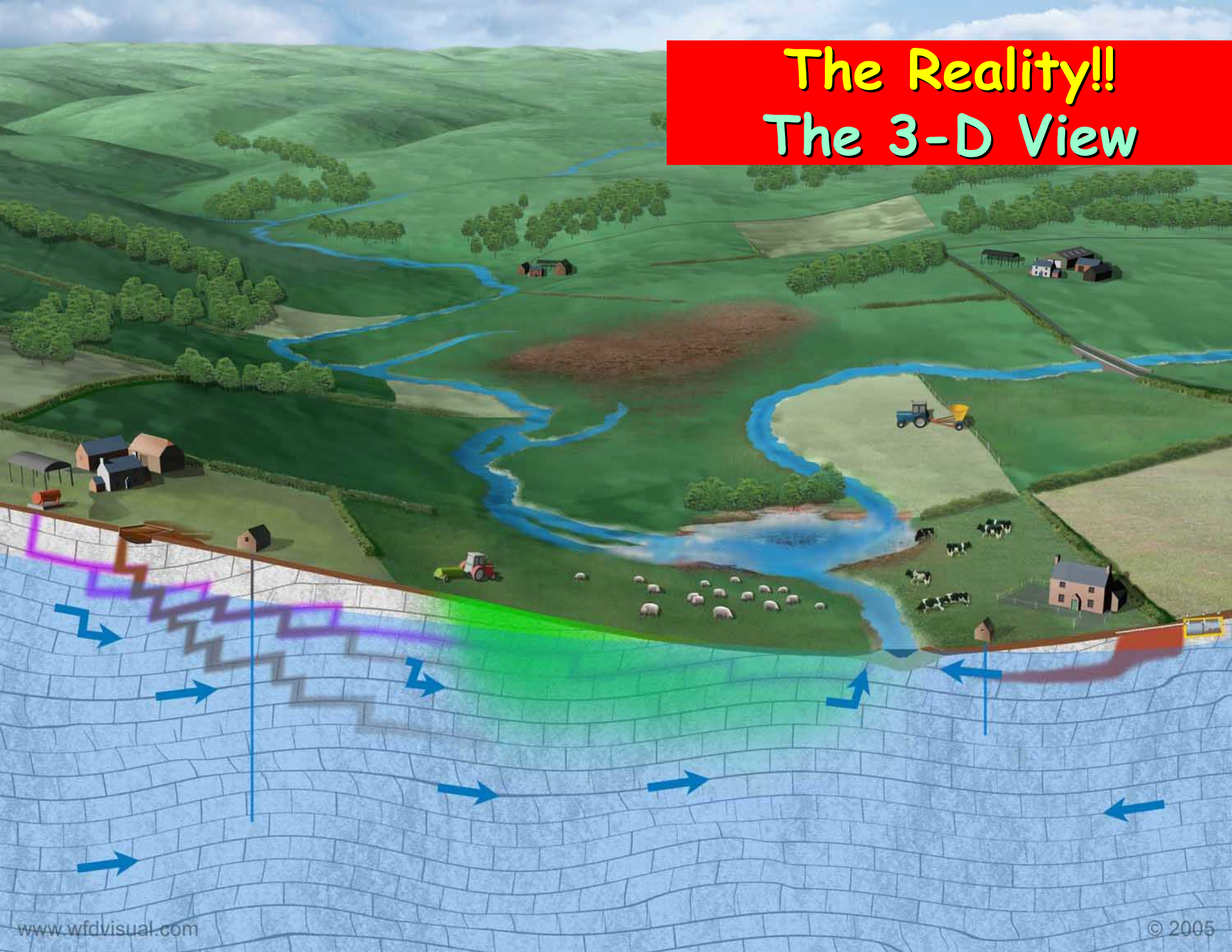
The central concept to the Water Framework Directive is the concept of *integration* that is seen as key to the management of water protection within the river basin district:

- **Integration of environmental objectives**, combining quality, ecological and quantity objectives for protecting highly valuable aquatic ecosystems and ensuring a general good status of other waters;
- **Integration of all water resources**, combining fresh surface water and groundwater bodies, wetlands, coastal water resources **at the river basin scale**;
- **Integration of all water uses, functions and values** into a common policy framework, i.e. investigating water for the environment, water for health and human consumption, water for economic sectors, transport, leisure, water as a social good;
- **Integration of disciplines, analyses and expertise,** combining hydrology, hydraulics, ecology, chemistry, soil sciences, technology engineering and economics to assess current pressures and impacts on water resources and identify measures for achieving the environmental objectives of the Directive in the most cost-effective manner;
- **Integration of water legislation into a common and coherent framework.** The requirements of some old water legislation (e.g. the Fishwater Directive) have been reformulated in the Water Framework Directive to meet modern ecological thinking. After a transitional period, these old Directives will be repealed. Other pieces of legislation (e.g. the Nitrates Directive and the Urban Wastewater Treatment Directive) must be co-ordinated in river basin management plans where they form the basis of the programmes of measures;
- **Integration of all significant management and ecological aspects** relevant to sustainable river basin planning including those which are beyond the scope of the Water Framework Directive such as flood protection and prevention;
- **Integration of a wide range of measures, including pricing and economic and financial instruments, in a common management approach** for achieving the environmental objectives of the Directive. Programmes of measures are defined in **River Basin Management Plans** developed for each river basin district;
- **Integration of stakeholders and the civil society in decision making,** by promoting transparency and information to the public, and by offering an unique opportunity for involving stakeholders in the development of river basin management plans;
- **Integration of different decision-making levels that influence water resources and water status,** be local, regional or national, for an effective management of all waters;
- **Integration of water management from different Member States,** for river



For the first time, a 3-D Hydrological Cycle approach to water management is required

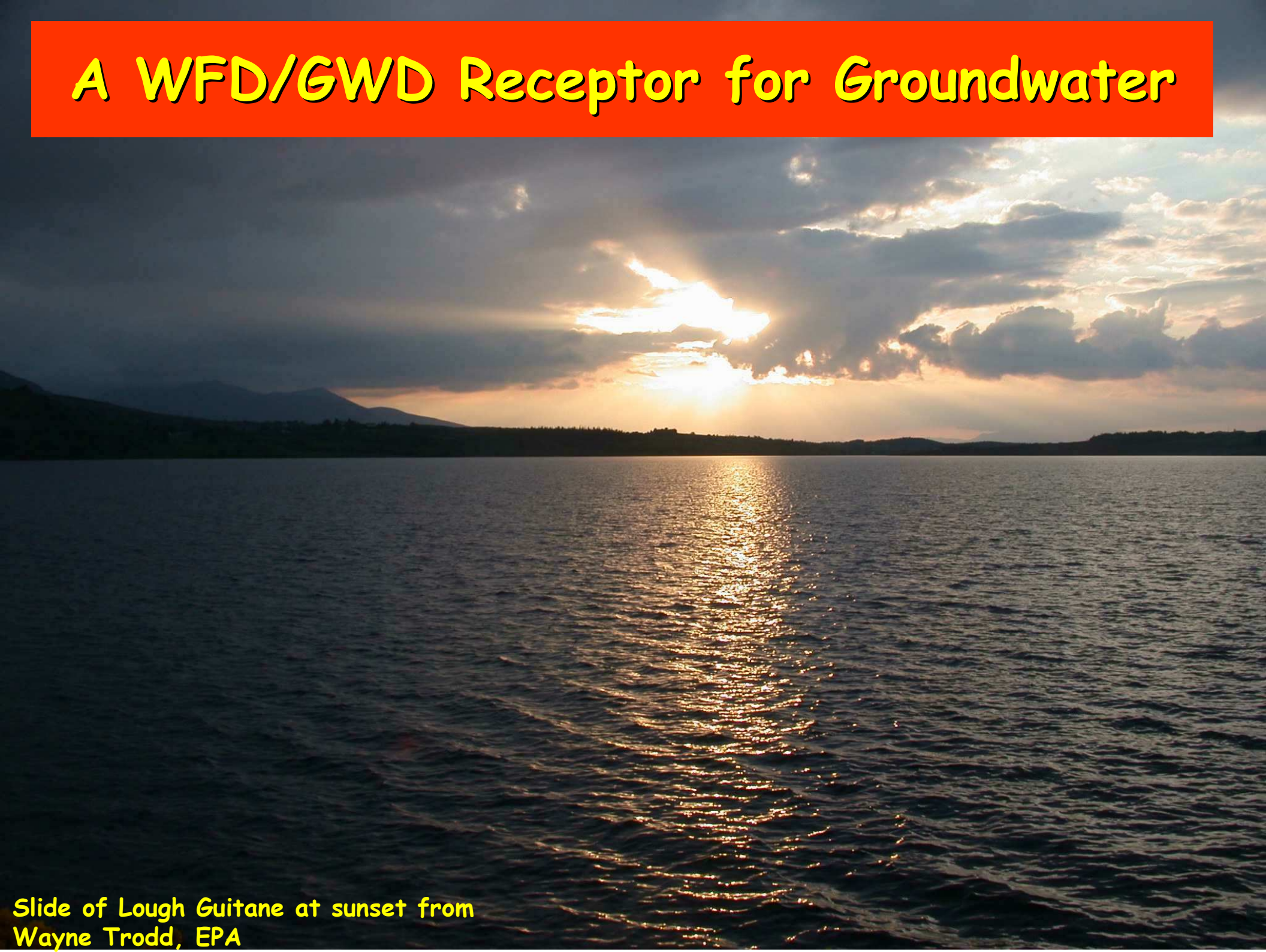
The 2-D view of the world!!


The Reality!!
The 3-D View
www.wfdvisual.com
© 2005

What does this mean?

- Multiple receptors
- In particular, seeing groundwater in terms of ecologically oriented objectives
  - Surface water ecosystems
  - Groundwater dependent terrestrial ecosystems (GWDTEs)

A WFD/GWD Receptor for Groundwater

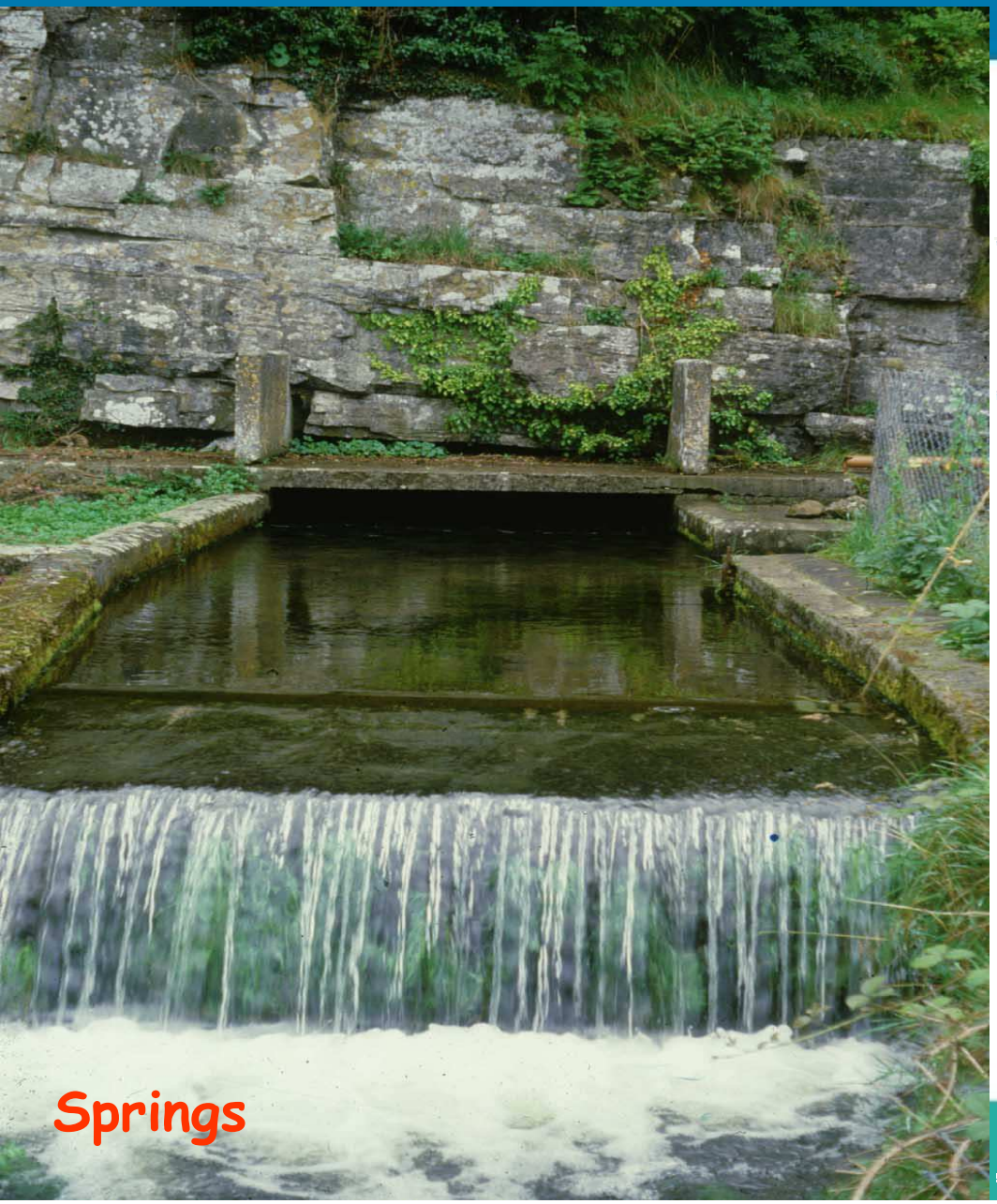


Slide of Lough Guitane at sunset from Wayne Trodd, EPA

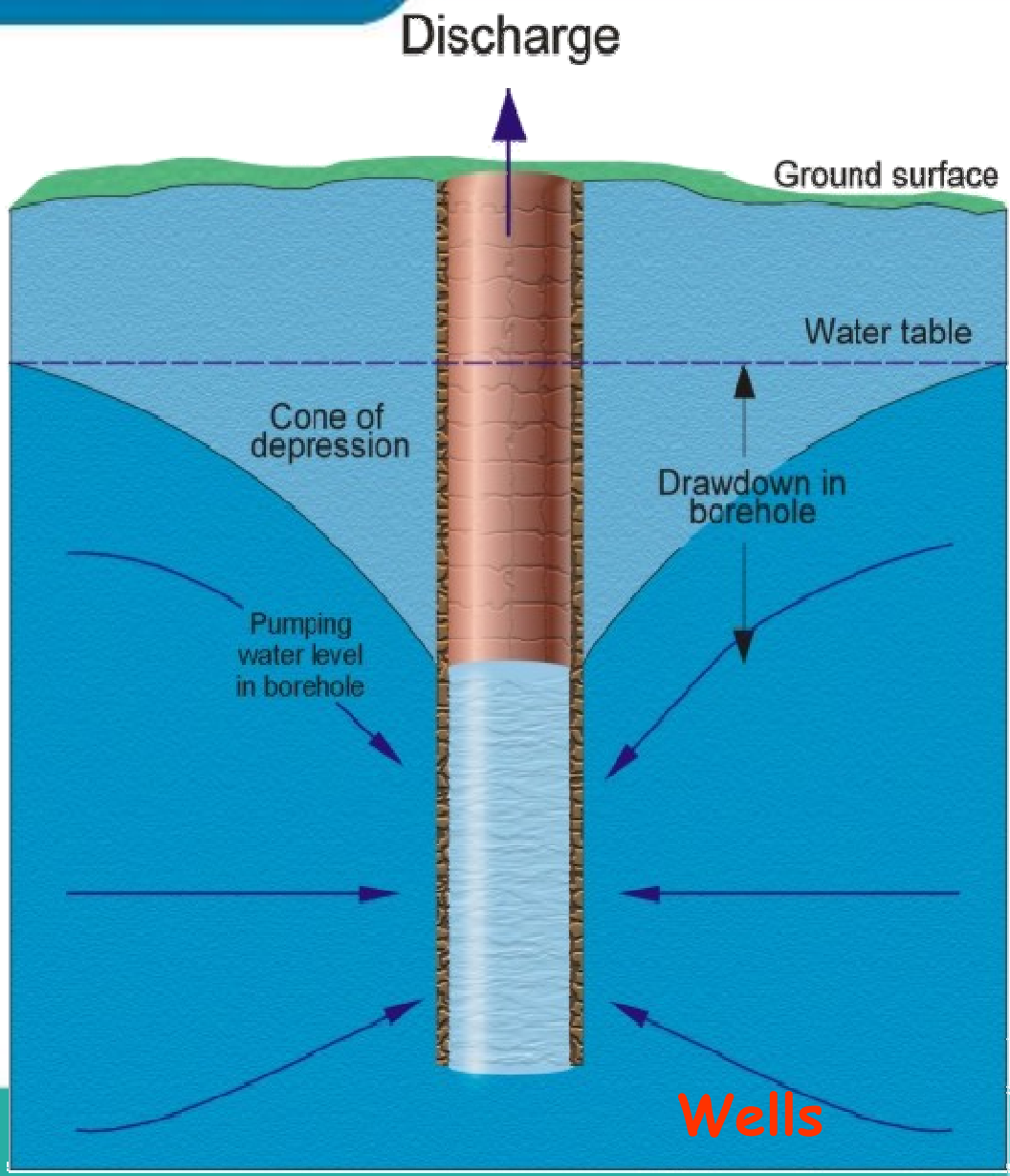
Pollardstown Fen - a GWDTE

A Groundwater Dependent Ecosystem (GWDTE)

Other WFD/GWD Receptors

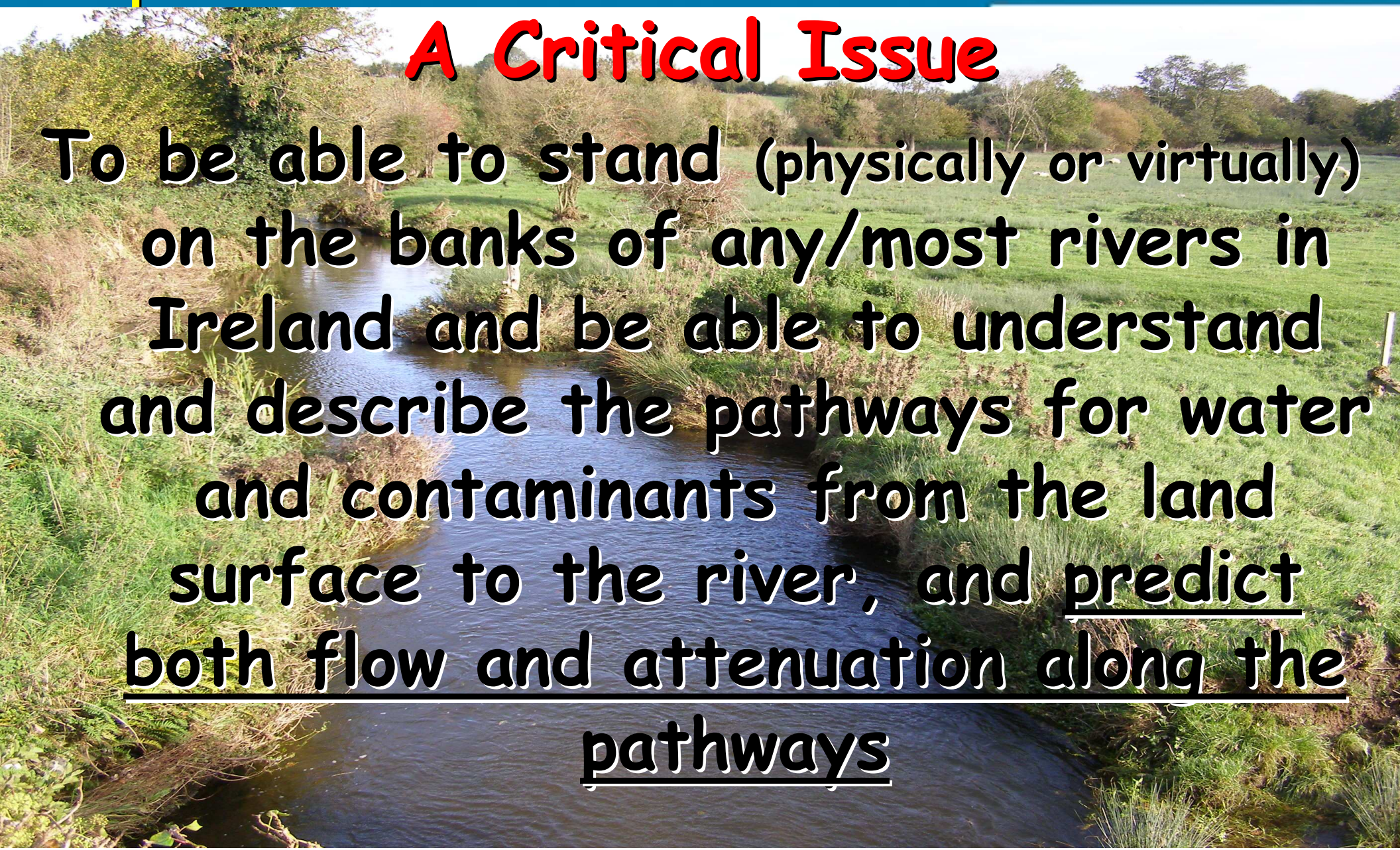


Springs



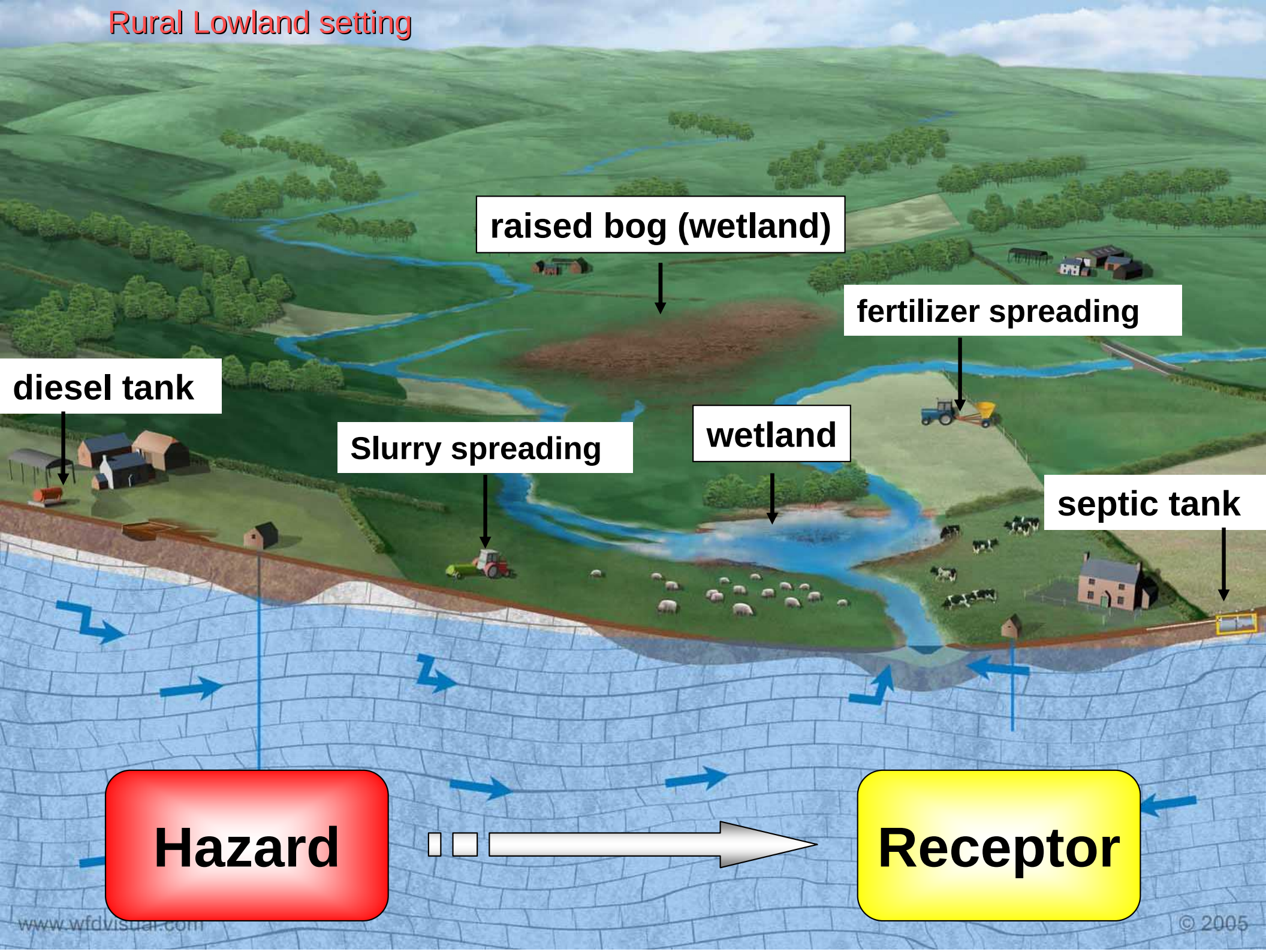
Wells

Arguably, the most important receptor



A Critical Issue

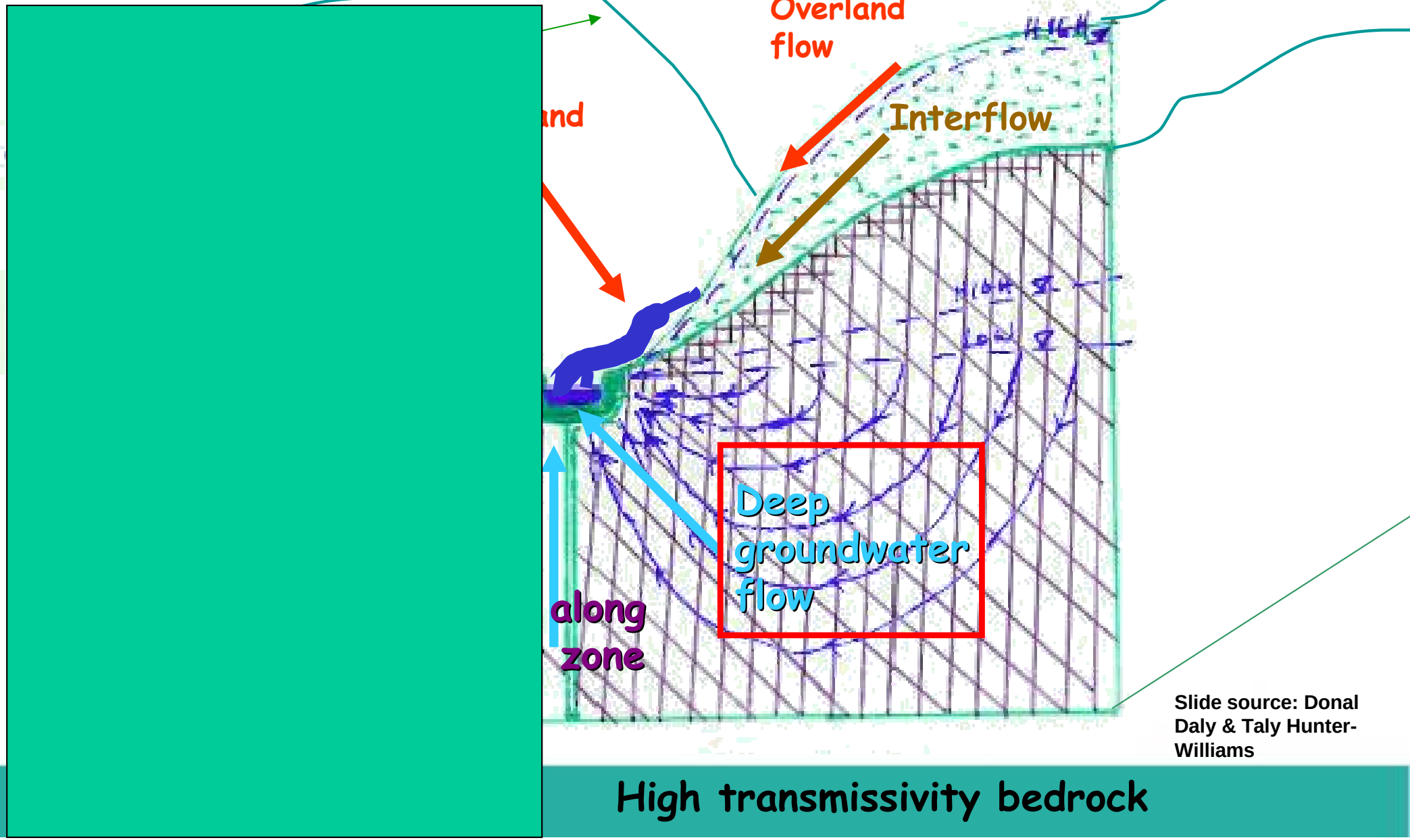
To be able to stand (physically or virtually) on the banks of any/most rivers in Ireland and be able to understand and describe the pathways for water and contaminants from the land surface to the river, and predict both flow and attenuation along the pathways


Rural Lowland setting
raised bog (wetland)
fertilizer spreading
diesel tank
Slurry spreading
wetland
septic tank
Hazard
Receptor
www.wfdvisual.com
© 2005

What does this mean?

- Thinking of "water" and not just "groundwater".
- Multidisciplinary approaches
- "Thinking outside the box"
- Thinking in terms of relevant "pathways" for water.
- Thinking of "environmental supporting conditions" for ecosystems.
- Dropping our "comfort blanket" of "GROUNDWATER"
- Slightly …….!!!!
- This will be a challenge for geoscientists.

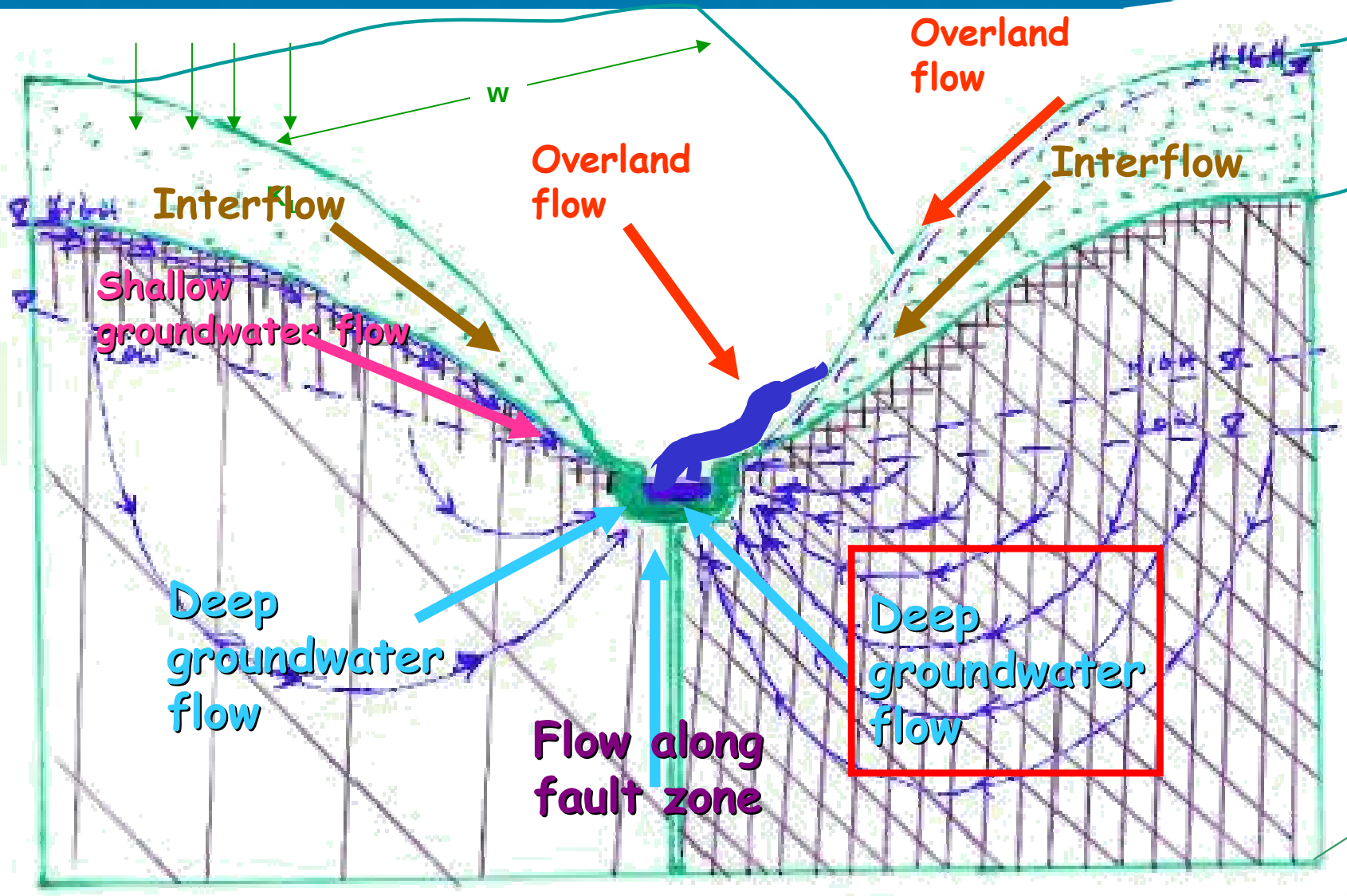
Potentially five flow pathways to Rivers



Slide source: Donal Daly & Taly Hunter-Williams

High transmissivity bedrock

Potentially five flow pathways to Rivers

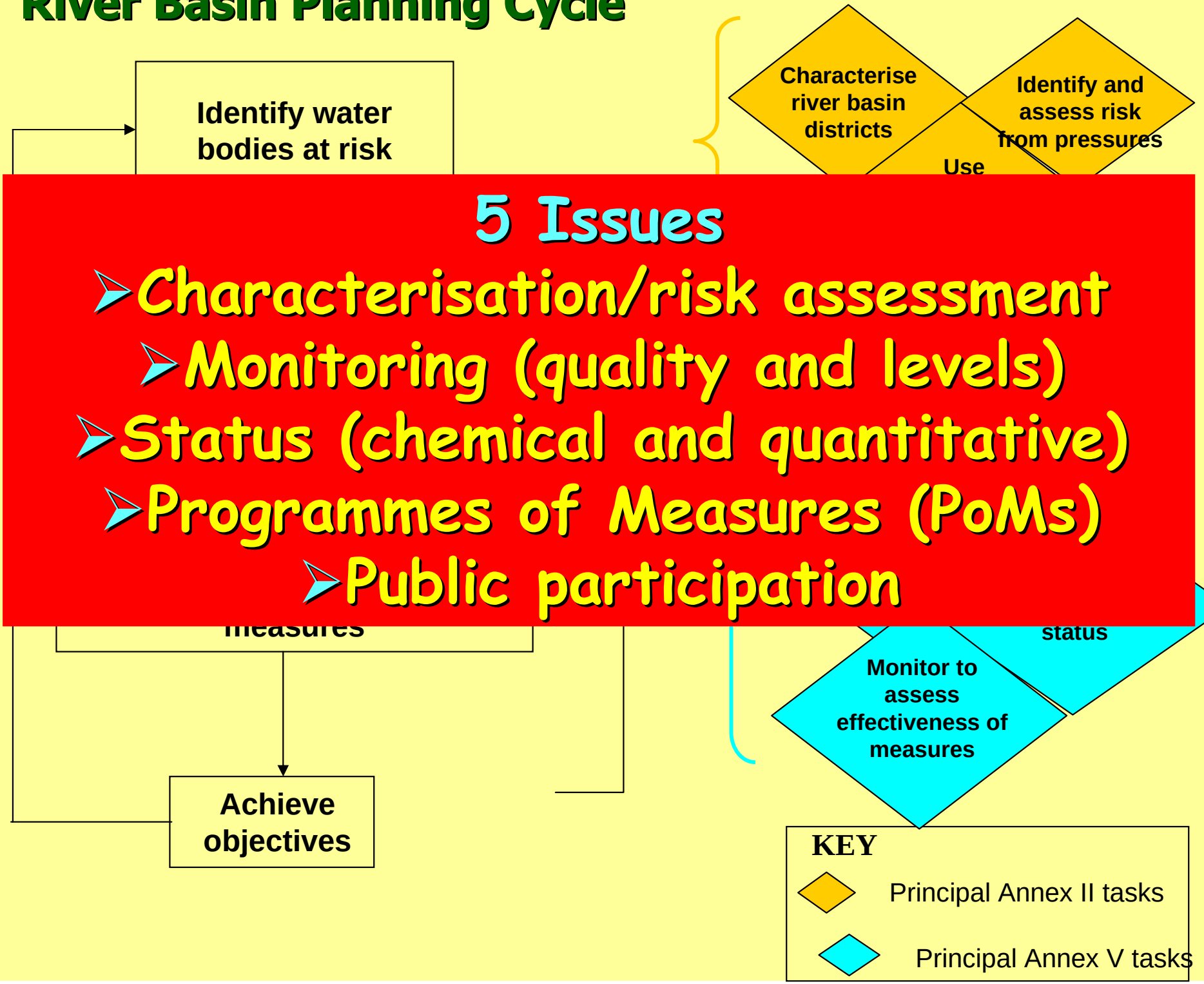


Slide source: Donal Daly & Taly Hunter-Williams

Low transmissivity bedrock

High transmissivity bedrock

River Basin Planning Cycle



5 Issues

- Characterisation/risk assessment
- Monitoring (quality and levels)
- Status (chemical and quantitative)
- Programmes of Measures (PoMs)
- Public participation

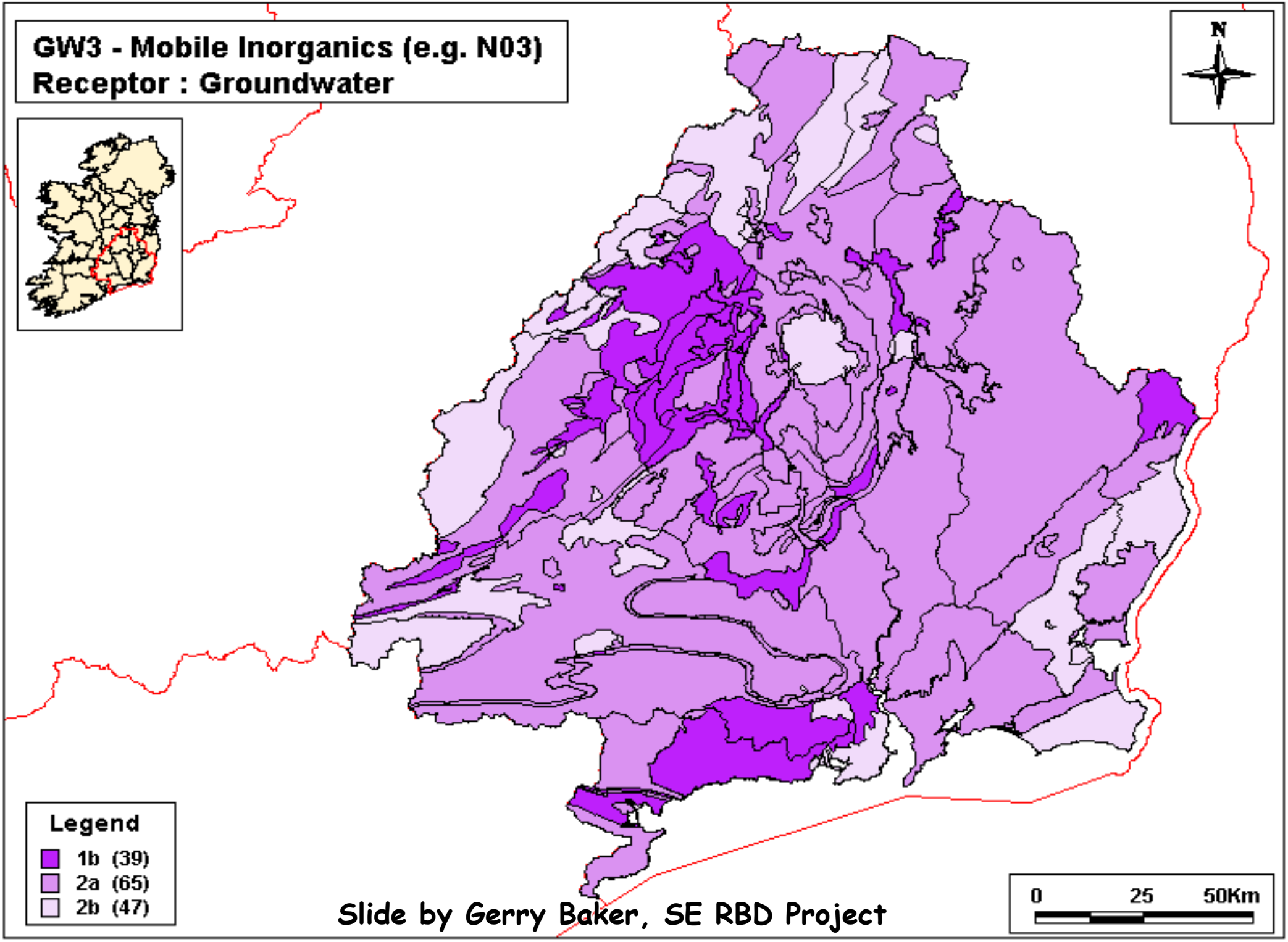
Characterisation/risk assessments

- 1st phase completed and reported to the EU in 2005
- Good quality geoscientific information and maps essential to good decision-making and sustainability
- Characterisation process has helped provide this:
  - National digital bedrock map (www.gsi.ie)
  - National aquifer map (www.gsi.ie)
  - National Teagasc soils and subsoils maps (www.epa.ie)
  - Subsoils permeability maps (mainly GSI)
  - Vulnerability maps (GSI and RBD consultants)
  - Recharge map (will be available soon on EPA website)
- In a co-operative way, we have made enormous progress.

Risk characterisation

Groundwater Bodies Affected by Diffuse Source Pollution

Reporting category	No. of GWBs	% of number	% area of country
At risk	0	0	0
Probably at risk	281	37.1	24.6
Probably not at risk	199	26.3	37.1
Not at risk	277	36.6	38.3
"at risk"	279	37.1	24.6


GW3 - Mobile Inorganics (e.g. N03)
Receptor : Groundwater
N
Legend
1b (39)
2a (65)
2b (47)
0
25
50Km
Slide by Gerry Baker, SE RBD Project

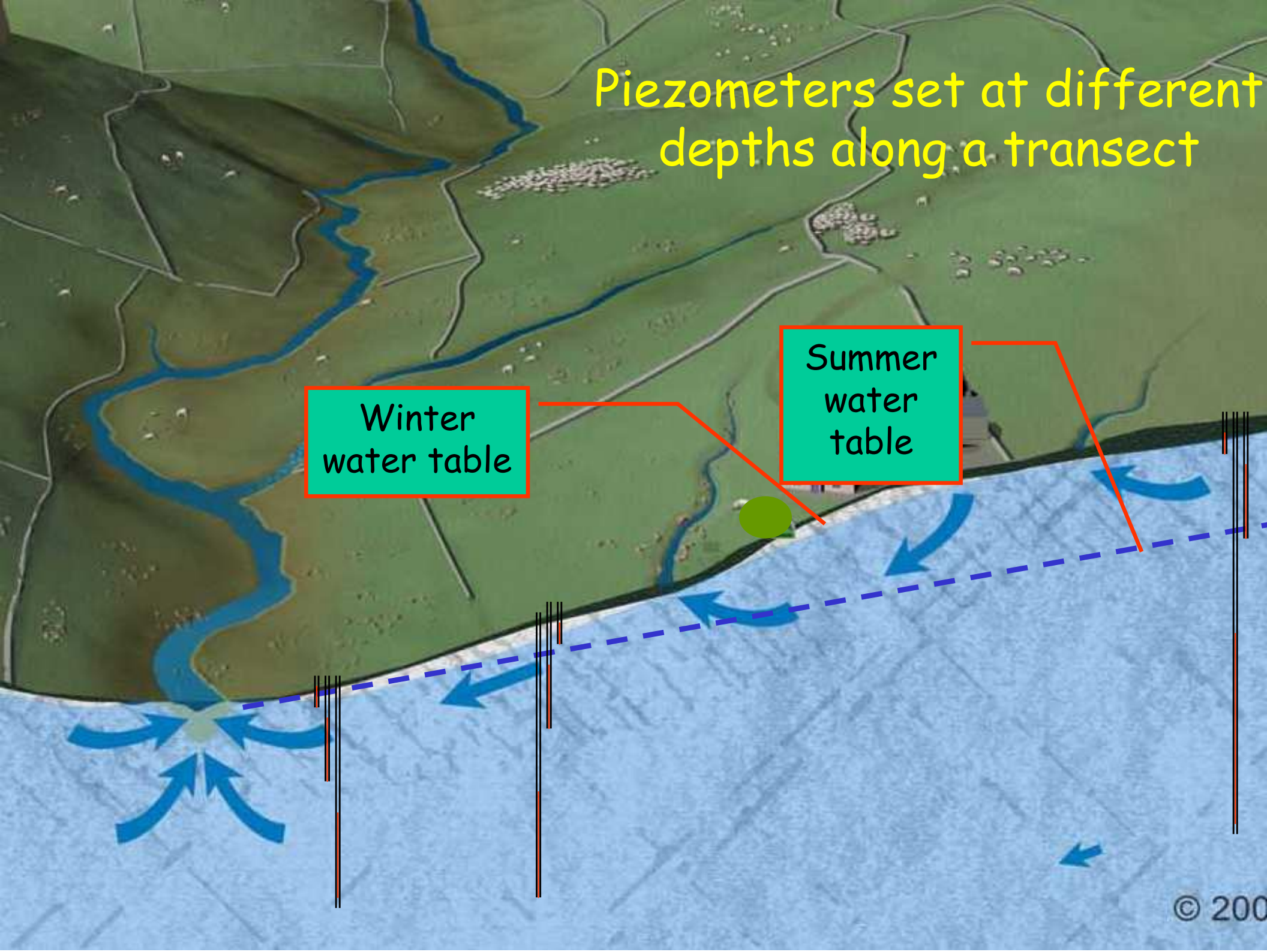
Monitoring

- 2007
  - 222 sources sampled monthly since July; 140 analysed for pesticides
  - 85 sites in national network; dipped monthly; data loggers to be installed before end of year
- 2008

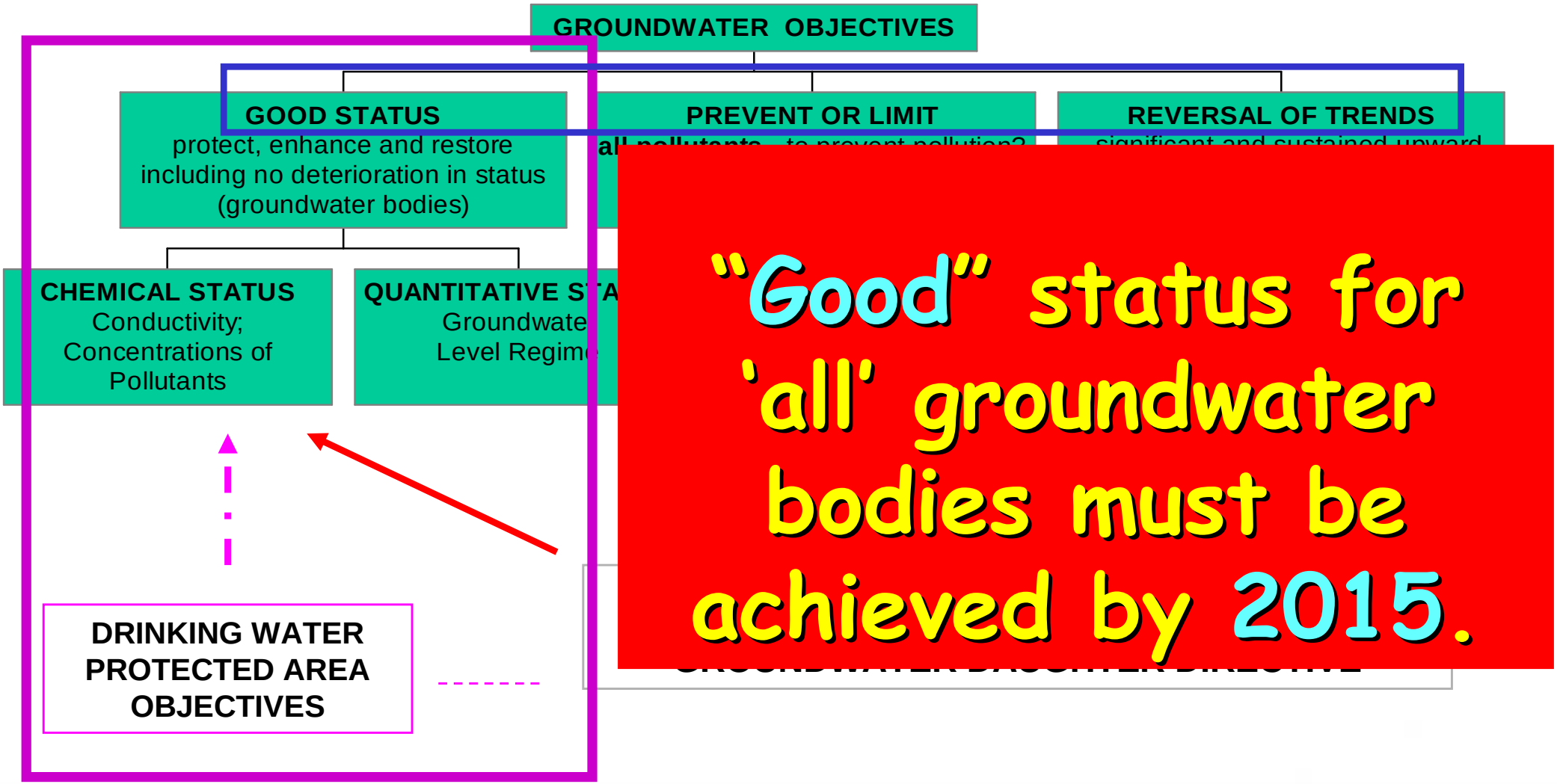
Predicted expenditure by EPA (DEHLG) in 2007 and 2008 = €4 million.

  - Emphasis on poorly productive aquifers

- 9 catchments in poorly productive scenarios chosen
- 9-12 piezometers to be installed in each catchment

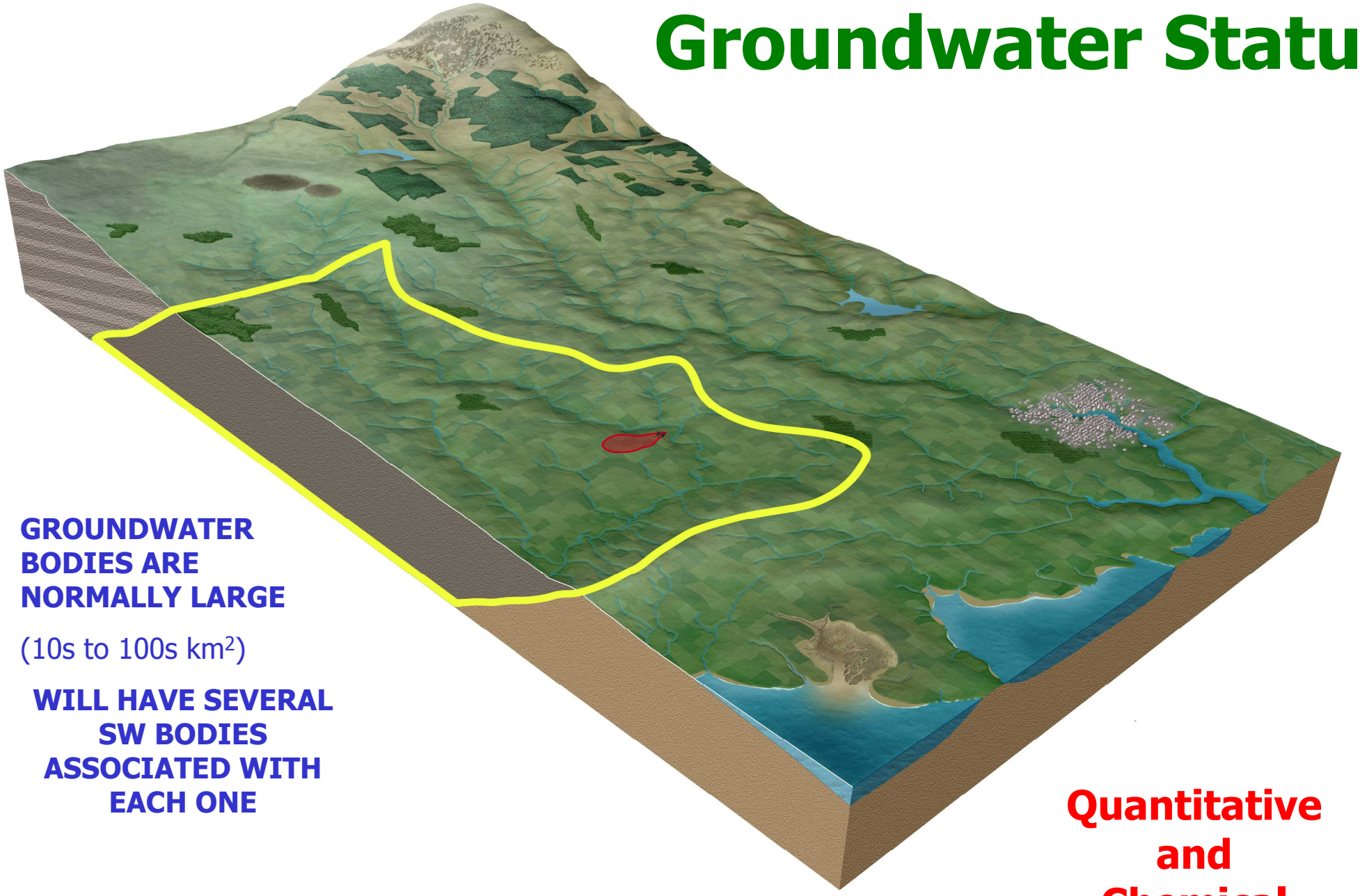

Piezometers set at different depths along a transect
Winter water table
Summer water table
© 200

Protection of Groundwater in the WFD & GWDD



"Good" status for 'all' groundwater bodies must be achieved by 2015.

Groundwater Status



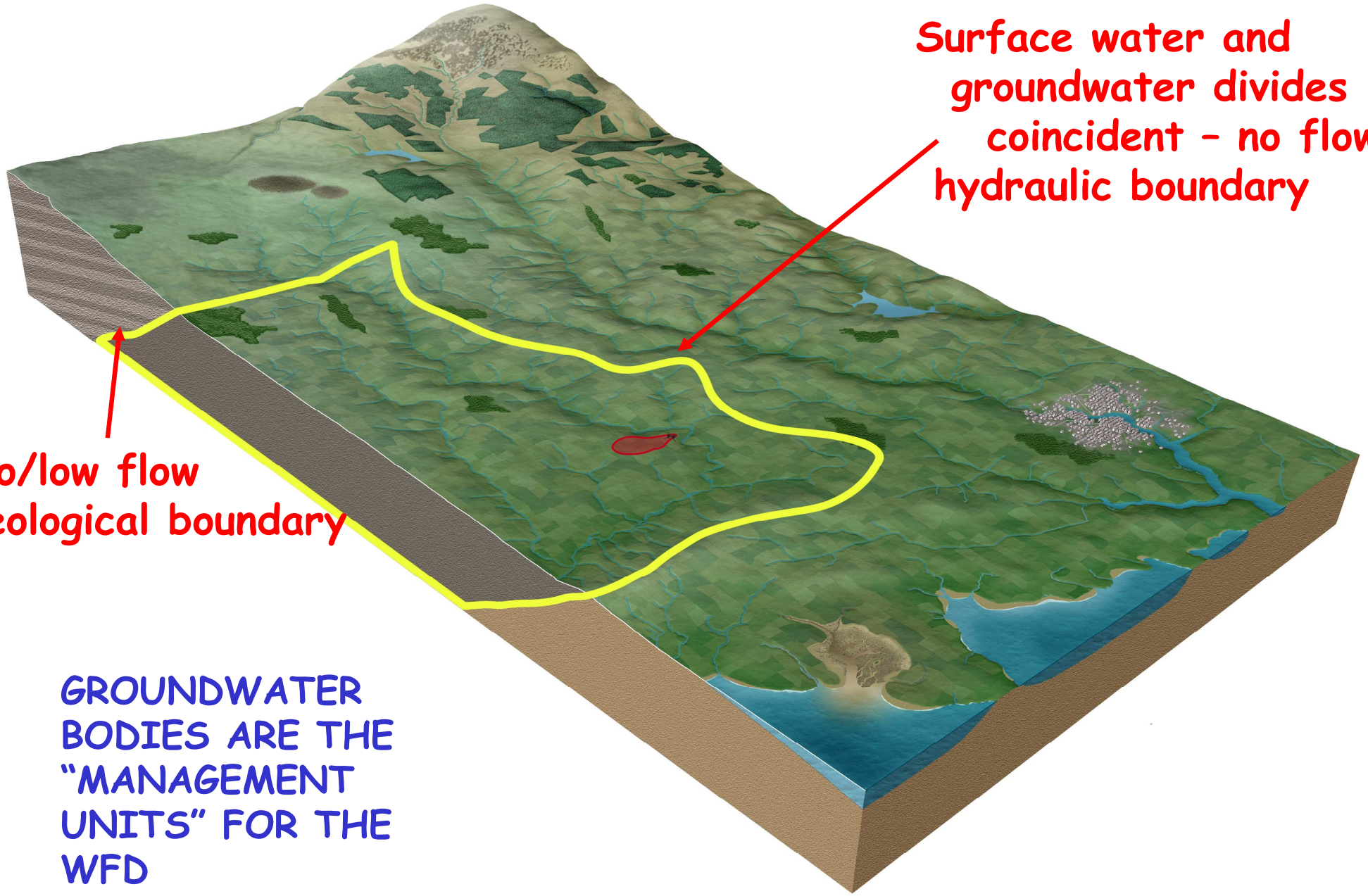
GROUNDWATER BODIES ARE NORMALLY LARGE

(10s to 100s km^2)

WILL HAVE SEVERAL SW BODIES ASSOCIATED WITH EACH ONE

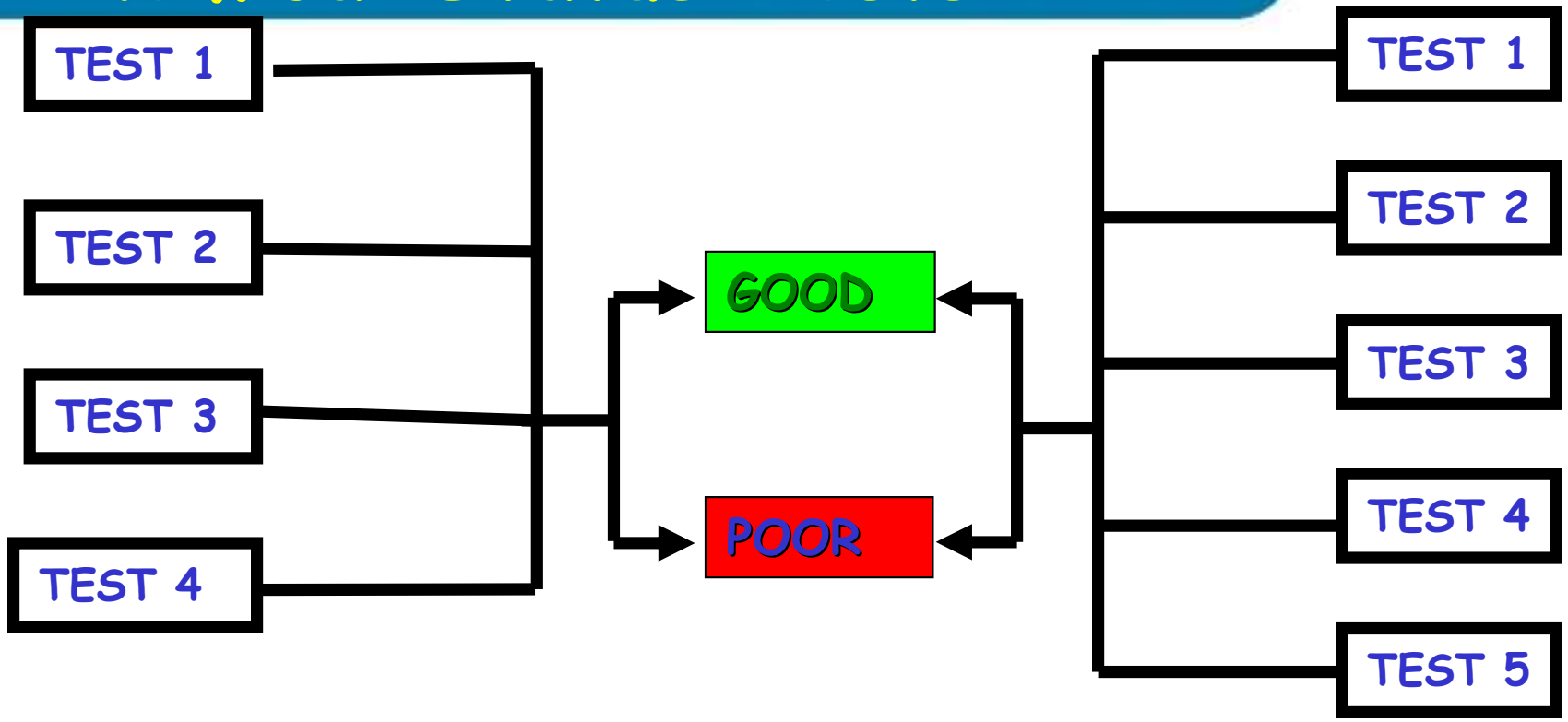
Quantitative and Chemical Status

Groundwater Bodies – 757 in RoI



GROUNDWATER BODIES ARE THE "MANAGEMENT UNITS" FOR THE WFD

Combination of Quantitative & Chemical Status Tests



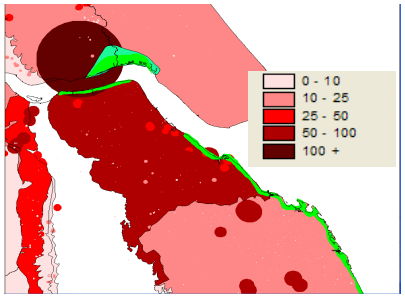
The results of each test will need to be combined for overall classification of POOR or GOOD STATUS for both quantitative and chemical status. The worst result will be reported for the body.

The Four Quantitative Tests

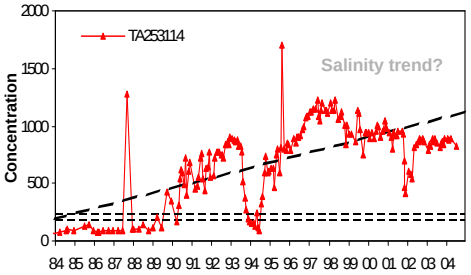
impacts on the GW body

impacts on dependent receptors

1. GWABS as % recharge



2. saline or other intrusions



3. SW body ecological status

4. GW dependent wetlands

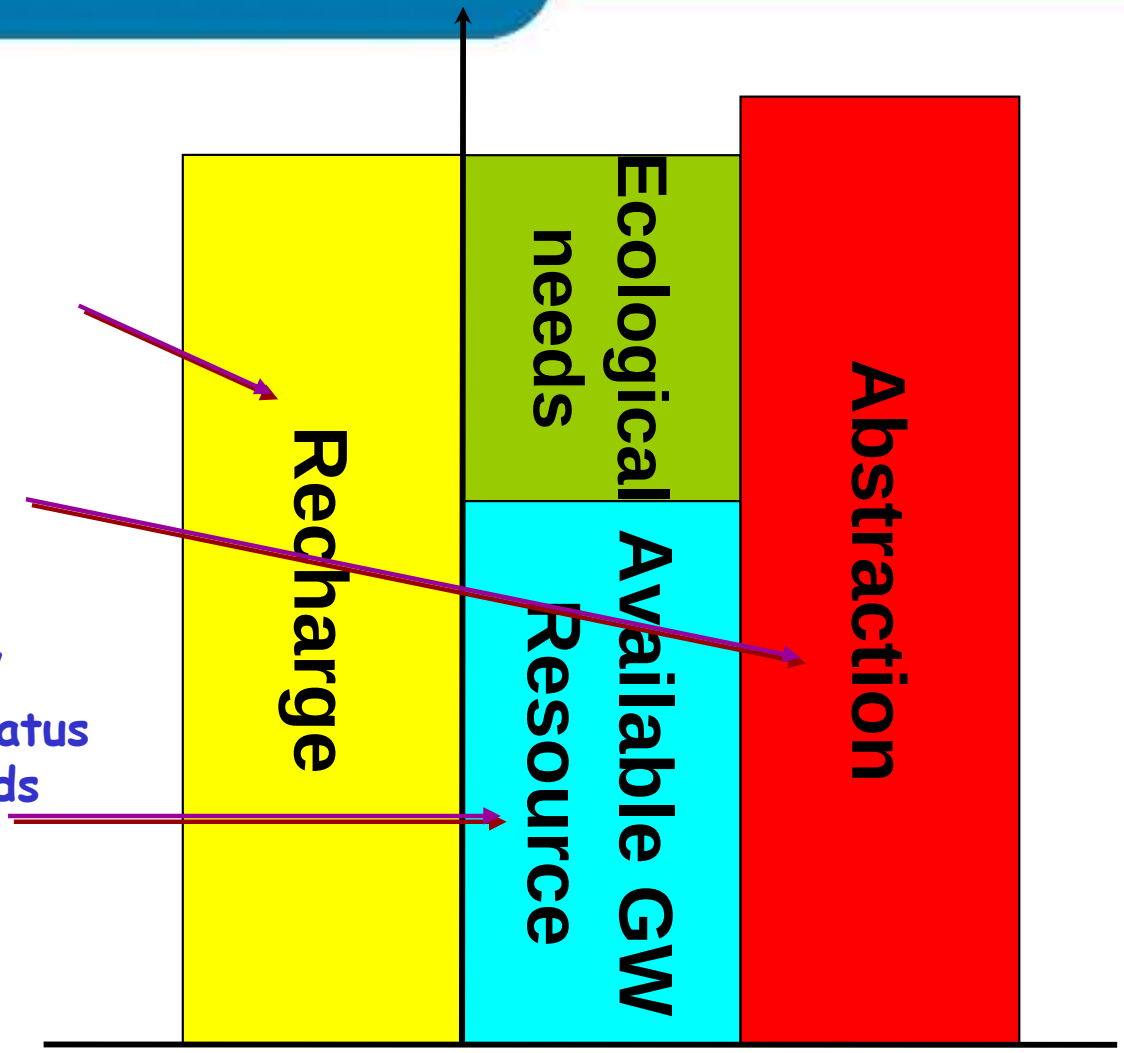
IF caused by GW Abstractions

GW quantity status

Water Balance Test

- Determine the long-term annual average recharge to the groundwater body and subtract the long-term annual average abstraction.

- Key point - Need to ensure GW status is consistent with SW status tests. Therefore ecological needs are assessed in separate test.



SW Test

Issue:

What low flow requirement is needed to support Good Ecological Status of Rivers (& Lakes)?

- If "yes", is GW abstraction significant in terms of the problem? Test of significance: If GW abstractions removed, would hydrological standards be met? Yes = poor status

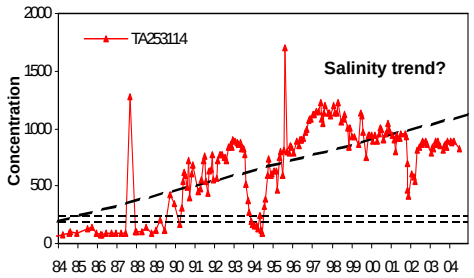
What is Good Chemical Status?

- The conditions in the WFD (Annex V 2.3.2):
  - no saline intrusions
  - don't exceed applicable quality standards (but GWDD allows 'appropriate investigation' for final decision)
  - no "impacts" on SW chemistry or ecology
  - no significant damage to wetlands
- GWDD adds the following:
  - requirements for Drinking Water Protected Areas (DWPAs) are being met
  - ability of the body to support "human uses" has not been significantly impaired by pollution.

The Five Chemical Tests

impacts on the GW body

1. Saline or other intrusions



4. Drinking Water Protected Areas

5. General Chemical Assessment

impacts on dependent receptors

2. SW body chemical & ecological status

3. GW dependent terrestrial ecosystems

GW chemical status

How do we assess Status?

- Have to use:
  - Groundwater Quality Standards from GWDD (Nitrates & Pesticides)
  - Threshold Values (TVs) to be established by MS by Dec 2008 (at national, RBD, or local level)
  - TVs are trigger values that prompt further investigation, rather than representing the boundary between good and poor status
  - NB: TVs only need to be set for those substances identified under

No "simple" "cookbook" approach.
Threshold values (TVs) do not map directly to status categories

General Assessment of Quality

- Key concept: Assessment of widescale problems
  - significance assessed from magnitude and areal extent of problem.
  - Only for nitrates, pesticides + other pollutants related to risk
- Threshold Values: % of the EU prescribed standards for nitrates and pesticides or a use-related standard
  - Default = 75% of standard
- The conditions for good chemical status are not met when:
  - Single site exceeds TV
  - Investigate = perform aggregation.
  - Aggregation exceeds TV = poor status.
  - Confirm / confidence = statistics + indication of problems (abandoned wells, etc)

Procedure

- TVs at individual MPs used.
  - TV = % of standard for nitrate and pesticides. For other pollutants, the higher of (1) upper limit of natural background range; or (2) an appropriate % of the standard
- If monitoring data exceed TV, carry out further investigation
- Good conceptual model of hydrogeology needed.
- GWB subdivided based on land use pressure, gw vulnerability and gw flow type (representative areas)
- Area-weighted aggregation of data undertaken using representative areas:

$$\text{Weighted value} = \frac{\text{area1 x mean conc + area2 x mean conc + area 3 x mean conc +...}}{\text{Total area of all representative areas in the GWB}}$$

- If aggregated result > appropriate % of use based standard, then GWB will be at poor status

No Significant Diminution of SW Chemistry and Ecology Test

- **Key concept:** SW classification & chemical inputs from GW bodies into SW bodies. **Is contribution from groundwater sufficient to threaten the WFD objectives for associated water bodies?**
- **Threshold Values:** SW quality standards adjusted by baseflow dilution and, where appropriate, attenuation factors.
- **The conditions for good chemical status are <u>not met</u> when:**
  - **TVs exceeded +**
  - **'less than good' status surface water body +**
  - **GW inputs ≥ 50% surface water EQS** **(This will require a 'tricky', 'careful' hydrogeological evaluation)**

Relevant pollutants

- Based on pollutants that cause river/lake WBs to
- s
- st
- Anything else?? What about nitrate????? Do we need to take account of transitional waters?

Bottom Line

This test depends on information and results from surface water (river & lake &? transitional waters) EQSs and classification

Procedure

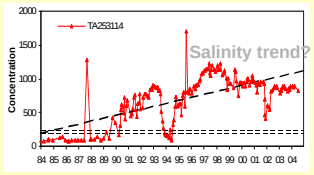
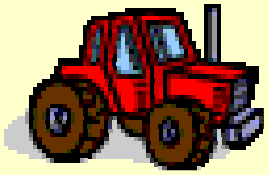
- Is SWB "at risk"? If yes, proceed …..
- Check that natural background levels not causing problems.
- Threshold value (TV) the higher of:
  - Upper limit of natural background
  - A surface water EQS, adjusted by dilution & attenuation to allow for the % contribution of GW to SW, and attenuation in the aquifer & stream sediments.
    - Effectively TV = SW EQS/Dilution factor (range 0.1-0.9)
    - Example – MRP: TV = 50/0.75 = 66 µg P/l for good status SWBs
      - If GWDTE EQS = 20, then TV = 26 µg P/l

Procedure

- Six-year averages from MPs aggregated across the GWB
- iform,
- gw
- This gives an estimate of the concs in SW due to GW
- This predicted SW conc is then compared with the SW EQS.
- If the contribution from GW is >50% of the EQS, the GWB (as well as SWB) is classed as poor status
- Therefore PoM has to cover GW (as well as SWB)

A Vital Requirement!!

A representative monitoring network

	Screening Values	Threshold Values
	Upper limit of natural background	As screening values but used in conjunction with trend assessment
	EQS with a check against background	EQS/Dilution factor or Upper limit of natural background
	To be determined	To be determined
	Appropriate % of DWS or other DWD requirement	Appropriate % of DWS used in conjunction with trend assessment
	At individual monitoring points: NO_3: 25 mg/l Pest: 0.05 ug/l (individ) 0.25 ug/l (total) Other subst – upper limit of natural background range or LOD	At individual monitoring points: Appropriate % of standard NO_3: 75% of 50mg/l = 37.5 Pesticides: 0.1ug/l (individ) = 0.075 Other subst – upper limit of natural background range or LOD Then Weighted Aggregate across GWB to investigate

Indicators of potential anthropogenic impact

Trigger further investigation to confirm whether the conditions for good chemical status have been met

Programmes of Measures (PoMs)

- Measures needed to bring poor status GWBs to good by 2015 and maintain good status GWBs
- Monitoring + status = "blood and sweat" elements, but interesting work!
- PoMs = "tears" and more greying/hair loss
- Sectoral pain!!!!!
- Achieving the WFD objectives (status, prevent & limit, reversal of trends) and implementing the PoMs → → "sustainable development"

Public Participation

We need high quality, accessible information so as to engage, discuss and explain what is happening, what measures are needed and why.

What does the future hold for Ella?

Will she love nature?

Will she enjoy biodiversity?

Will see glaciers in the Alps?

Will she have access to clean water??

Will she count on an affordable energy supply?

Will she experience the richness of ecosystems around the world?

Will she have the possibility to pass on a healthy environment to her children?

<u>Will she be able to fulfill her dreams?</u>

Ella, European citizen from Ireland, born on the 12th January 2006

Slide concept from: The JRC Institute for Environment and Sustainability