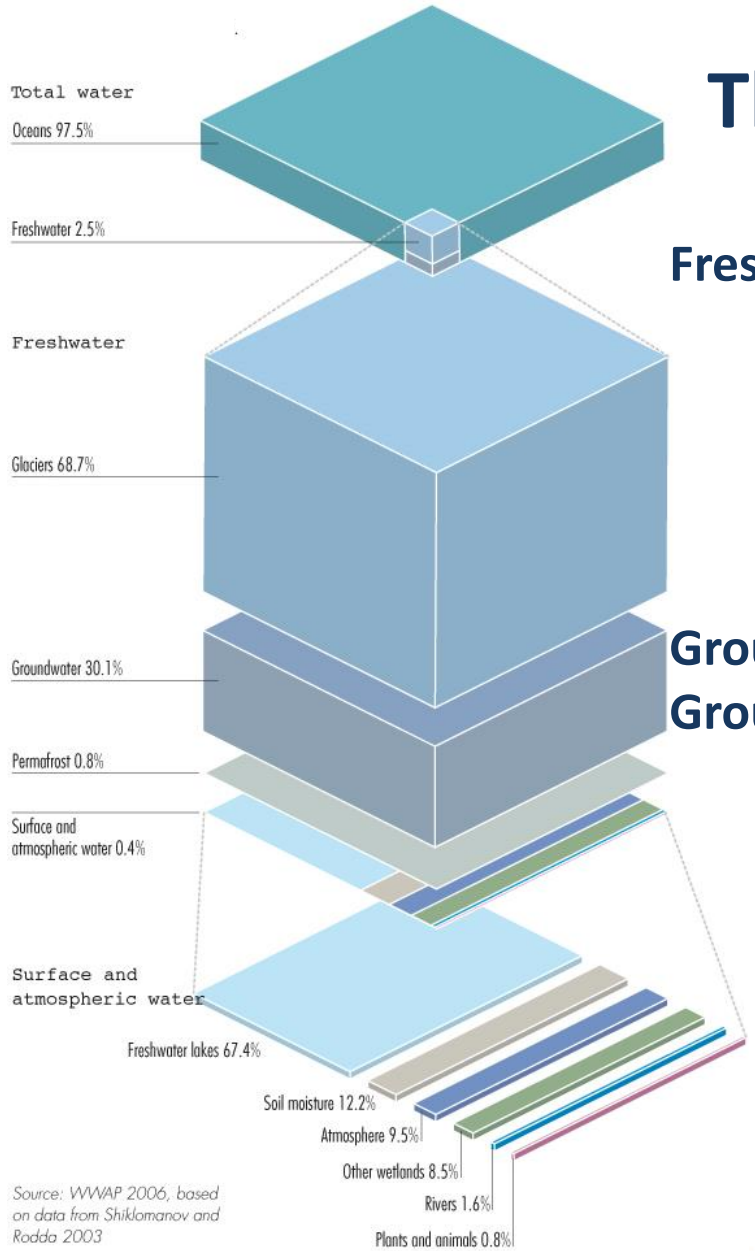
Groundwater
"Out of sight, out of mind?"
Let's explore the water table!

UK Groundwater Forum

Contents

The World's Water

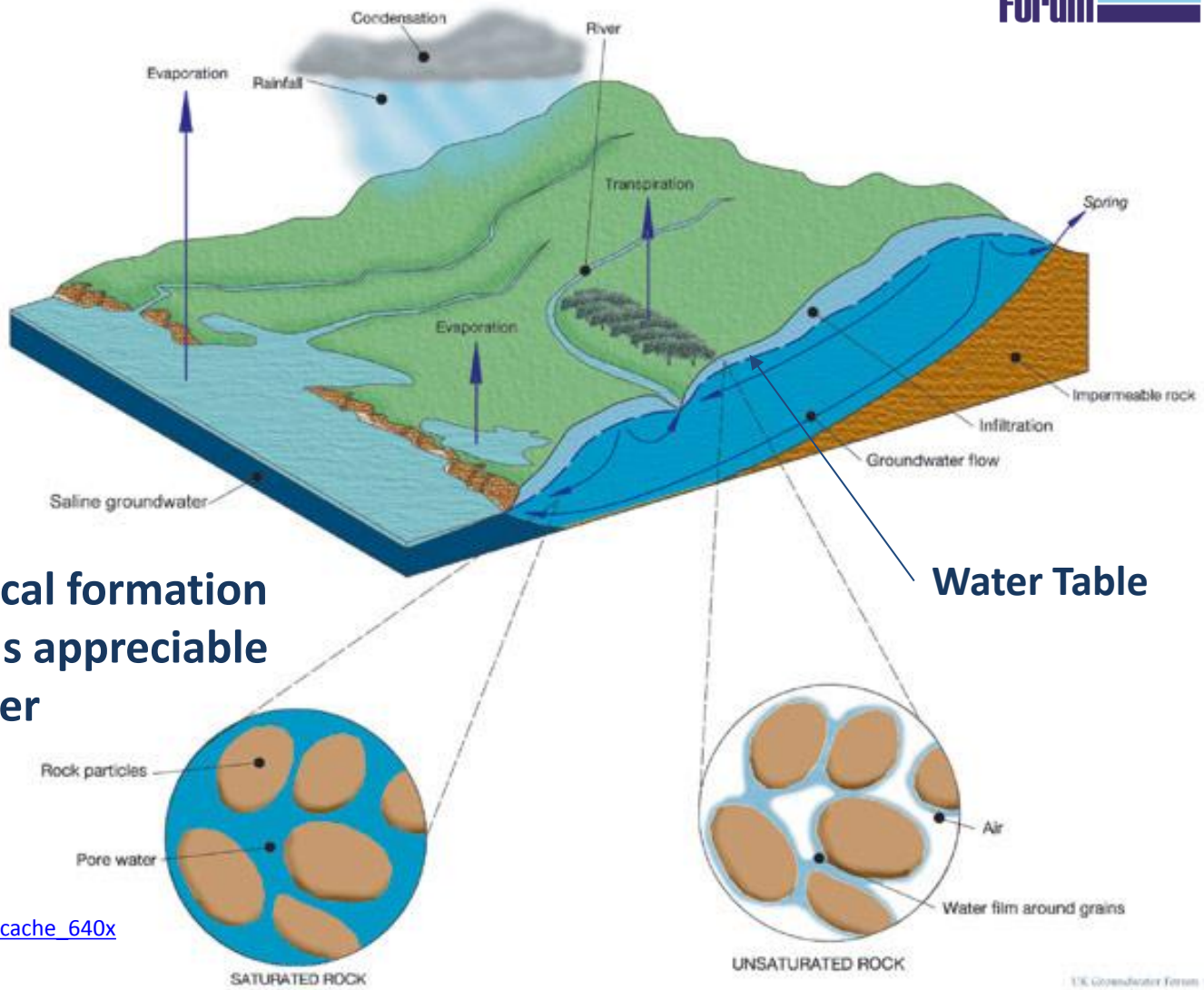


Freshwater = 2.5% of all water: 35,000,000 billion m^3

Groundwater = 30% of freshwater: 10,500,000 billion m^3
Groundwater = 96% of available freshwater

Groundwater:
The World's most extracted raw material
600-700 billion m^3/year

The Water Cycle



Aquifer
An underground geological formation that transmits & contains appreciable quantities of groundwater

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf048.jpg

Why Use Groundwater?

- Often occurs where there are few rivers & streams
- Responds slowly to changes in rainfall & stays available in summer & droughts when rivers & streams have dried up
- Groundwater quality is often very good & doesn't need as much treatment as river water to make it safe to drink
- Can be found close to towns & so doesn't require the large costs often needed for capturing, treating and piping river water
- Groundwater doesn't require expensive reservoirs to store water in before it is used; aquifers are the underground reservoirs of groundwater

What does a hydrogeologist do? #1

Rachel Bell, Hydrogeologist, British Geological Survey

At BGS I work on a wide variety of projects relating to groundwater, including fieldwork collecting samples, gauging streams and springs, or visiting sites with groundwater contamination problems. My work sends me all over the world, with trips to Africa and Nepal. I also spend time analysing the data I've collected and looking at how that can improve our understanding of the sub-surface.

Principal Aquifers of the World

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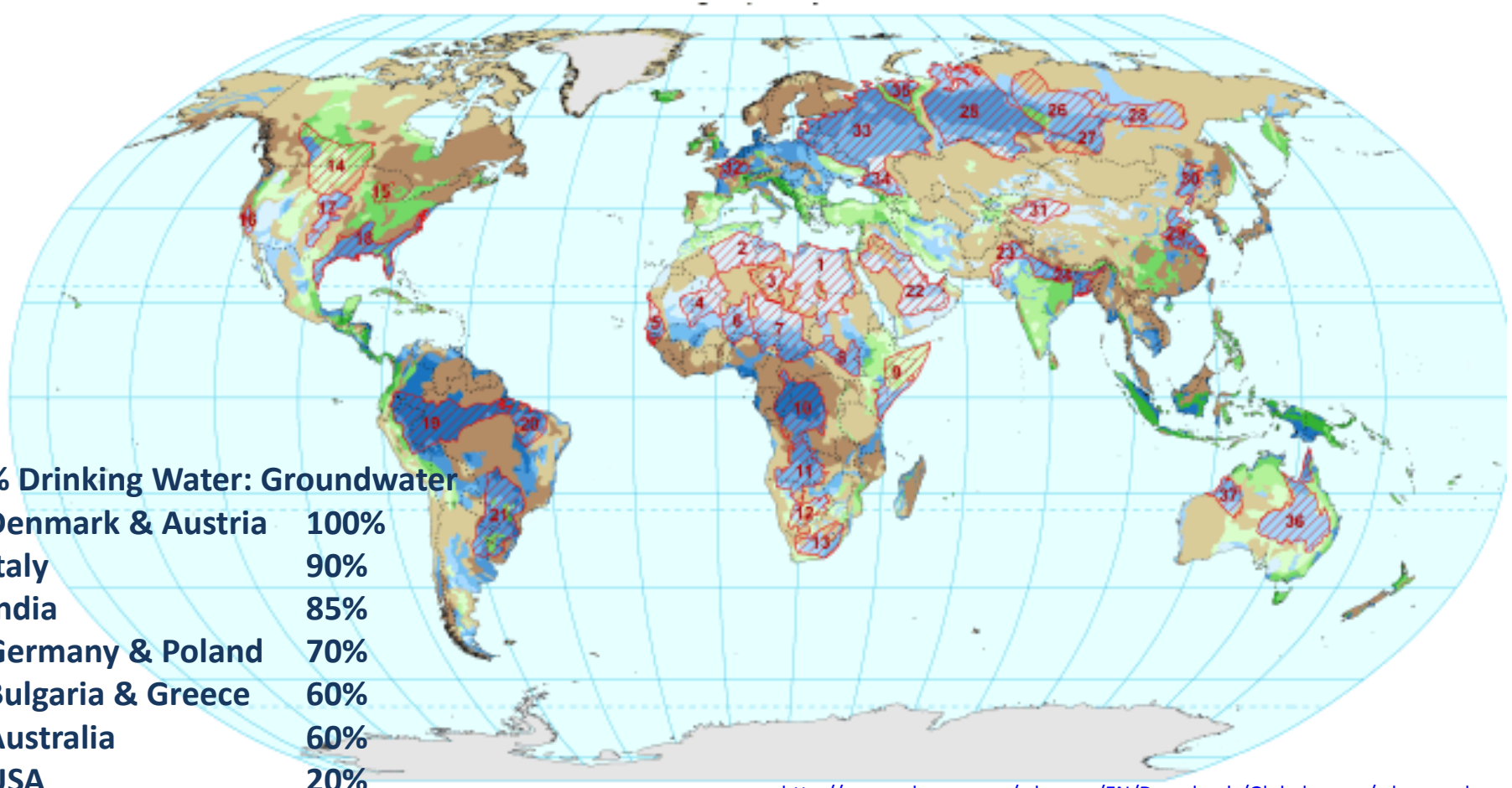


% Drinking Water: Groundwater	
Denmark & Austria	100%
Italy	90%
India	85%
Germany & Poland	70%
Bulgaria & Greece	60%
Australia	60%
USA	20%

WHYMAP & Margat 2008

http://www.whymap.org/whymap/EN/Downloads/Global_maps/whymap_largeaquifers_pdf.pdf?__blob=publicationFile&v=3

Principal UK Aquifers & Groundwater Use

Principal UK aquifers:

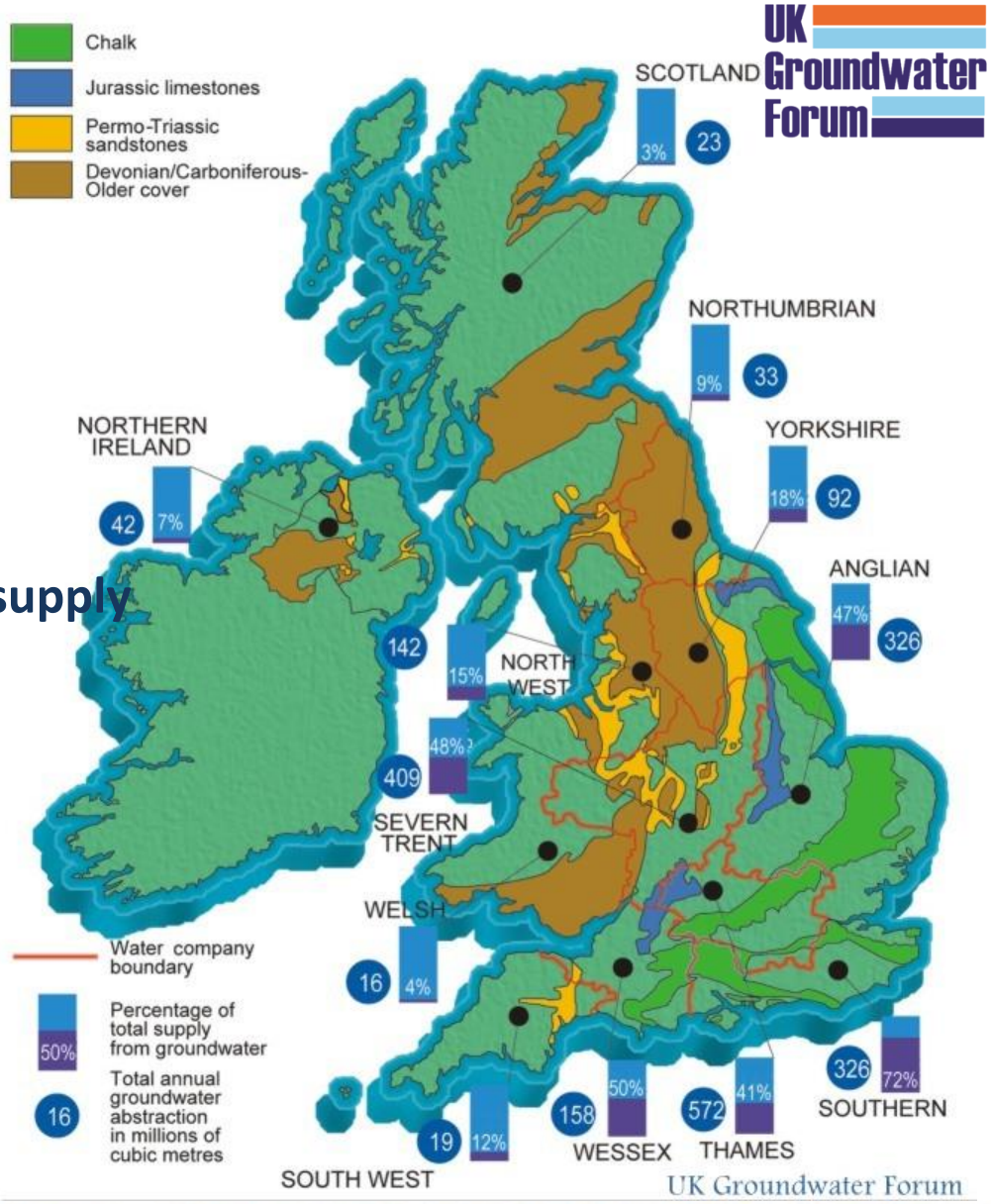
- Cretaceous Chalk
- Jurassic Limestones
- Permo-Triassic Sandstones

Groundwater provides ~35% of water supply

Regionally variable:

- 3% in Scotland
- 72% in South East England

Recent peak groundwater abstraction 2.3 billion m^3 in 2003



http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf005.jpg

Uses of Groundwater

1. Drinking & domestic use
2. Farming, e.g. irrigation, cattle watering, fish farming
3. Construction, e.g. concrete, cement
4. Food & drinks manufacturing
5. Heating & cooling buildings
6. Industry, e.g. hydrocarbons, fracking
7. Mining, e.g. minerals processing

Groundwater in the Environment

1. Where can we see groundwater?
2. The ups & downs of groundwater
3. Why do rivers flow when it's not raining?
4. The emergence of groundwater: a natural hazard
5. Life underground

Unconfined & Confined Aquifers

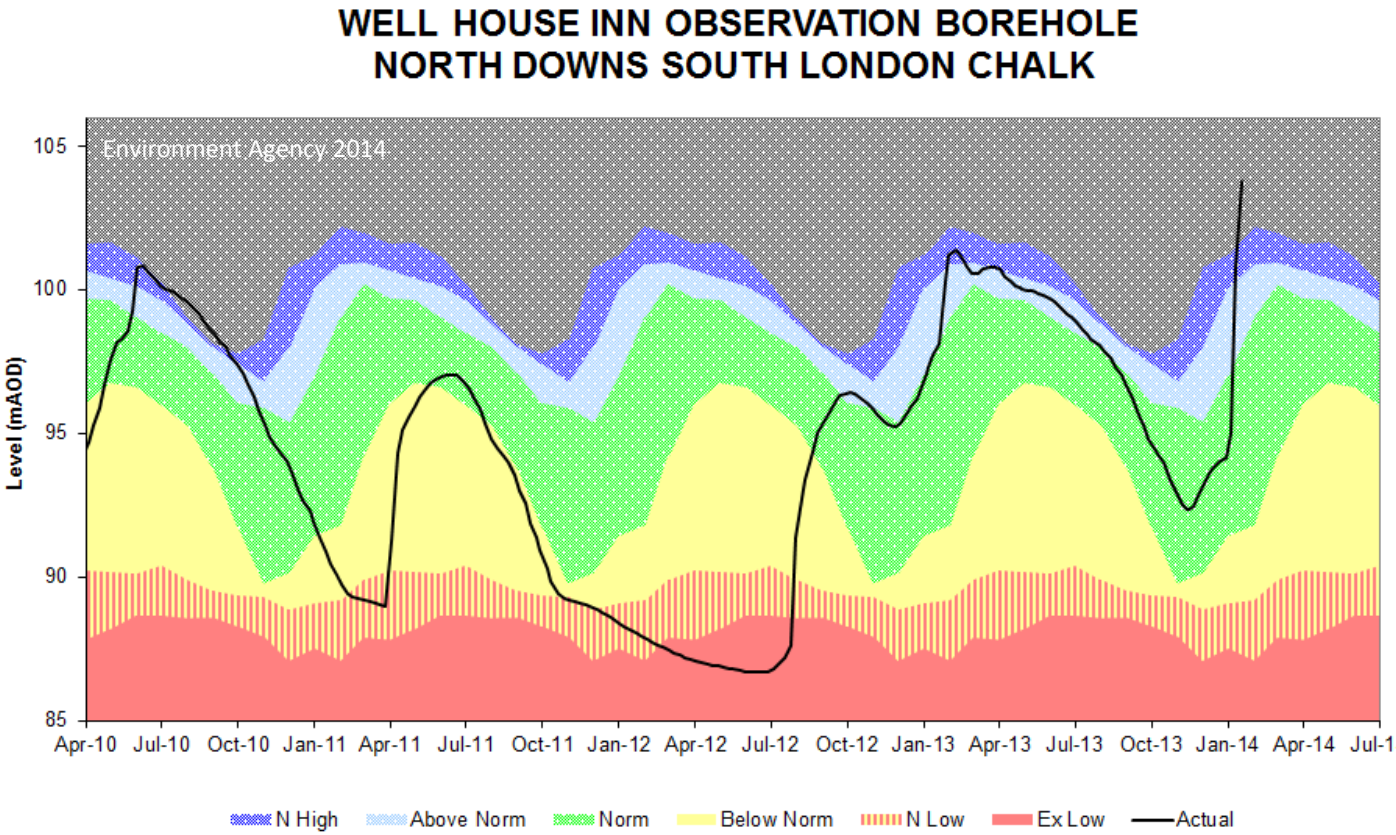
Confined aquifer
Permeable rock units overlain by less permeable layers

http://www.ahwelldrilling.ca/well-drilling/artesian-wells/

http://cehsciencenews.blogspot.co.uk/2013/10/hydrometric-data-long-view.html

http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf011.jpg

The Ups & Downs of Groundwater



Future of forecasting from www.hydoutuk.net

Groundwater as River Baseflow

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River Pang – this is groundwater

Where's the groundwater gone?

http://www.thetimes.co.uk/tto/weather/article3618227.ece

Groundwater Flooding – The Other Extreme

http://www.bgs.ac.uk/research/groundwater/flooding/groundwaterHomesFAQ.htm

http://www.bgs.ac.uk/news/events/FTLEseminar/docs/posters/AHughes_Integrated_modelling.pdf

Life Underground

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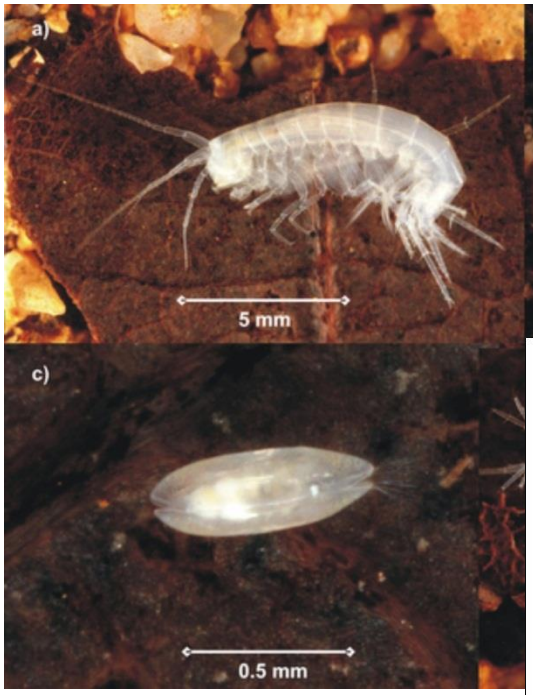
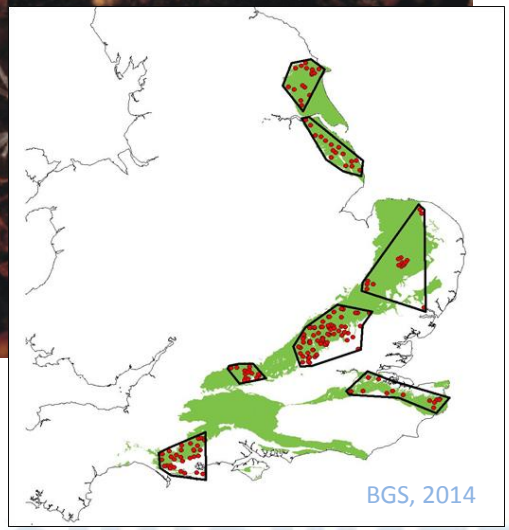
Groundwater can contain distinctive animals adapted to live in the dark. These are stygobites, but how important are they?

BGS, 2014





BGS, 2014

How to get at Groundwater

1. Abstraction boreholes
2. Wells with adits
3. Groundwater abstraction & rivers

Borehole Construction & Operation

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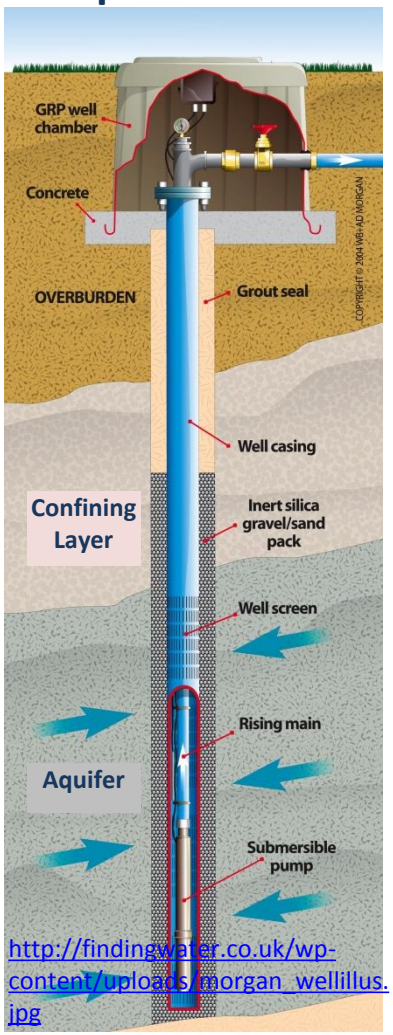
Drilling

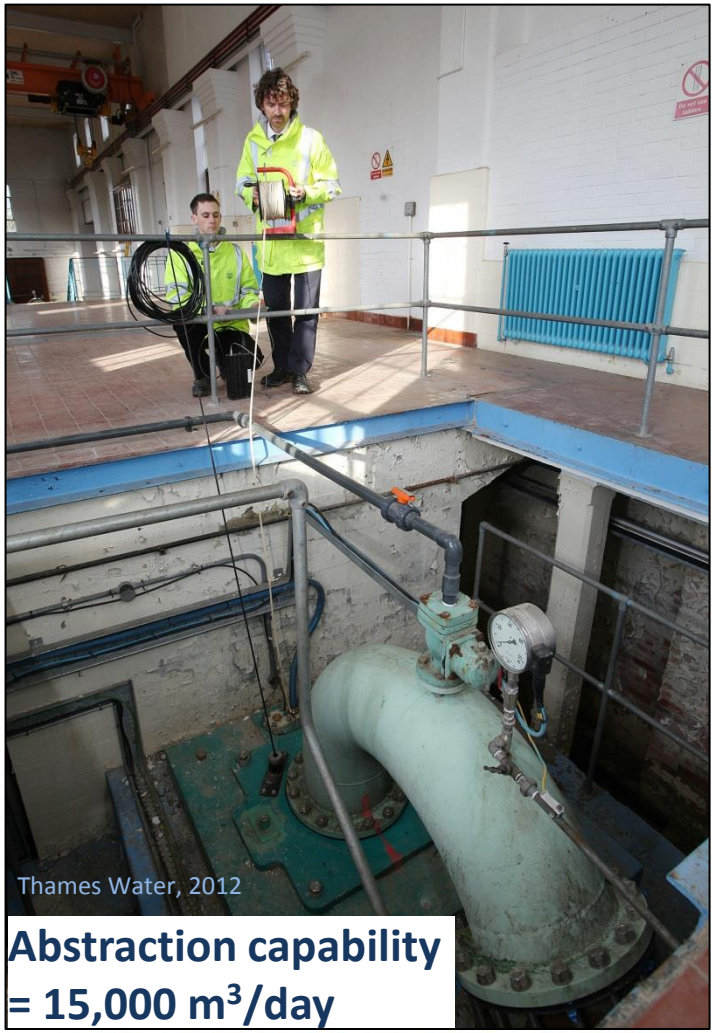
Thames Water, 2012

Pump Installation



http://findingwater.co.uk/wp-content/uploads/morgan_wellillus.jpg

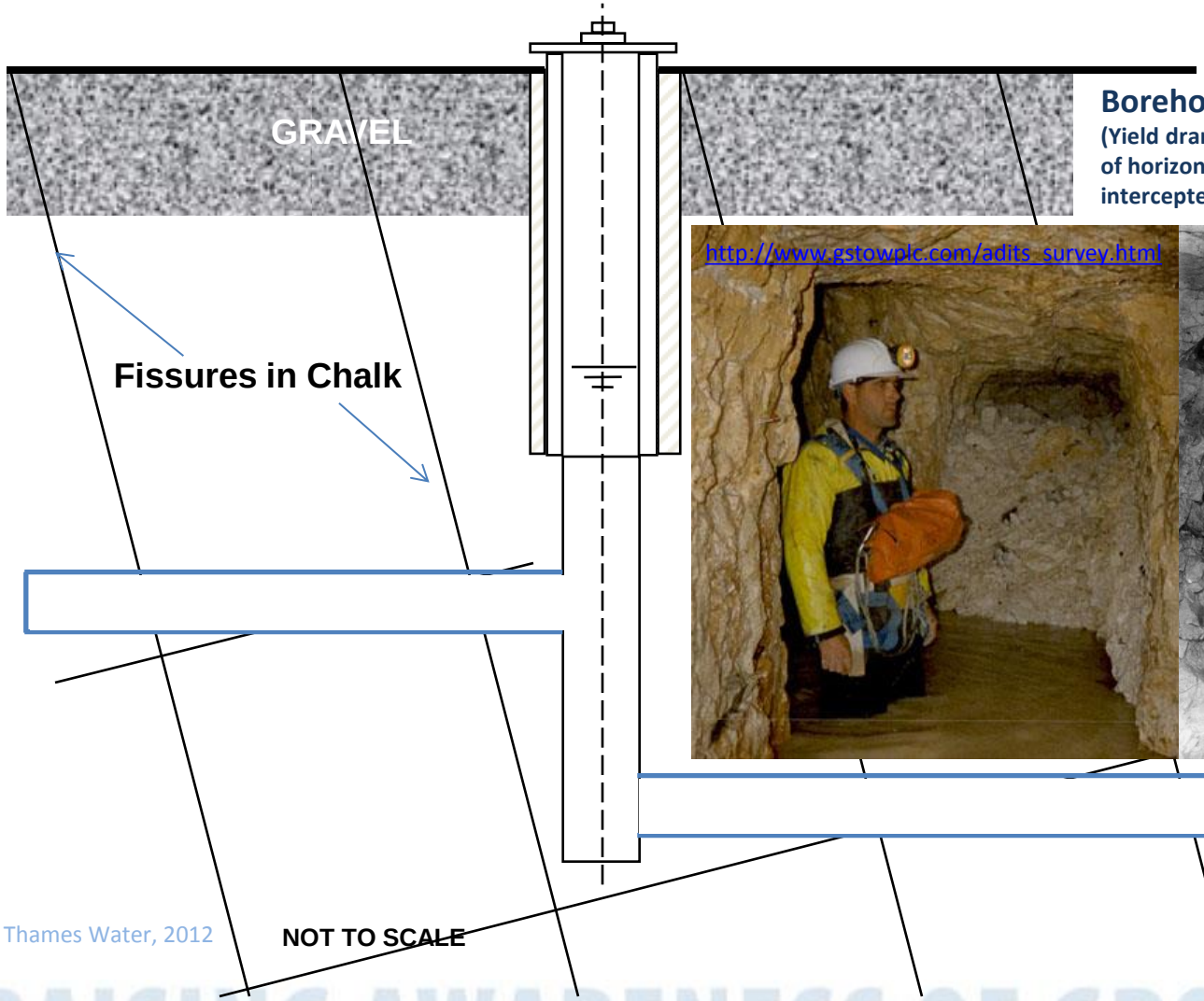
Headworks



Thames Water, 2012

Abstraction capability = 15,000 m³/day

Abstraction Wells

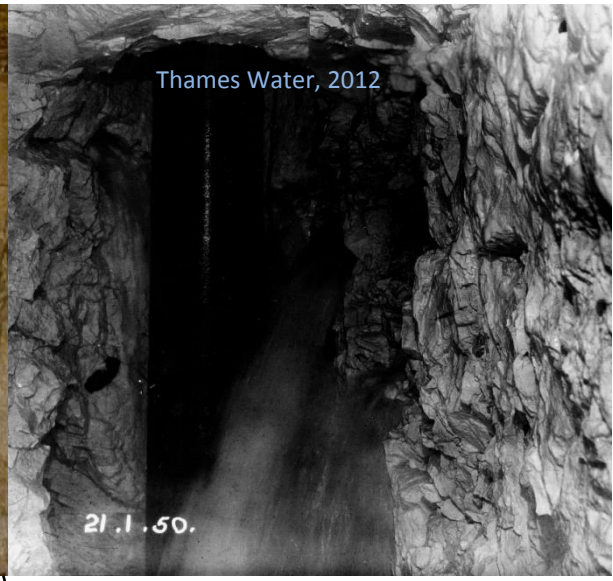


Thames Water, 2012

Borehole with Adits

(Yield dramatically improves with construction of horizontal adits – several vertical fissures are intercepted)

http://www.gstowplc.com/adits_survey.html



Thames Water, 2012

What does a hydrogeologist do? #2

Simon Starling, Groundwater Resource Analyst, Thames Water

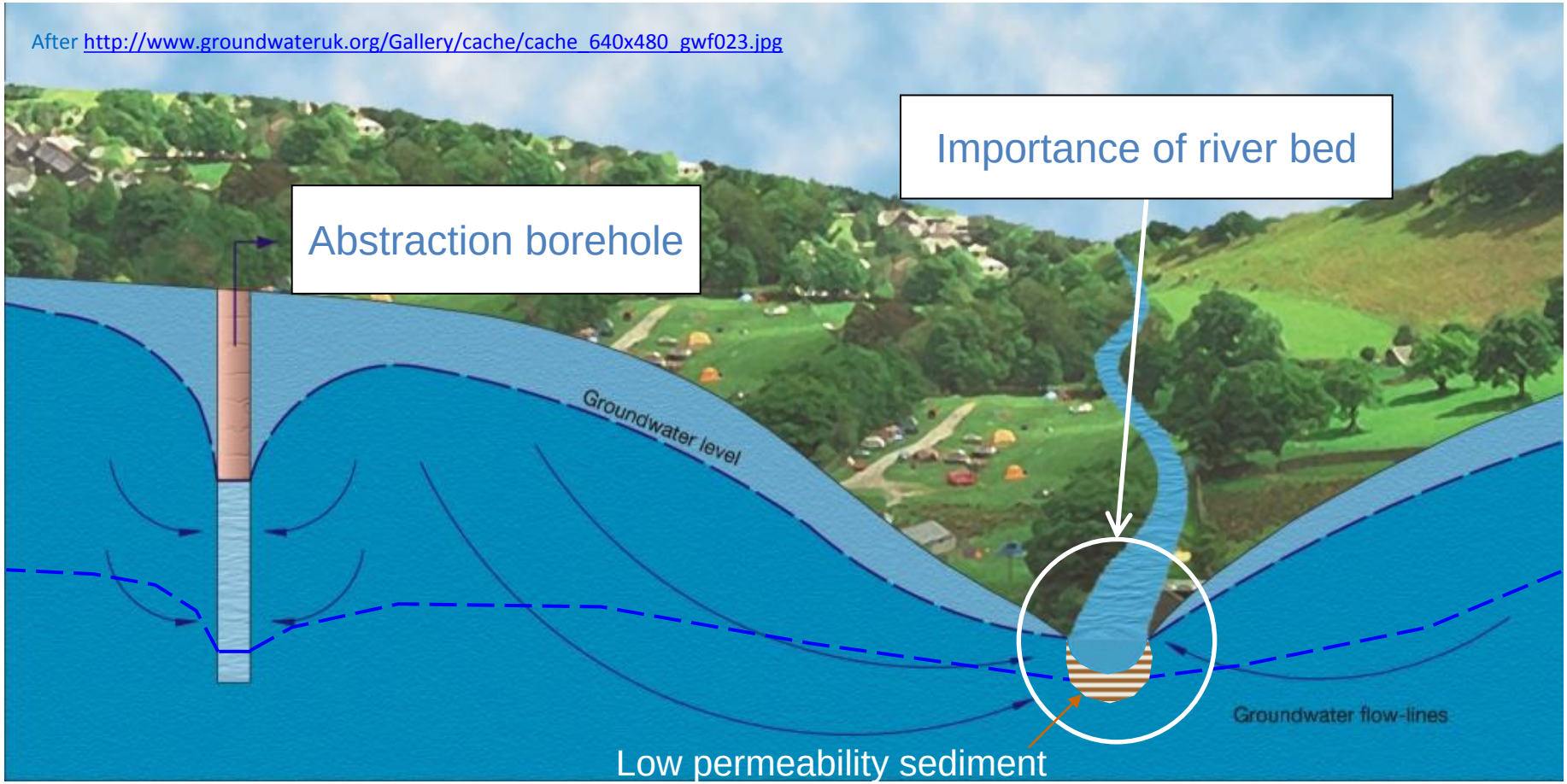
My role is to help protect Thames Water's public water supply groundwater sources; this ensures that groundwater abstraction is not affected by things such as pollution incidents, farming activities and local housing developments. I have a good balance of work on-site and in the office, and there are always new things to learn and understand working within the UK's largest water company.


Thames Water, 2014


Thames Water, 2014


Thames Water, 2014

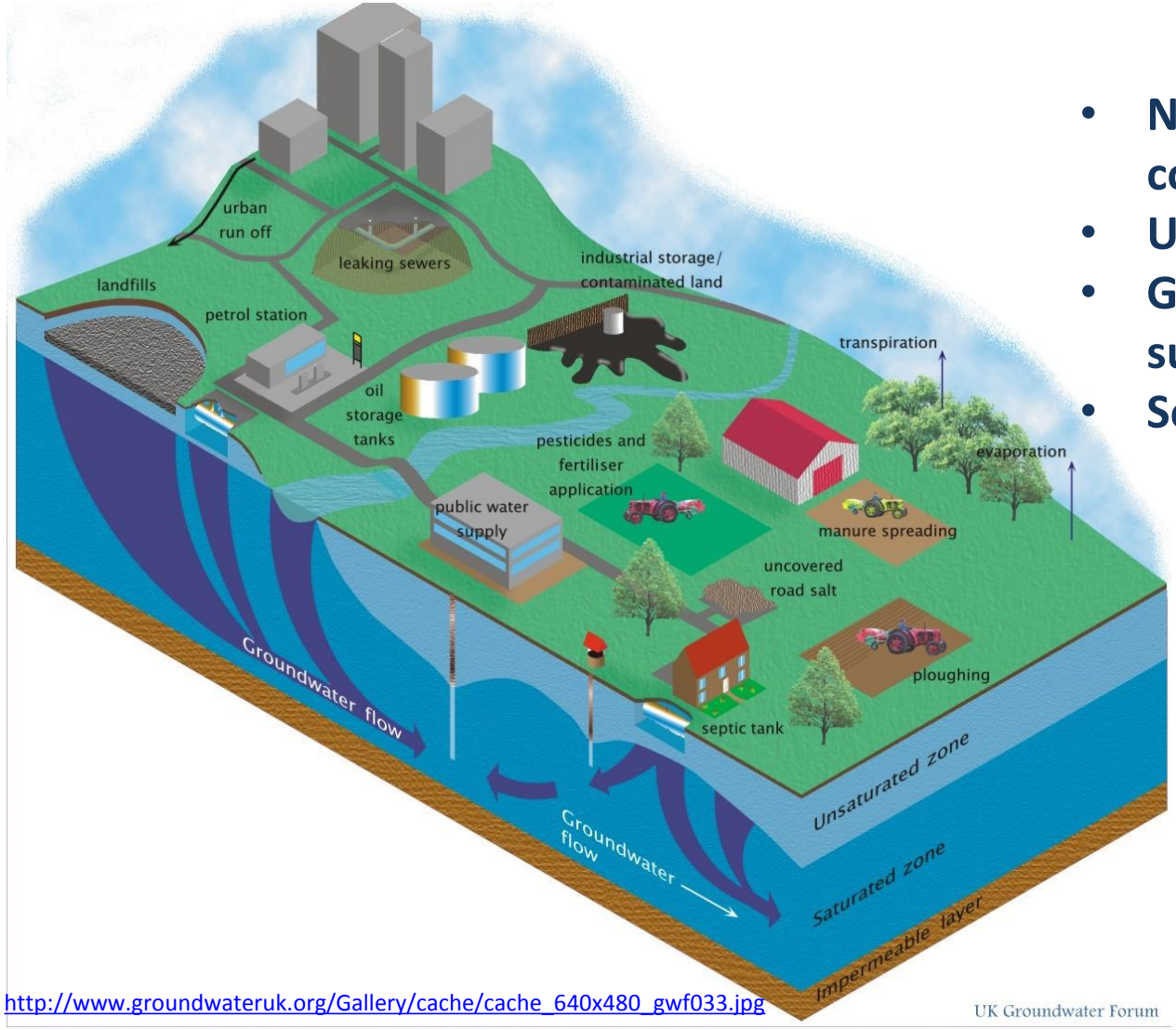
Groundwater Abstraction & Rivers



Groundwater Contamination & Protection

1. Contamination hazards
2. Groundwater vulnerability
3. Groundwater and shale gas

Groundwater Contamination Hazards



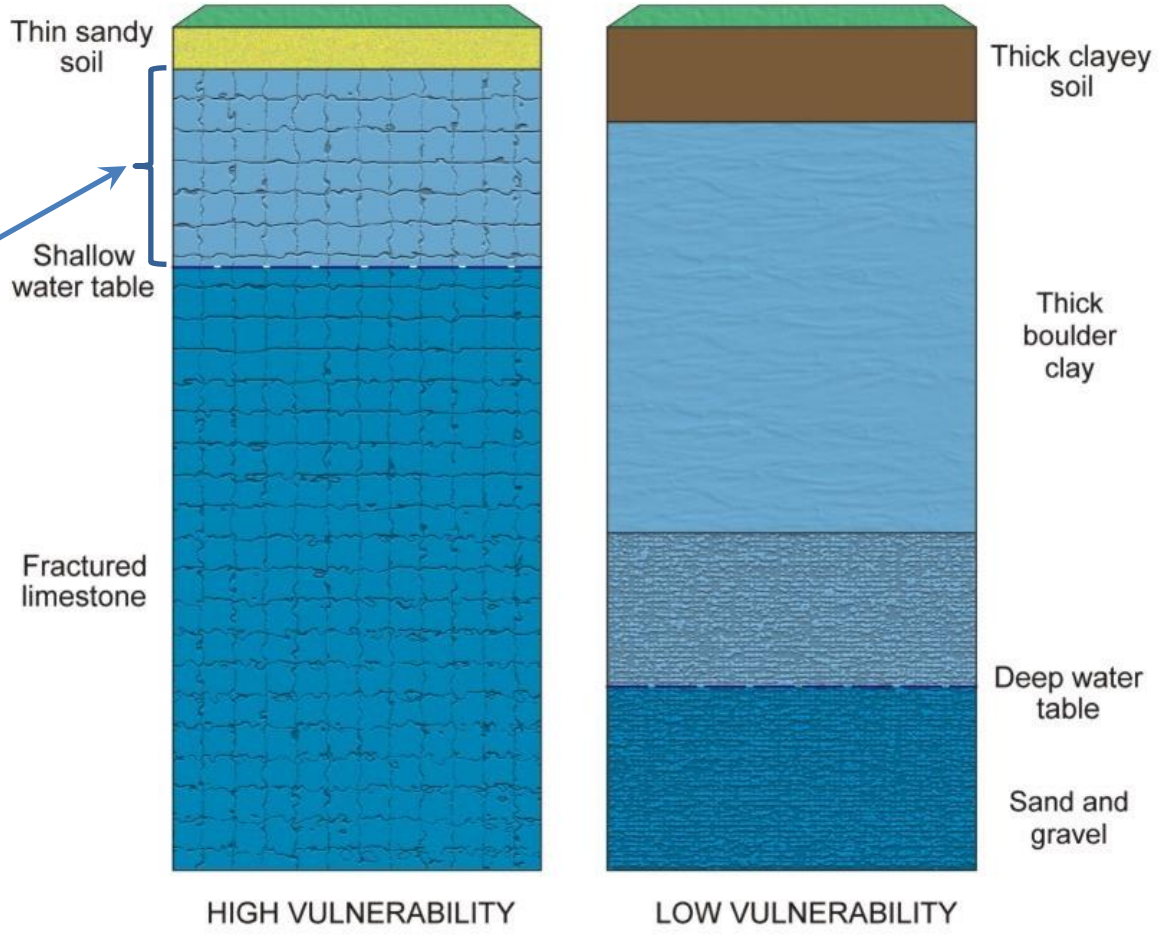
http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf033.jpg

- Numerous sources of contamination
- Urban & rural
- Groundwater & water supply sources at risk
- Source-Pathway-Receptor

Groundwater Vulnerability

Geology & hydrogeology can provide natural protection

- **Contaminants move slowly through unsaturated zone**
- **Groundwater moves faster through aquifers with fractures**
- **Clays have low permeability**

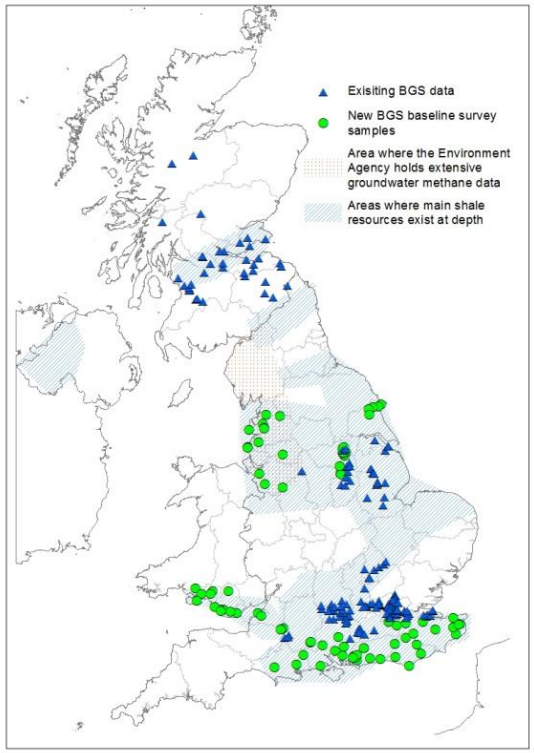


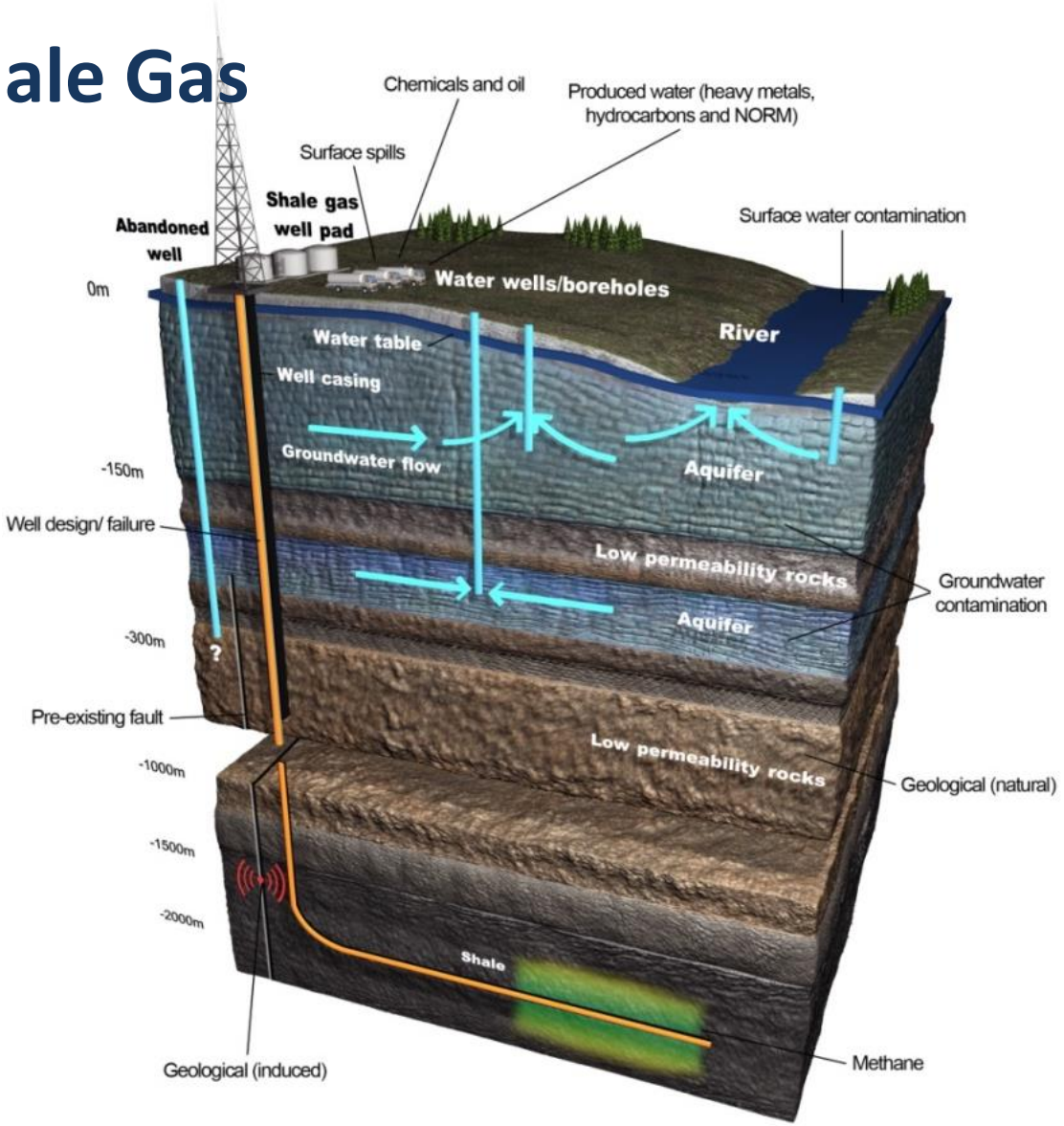
http://www.groundwateruk.org/Gallery/cache/cache_640x480_gwf034.jpg UK Groundwater Forum

Groundwater and Shale Gas

Hazards & Risk

- Additional water demands
- Pollution from gas, fracking fluid & contaminated water

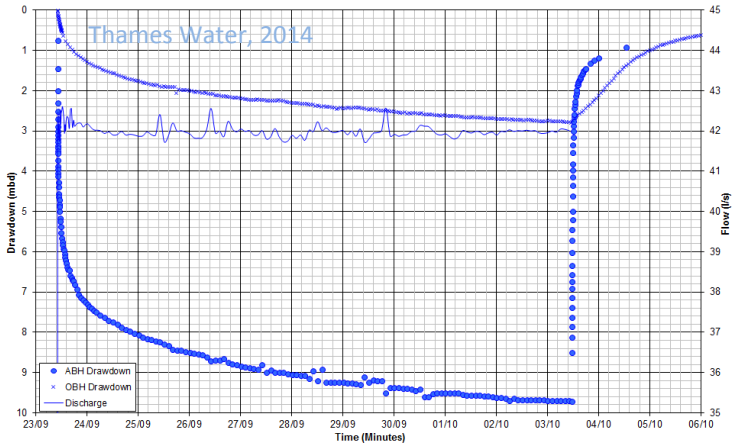




What does a hydrogeologist do? #3

Lucy Snape, Technical Officer, Environment Agency

As a Technical Officer I provide technical support and guidance to internal and external customers on groundwater protection and land contamination issues on a daily basis. I am also involved in determining abstraction licence applications, including analysis and interpretation of pumping tests and groundwater level monitoring.



A career as a hydrogeologist

Water companies – in some areas of the UK, groundwater provides a major component of the water supplied. Many water companies employ groundwater specialists.

Environment Regulators – Environment Agency, Scottish Environment Protection Agency, Natural Resources Wales, local & central government.

Who employs hydrogeologists?

Universities – several universities undertake specialist teaching and research in groundwater, employing lecturers and researchers.

Consultants – work for private and government clients in the UK and overseas, including environmental impact, landfills, mine dewatering, water supply.

Contractors – drill boreholes, construct roads, tunnels, airports, and employ hydrogeologists as specialists to design & supervise groundwater works.

How to become a hydrogeologist…….

- Hydrogeologists often come from a wide variety of backgrounds – geology, environmental science, engineering, mathematics & many others.
- The usual route after an undergraduate degree is to obtain a 1 year MSc in a relevant subject, such as hydrogeology, water management, environmental geology.
- Others may choose to do a PhD/EngD in hydrogeology, which can take 3-4 years and are funded by research councils, universities & industry.

Groundwater
“Often out of sight, but never out of mind”

Check out the UK Groundwater Forum web site www.groundwateruk.org

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