Affinity Water

Planning Applications & Groundwater Protection

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Aims: raise awareness to LPA about groundwater protection aspects

In details we will discuss:

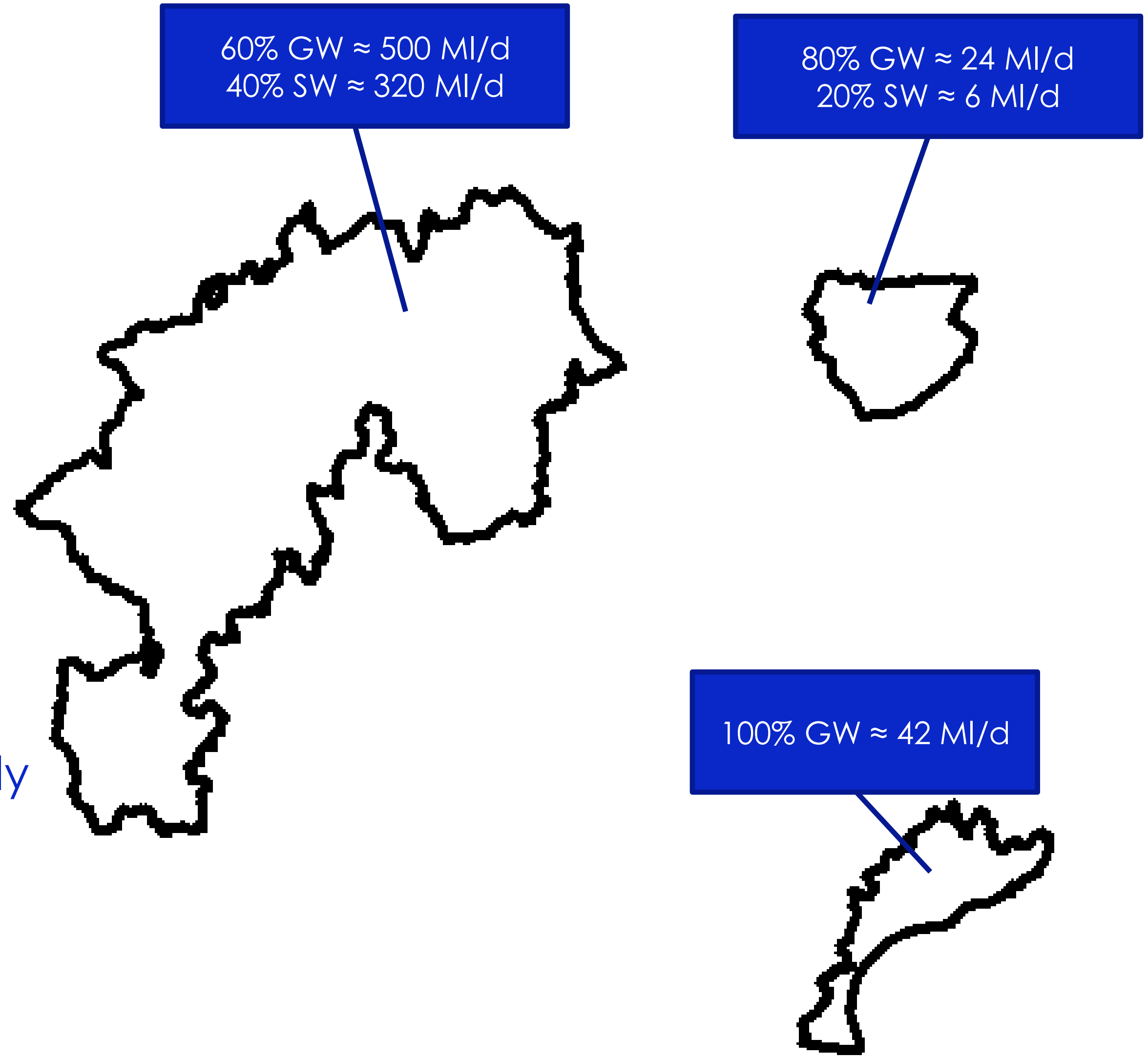
- *The importance of groundwater for our distribution input*
- *What is the Chalk aquifer, what are its characteristics and how groundwater is abstracted from it*
- *SPZs*
- *Affinity Water main concerns from groundwater protection perspective*
- *When things go wrong…*
- *Our response to planning application consultations*
- *PFAS*

Why Affinity Water needs to protect Groundwater?

- On average, **65%** of the total water in our 3 regions that is distributed to customers comes from **groundwater** (GW)
- The remainder **35%** comes from **surface water** (SW) sources and imports

- In our Southeast region, all (100%) the water we supply to customers is groundwater-derived
- In our Central region, the groundwater is 60% of our total supply whereas in our East region it is 80%

- Groundwater is generally clean because it is naturally filtered through the sediments and rocks
- Groundwater typically needs minimal treatment before being distributed into supply
- Groundwater is believed to be resilient to drought/flood and climate change effects



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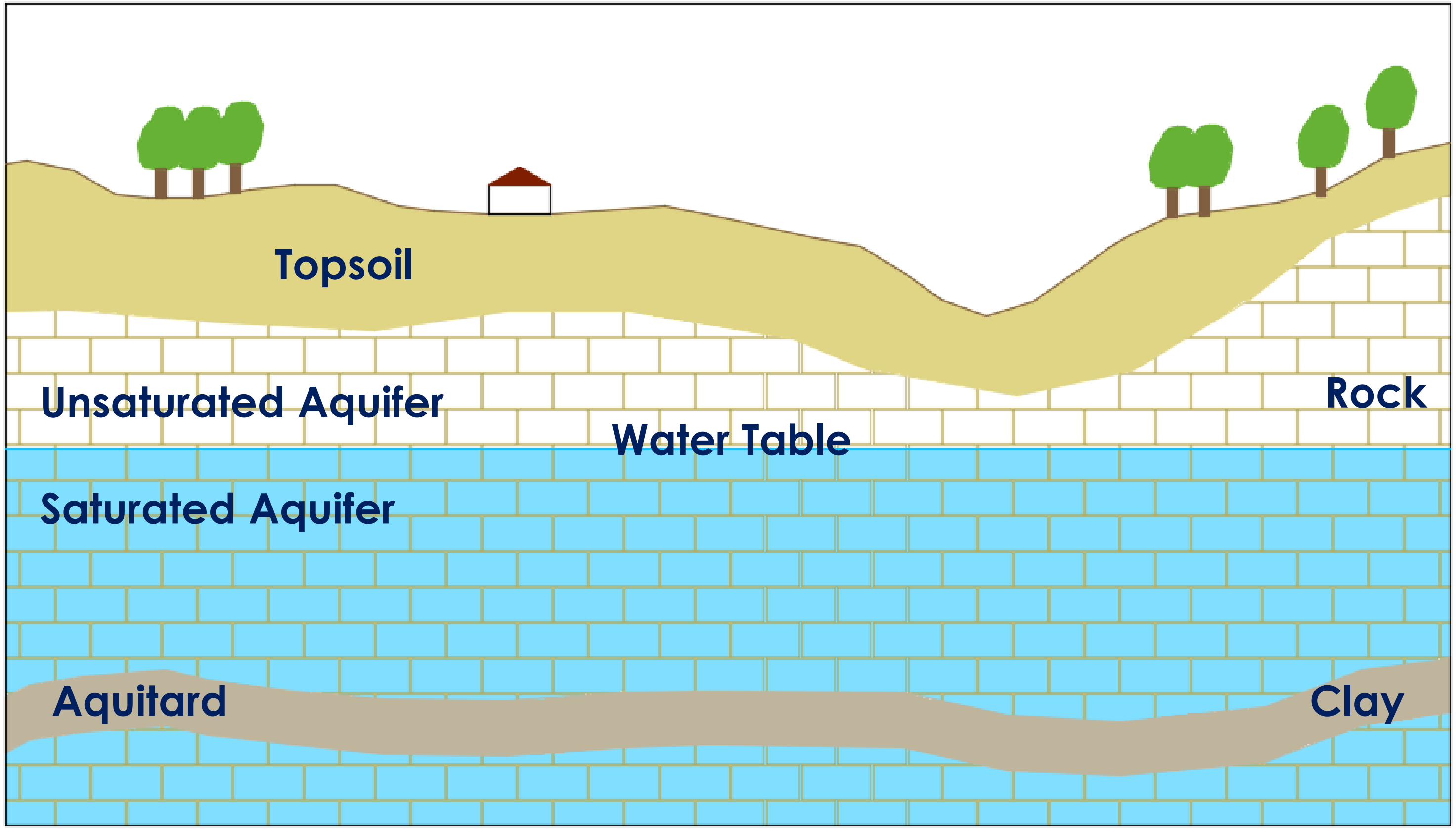
What is an aquifer?

- It is a mass of rock or sediment able to **hold and transmit groundwater**
- It has an **unsaturated zone** (dry rock) and below the **water table** has a **saturated zone** (rock filled with groundwater)
- It could be assimilated to a hard **sponge**, partially saturated with water
- It might contain different layers of soils and rock, making it rather **heterogeneous**
- If it is made of clayish soil/rock, it restricts the groundwater flow and it is called an **aquitard**



An aquifer….. IS NOT an underground river

An aquifer…… IS NOT an underground lake

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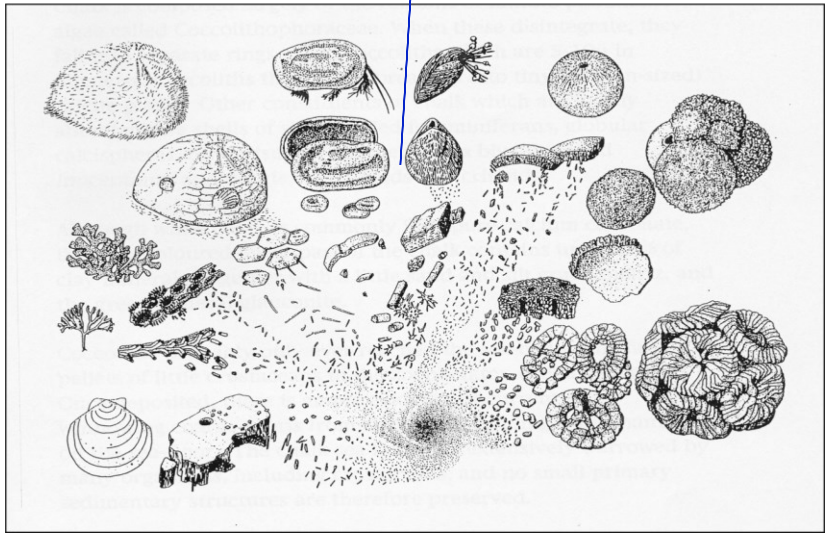
What is the Chalk?

- It was formed in the late Cretaceous period between 99 and 65 M years ago (after Dinosaurs became extinct and when England was submerged under sea level)

- It is a **Limestone rock** made of the remains of shells or biological marine sediments such as fragments of tiny shells, all packed together



- The Chalk represents **the most important aquifer in UK**

Chalk is very vulnerable to contamination

- The Chalk has karts dissolution features

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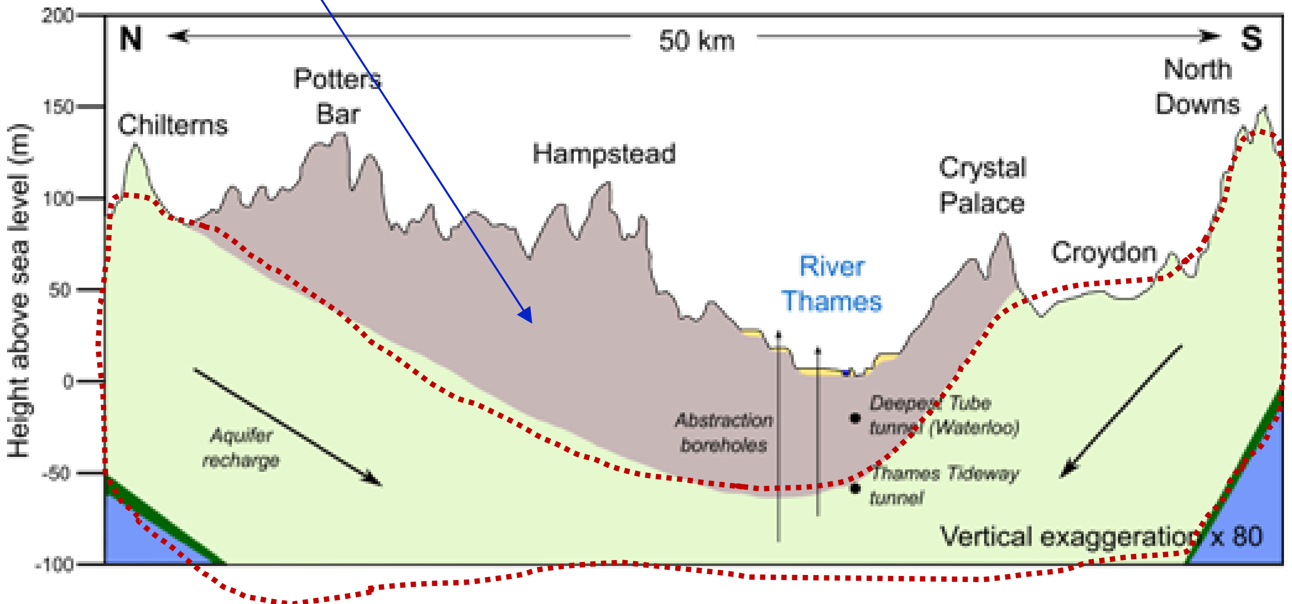
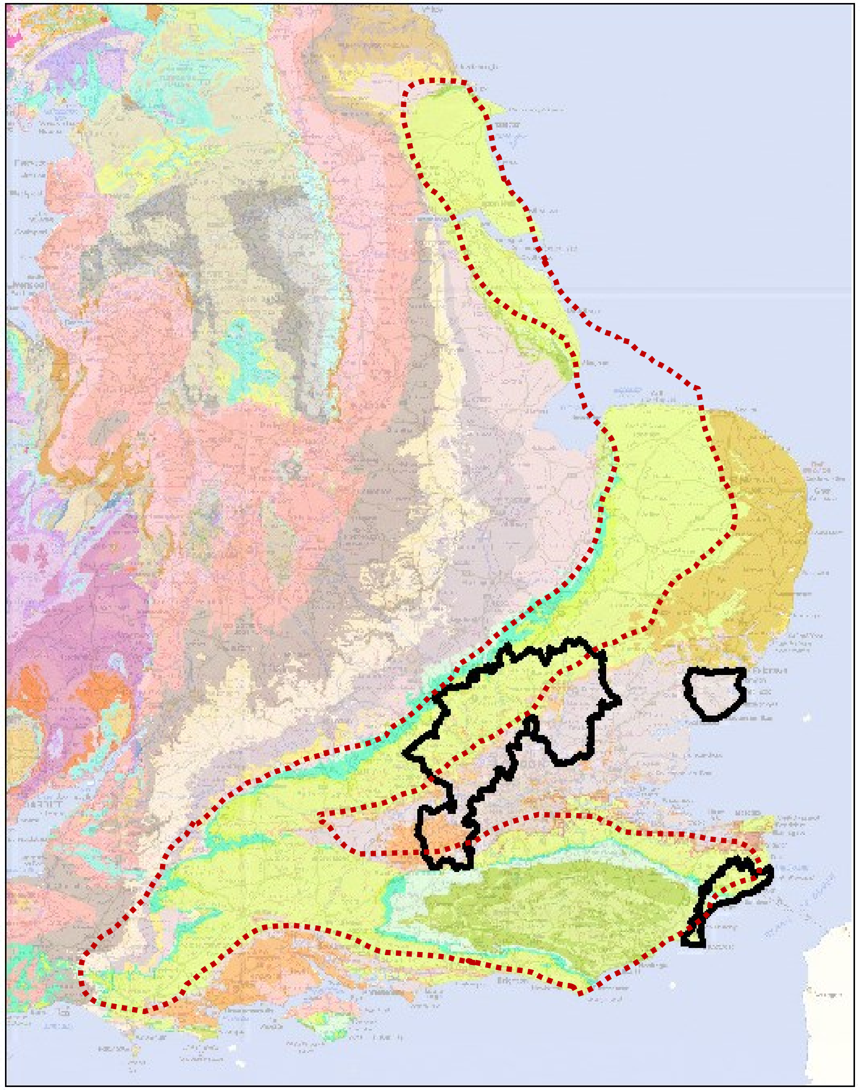
Where is the Chalk found?

- The Chalk (pale green on the map) is found in most of Southern England and it extends to East Anglia, Lincolnshire and the Yorkshire coasts
- It covers most of our Central and Southeast supply regions
- If we take a slice through the earth from the Chiltern Hills to the North Downs, we will see the Chalk dipping gently towards the London Basin and rising again in South London, in a “U” shape underground structure
- In the London area and the East region, it is overlain by the London Clay (pale brown), an aquitard with low permeability





The Chalk can reach up to 200 m in thickness

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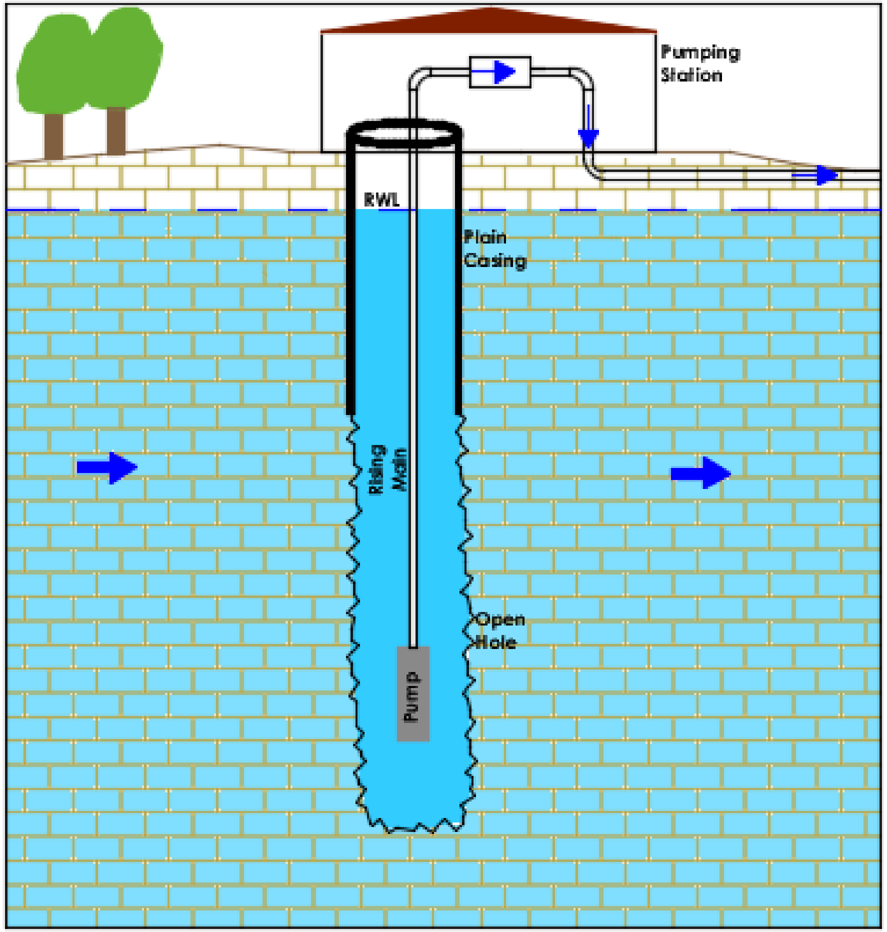
How the groundwater from the aquifer is abstracted?

- We abstract groundwater from aquifers through boreholes and wells (large diameter boreholes)
- Typically our boreholes are made of a metal plain casing pipe down to 20-30 m below ground, with the rest being just a circular hole in the rock
- The borehole houses a submersible pump and a rising main that brings the water up to ground level



When we start pumping, the groundwater level drops because of the pumping, until it stabilises; we call it pumping water level (PWL)

When the pumping stops, the groundwater level recovers and then stabilises again; we call it rest water level (RWL)

This dynamic movement of groundwater in the aquifer occurs in the vicinity of the borehole, every time we abstract

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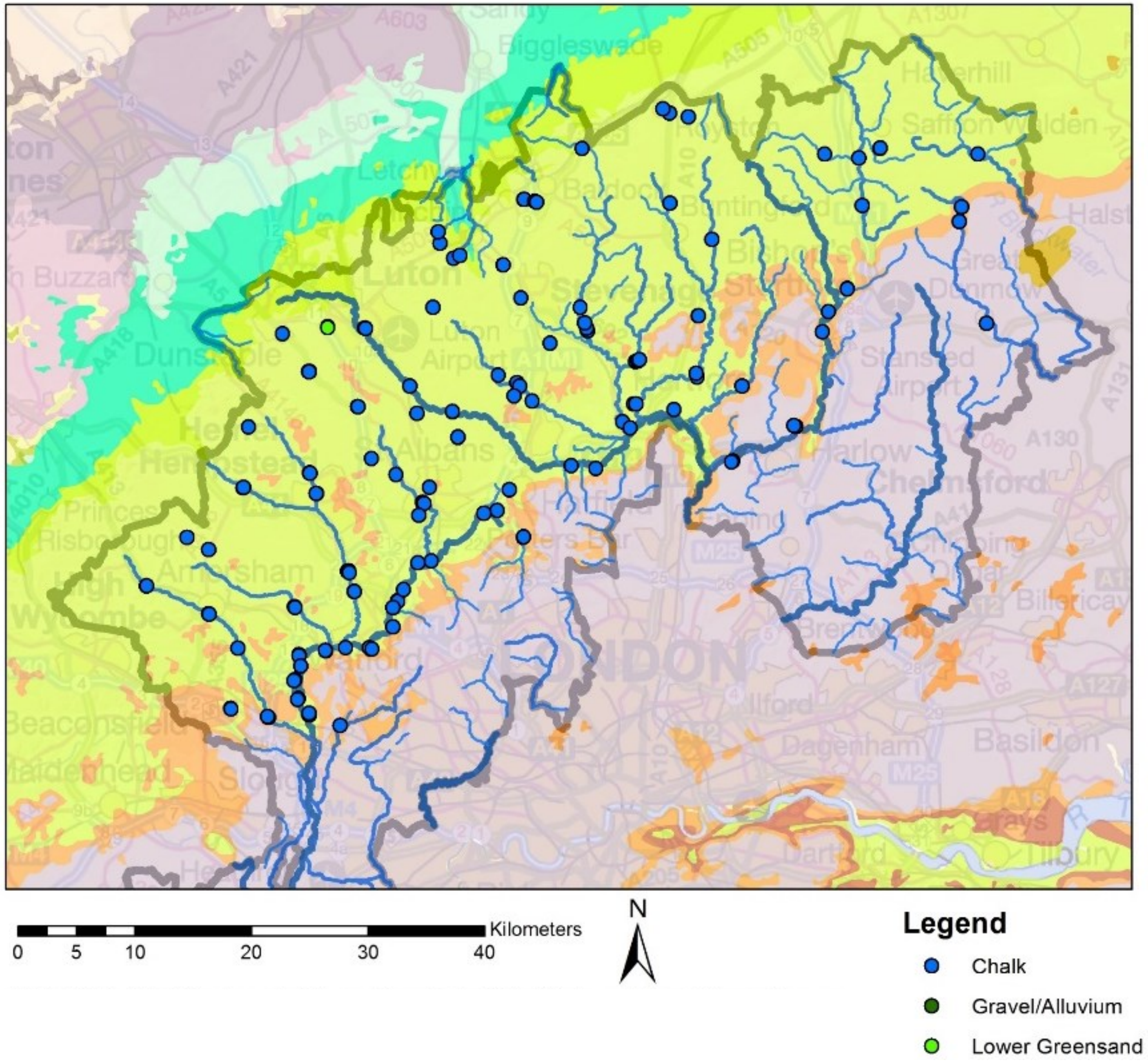
Borehole across the Central Region

Operational within Central, East and Southeast

- 368 boreholes across our region
- 224 borehole in operation

Central region

- 191 boreholes in operation
- The majority of central boreholes are in the chalk
- The boreholes in our Central regions abstract every day an average of 500-600 Megalitres of groundwater



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Source Protection Zones

SPZ1 = 50 days travel time (min 50 m distance)

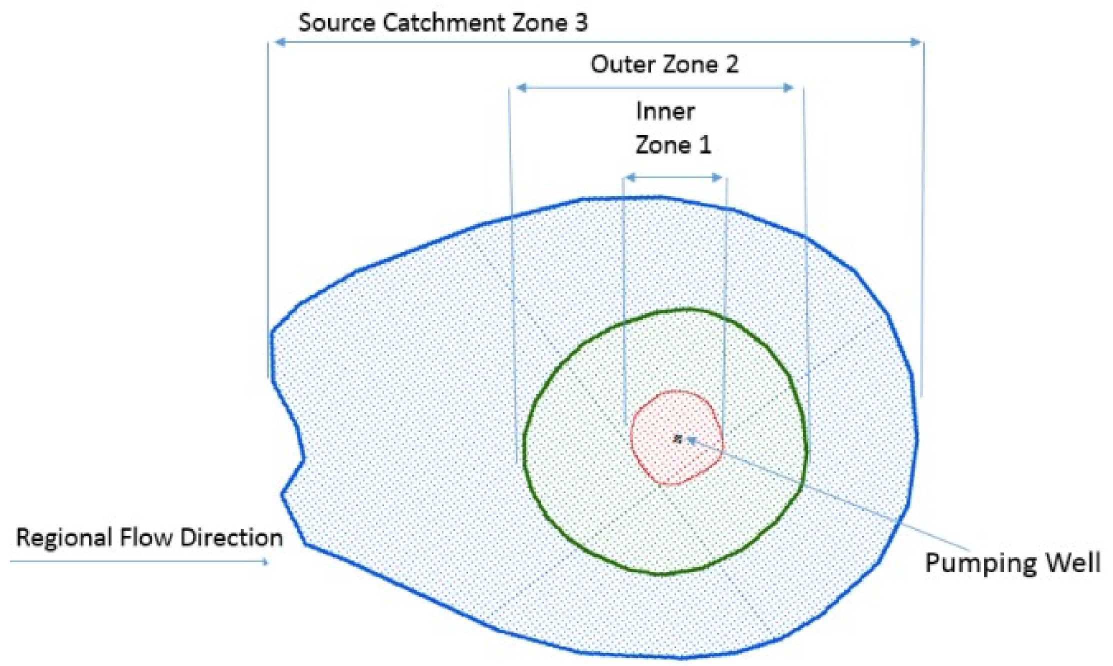
SPZ2 = 400 days travel time (min 250-500 m distance)

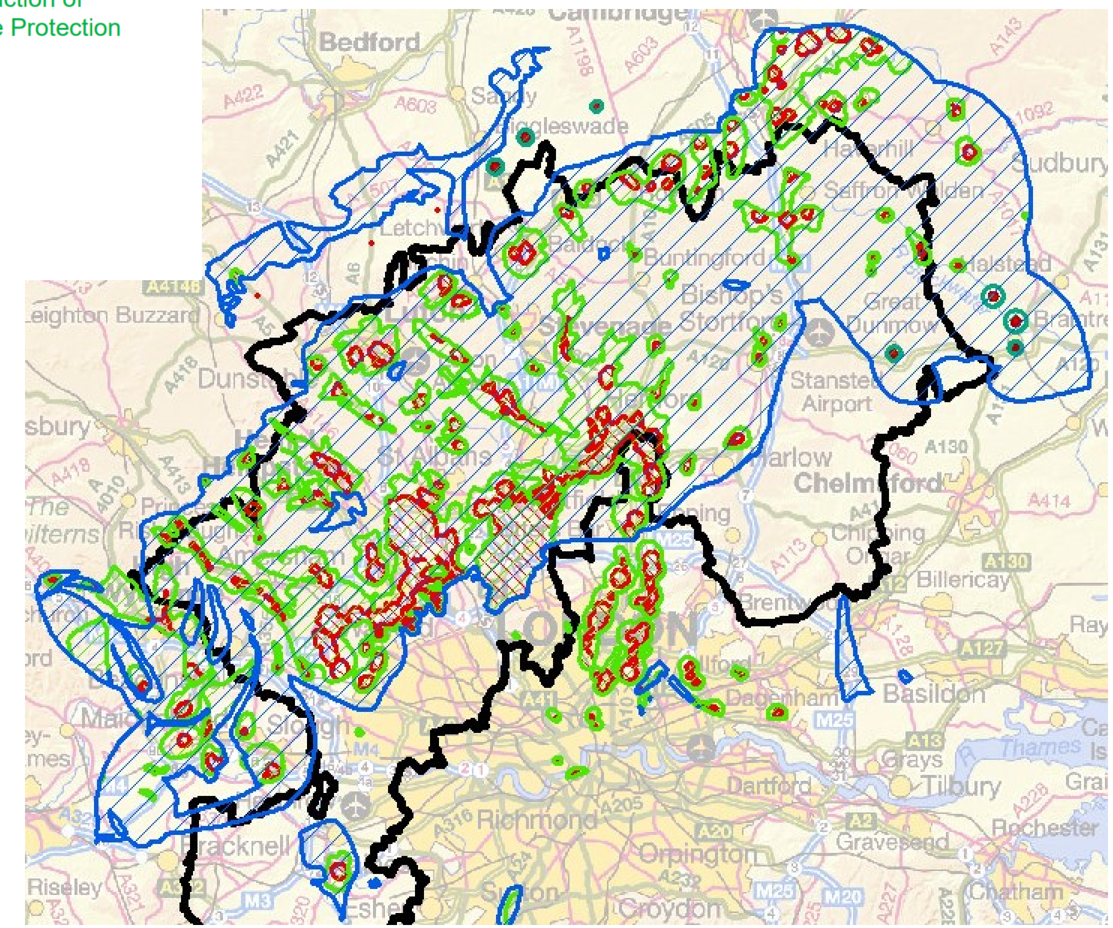
SPZ3 = Total capture zone

SPZ4 = Special interest additional protection zone

Manual for the production of Groundwater Source Protection Zones

March 2019





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Main concerns from Groundwater protection perspective

A. Ground works intercepting the saturated aquifer depth (piling)

B. Mobilisation of existing contaminant

C. Opportunity to identify source of on-going aquifer contamination

D. Drainage strategy

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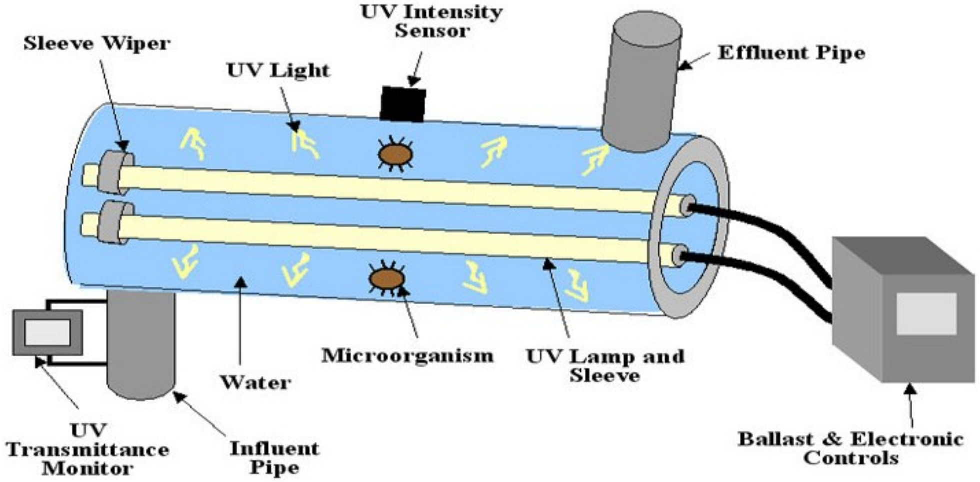
A – Ground works intercepting the saturated aquifer depth (piling)

From: AGS July 2003



https://www.unh.edu/wttac/WTTAC_Water_Tech_Guide_Vol2/uv_homepage.html

Chalk Turbidity particles prevent full UV disinfection, as they can screen microorganisms from UV radiation

Drinking Water Inspectorate allows water into supply if **NTU is < 1.0 NTU**

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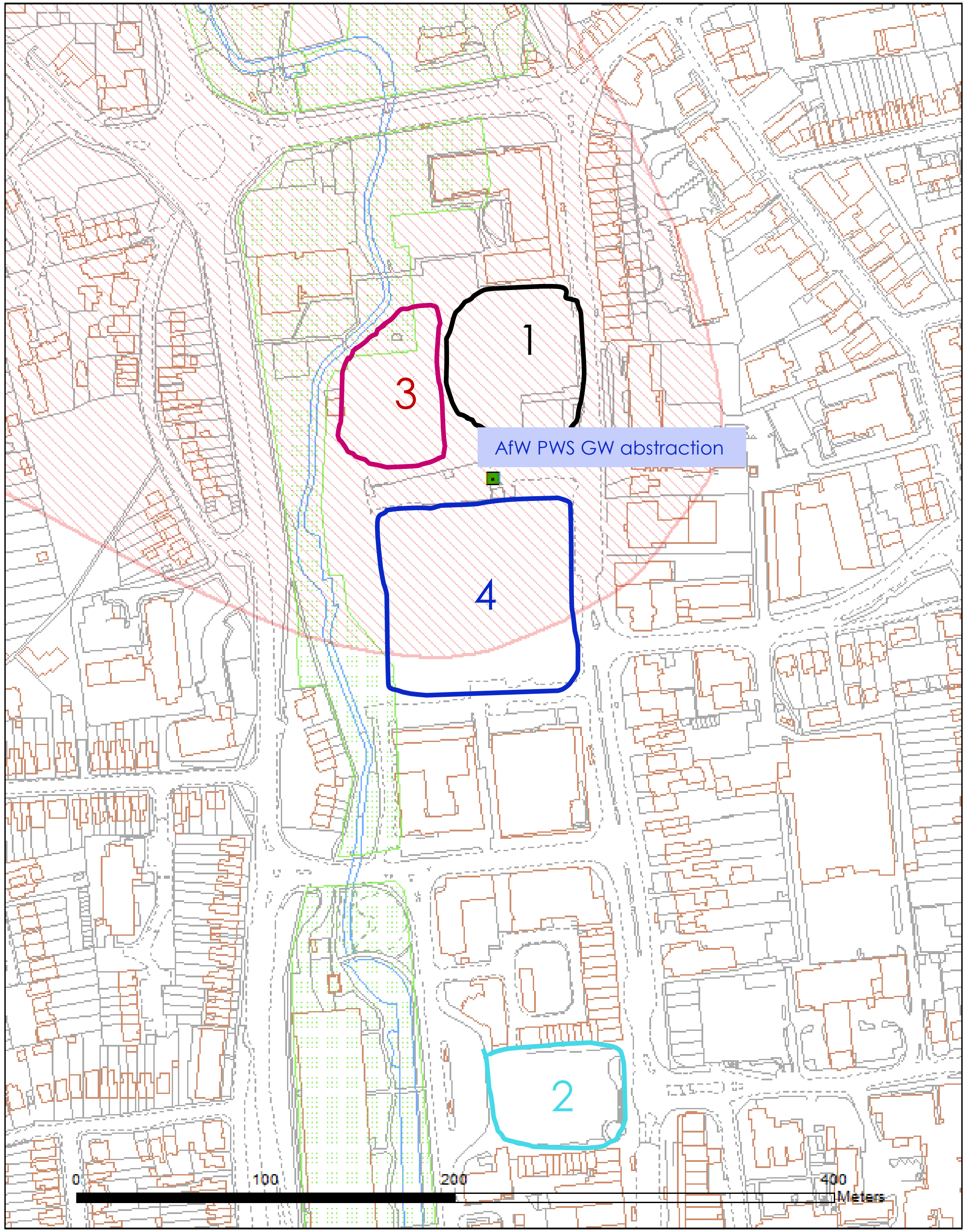
Developments near PWS GW abstractions with piling works



1- College:
Soil vibration works target depth 4 m (above Chalk)
Completed in May 2019

2- Residential block of flats
Piling depth 8-15 m (within the sat Chalk)
Completed in Dec 2019

3- Residential block of flats:
Piling depth 27 m (within the sat Chalk)
Completed in Nov 2019

4- Civic Centre:
Piling depth 15-18 m (within the sat Chalk)
Demolition completed Jan 2021
Piling?

Plenty of possibility to get turbidity into the aquifer generated by piling
Risk of PWS disruption

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April 2019 - Recommissioning PWS abstraction failed because of turbidity

August 2019 – another attempt failed for turbidity again

Further attempts following months failed for turbidity

Cause of turbidity
Likely foundation works (piling) nearby

Feb 2020 Large temporary treatment before PTW and turbidity lowered <10 NTU (**spent £xxxk and lost over 1 year of public water supply**)

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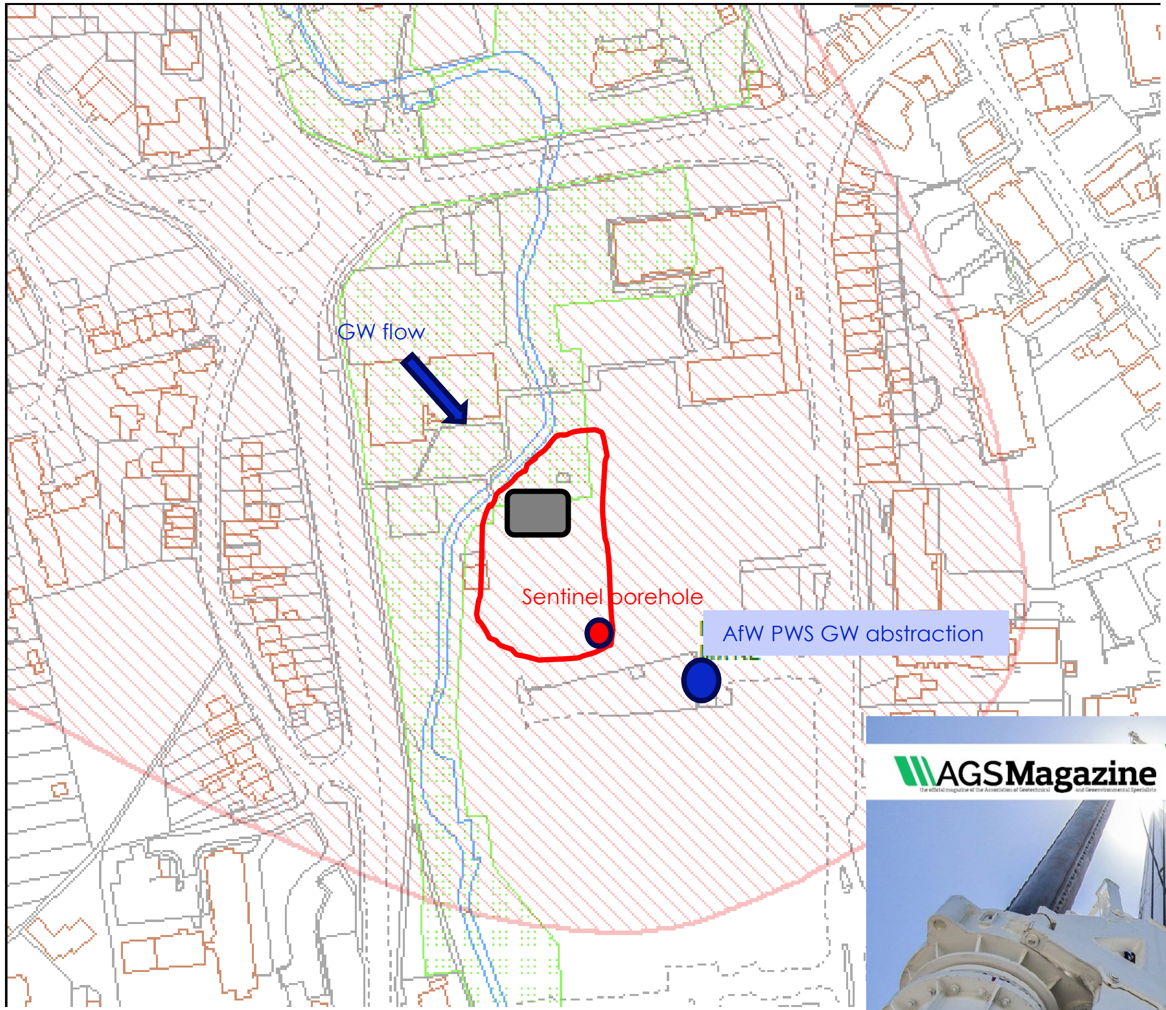
Mitigation measures

Can the Developer consider shallow foundations?

If not, can we agree period for piling works which does not coincide with peak water demand?

Can the Developer install sentinel BH?



AGSMagazine

July 2023

TURBIDITY RISKS FROM PILING

Is further assessment and mitigation required following the increasing drive from regulators and water companies to assess risks?

OPENING CORELINER How the industry takes various approaches to splitting coreliner

GEOTECHNICA 2023 PREVIEW An overview of next week's conference line-up at the Warwickshire Event Centre

SiLC DoWCoP INDUSTRY SURVEY Findings on regulatory challenges for regeneration

Assessment and Mitigation of Turbidity Risks from Piling

Article contributed by
Tim Rolfe (Director, YES Environmental) and Craig Speed (Technical Director, Wardell Armstrong)

In recent years geo-environmental practitioners have experienced an increasing drive from regulators and water companies to assess risks to groundwater abstractions from turbidity that can be created by piling. There is currently no authoritative UK guidance on how to assess this risk.

Piling operations present a number of potential risks to environmental receptors if not correctly managed. These can include vibration and ground movement hazards, noise and creation of new pathways for contamination. Geo-environmental specialists are familiar with assessing risks from piling related to contamination, with reference to the Environment Agency's 2001 guidance (EA, 2001), however, this does not cover turbidity. The Environment Agency has recently commissioned CL:AIRE to update the guidance and it is understood that the revised version will refer to turbidity, but that the release date is unlikely to be before the end of 2023. Planning consents for developments in sensitive areas such as the Source Protection Zone 1 (SPZ1) of a public water supply borehole often include conditions to assess and mitigate risks to the abstraction, and can specifically require turbidity to be assessed.

Why is Turbidity Assessment Required?

Abstractors of groundwater are required by the Drinking Water Inspectorate to regularly test groundwater for turbidity. The turbidity results are used as a marker for risks from pathogens such as Cryptosporidium and E. coli, which the turbidity test does not differentiate from mineral particles. Therefore, if increased turbidity is detected the operator has to shut down the abstraction until mitigation has been implemented (Burris et al, 2020). This has significant implications for supply of water to local consumers and to the cost of water treatment. Additionally, increased turbidity can compromise the disinfection process, and where the abstracted water is treated using membrane filters then the filters can become fouled by the turbidity, resulting in replacement costs running to potentially millions of pounds. Operators of a site at which piling resulted in the shutdown of an abstraction could face significant financial and reputational liabilities.

The turbidity of water presented for disinfection must be less than 1.0 nephelometric turbidity unit (NTU), and in areas where background turbidity is elevated then water companies may apply their own more stringent criteria, which can be as low as 0.2 NTU. These are lower than the UK Drinking Water Standard of 4 NTU when supplied at consumer's taps (DWI, 2016). For context, the image below shows water with 20 to 800 NTU. The abstracted water target is clear to the naked eye and a turbidity sensor is required to detected turbidity < ~50 NTU.

> " The abstracted water target is clear to the naked eye and a turbidity sensor is required to detected turbidity < ~50 NTU.

The low target values that must be achieved by the abstractor, therefore, present significant challenge to the risk assessor.

Case study – abstraction suspected to be impacted by foundation works

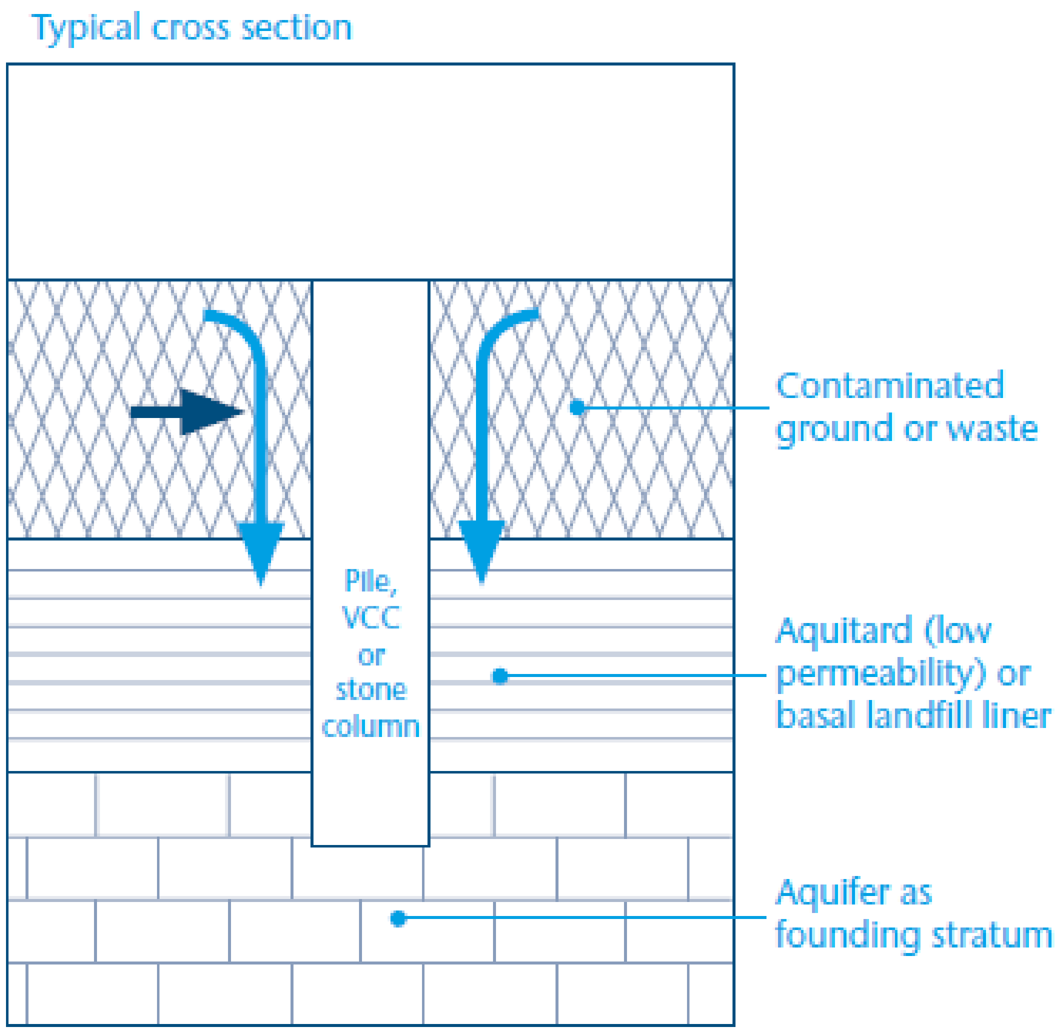
A public water supply groundwater abstraction in Hertfordshire has been affected by persistent turbidity issues in the Chalk aquifer. Intrusive foundation works were undertaken concurrently on three development sites within SPZ1 of the abstraction. Specifically, continuous flight auger piling foundations into saturated Chalk occurred at two separate sites 80 m and 95 m from the abstraction. At another site less than 50 m from the abstraction, vibro ground improvement was applied to superficial deposits directly overlying saturated Chalk. Telemetred continuous turbidity monitoring was in place only for the piling foundations at 80 m the distance site and did not indicate a direct link with the turbidity issues. The other sites either had no monitoring or inadequate monitoring of turbidity, therefore, it was difficult to definitively confirm if either, or a combination, induced turbidity detected at the abstraction.

How to Assess Risks?

Review by others has not identified an authoritative methodology for quantifying risks (Burris et al, 2020), however, a qualitative approach can be employed. By development of a robust conceptual site model (CSM) similar to those used for contaminated land risk assessment, the potential risks can be qualitatively assessed. The principles of source, pathway and receptor creating a potential pollutant linkage are similar to those set out in the Environment Agency's Land Contamination Risk Management guidance (EA, 2021). For the piling CSM the greatest

B – Mobilising of existing contaminants

- the site overlies a Major or Minor Aquifer;
- the site is located within a Source Protection Zone (SPZ);
- groundwater is currently of good quality;
- the water table is shallow or likely to be intersected by piles;
- the geological strata are fractured or fissured;
- works are close to a surface water body and run-off from arisings could pollute those waters.
- piling would breach an aquitard or connect two previously discrete aquifers;



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B – Mobilising of existing contaminants

[redacted] Report No: [redacted] PHOTOGRAPHIC LOG

Client name: [redacted]	Site Location: [redacted]

Photo No.	Date:
17	10/06/15

Direction Photo Taken:

South

Description:

Effluent Collection tank

V44 – V51

Existing contaminants trapped in the unsaturated zone can be mobilised during excavation works

They infiltrates into ground when exposed due to rainfall / drainage

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C – Opportunity to identify source of aquifer contamination

Former Industrial site being redeveloped to residential

Phase I identified likely contamination

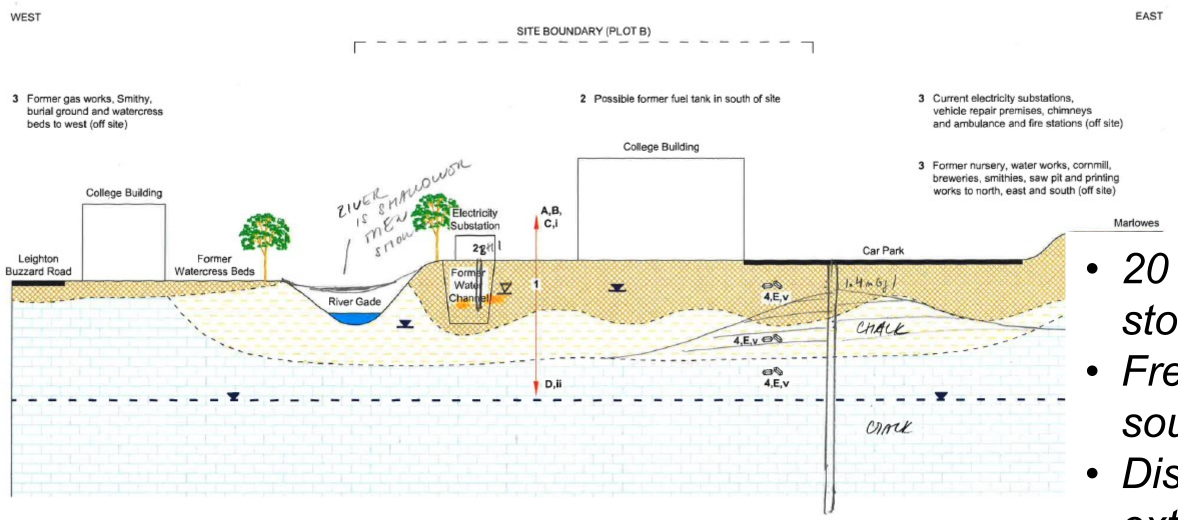
Nearest AfW PWS abstraction has exceedances of PCE, TCE and PFOA

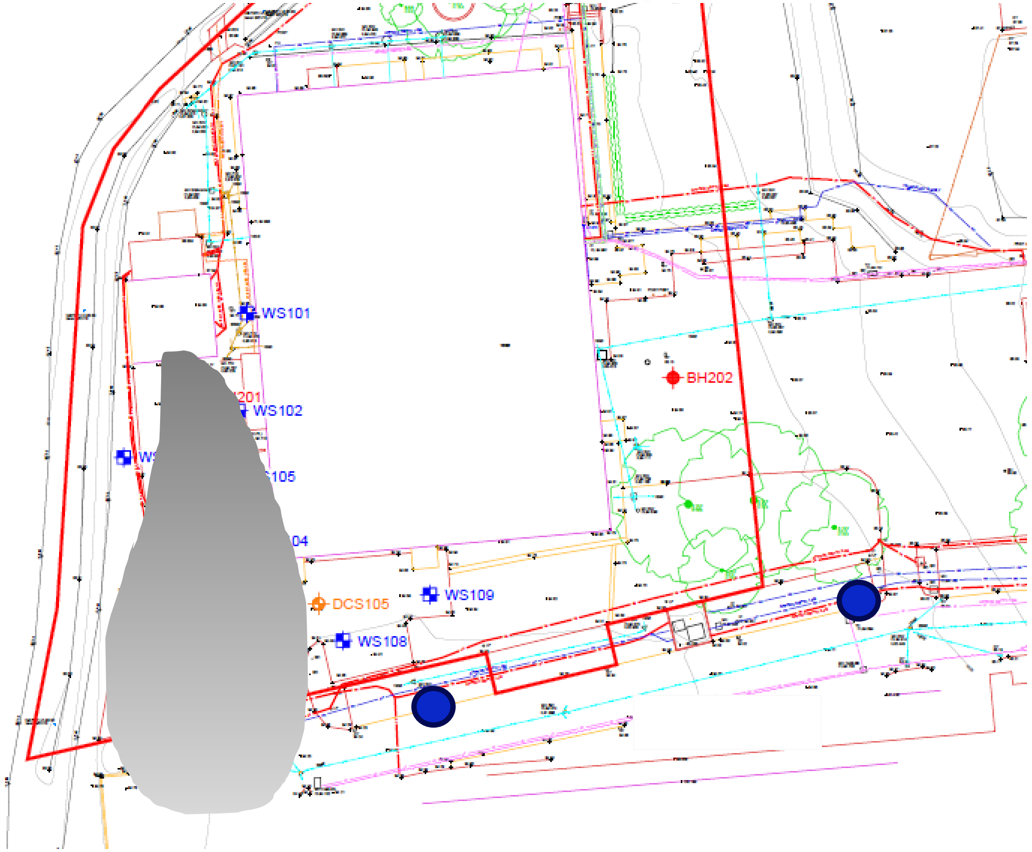
Through consultation process AfW (and usually EA) request Phase II ground investigation (including GW quality)

Phase II confirms presence on site of contaminants, including:

- **Ammoniacal nitrogen**
- **Bromide**
- **Trichloroethylene (TCE)**
- **Tetrachloroethene (PCE)**
- **PFOA**

The site is flagged as likely source of AfW PWS contamination → Site is included in contaminated land regime → Developer undertake DQRA → Agreed aquifer remediation and contamination decreased to acceptable levels agreed with DQRA





C – Aquifer remediation (when things go well)

- *20 years old diesel spill from storage tank*
- *Free phase product near the source*
- *Dissolved phase plume extended offsite*

- *AfW PWS stopped*

- *Env Consultant produced reliable CSM and proposed remediation*

- *Remediation agreed with EA, LPA and AfW and implemented*
- *Post remediation monitoring data satisfactory*

- *Site redeveloped*
- *PWS abstraction protected (minimal disruption)*

C – Aquifer remediation (when things go wrong)

- Electroplating works from post WWII to **2003, when the activity ceased**
- **Illegal discharges found in 1993**
- Some early investigations 2003-2004 (started from Env Health Authority) found soil contamination and chemical stored inappropriately and recommended disposal
- A total of 88 tanks, tubs, drums or jars of potentially hazardous materials was recorded including zinc, cyanide, sodium cyanide, aluminium, chrome VI, various oils (including engine oil),, various acids and alkalis including chromic acid, Si Cadmium, Acetic acid & silver, sodium hydroxide & tin, and heavy metal based dyes.
- The buildings were demolished down to floor slab level in October 2009

From RSK report

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C – Aquifer remediation (when things go wrong)

- The landowner went through a **planning application process (2012 – 2015)** with LPA and EA contaminated land office was involved.
- Despite the site being close to our PWS abstractions (SPZ2) **Affinity Water was not consulted or informed at any time**
- Consultant developed a conceptual site model predicting risks for AfW PWS GW abstraction
- DQRA produced in Dec 2015 modelled contaminant migrating to AfW abstraction using **50 ug/l as DWS for Total CrVI whilst the DWI letter was published in Oct 2015 lowering the DWS to 10 ug/l of CrVI**

- **DQRA model predicted max 2-3 ug/l of CrVIat our boreholes. Based on that, EA, LPA and landowner agreed soil excavation only as voluntary remediation strategy (undertaken in 2015)**
- **In 2015, we were already aware of having exceedances of CrVI at our boreholes (>15 ug/l) but we did not know where was coming from**

- **Site fully redeveloped in a new industrial unit and planning conditions discharged (2018); aquifer remediation very challenging. AfW requested OFWAT £XXM of investment from treatment**

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Scale of the problem for Affinity Water

- 130 out of 600 Ml/d of GW **(22%)** we abstract in Central region has levels of **contamination** that required treatment, over 25 PWS abstraction sites affected
- **9 on going major pollutions** currently affecting over 70 Ml/d in the last 2 decades
- **£ xxxM of investment required for treatment**, **years of disruption of PWS**, aquifer and environment deterioration, reputational damage for all stakeholders

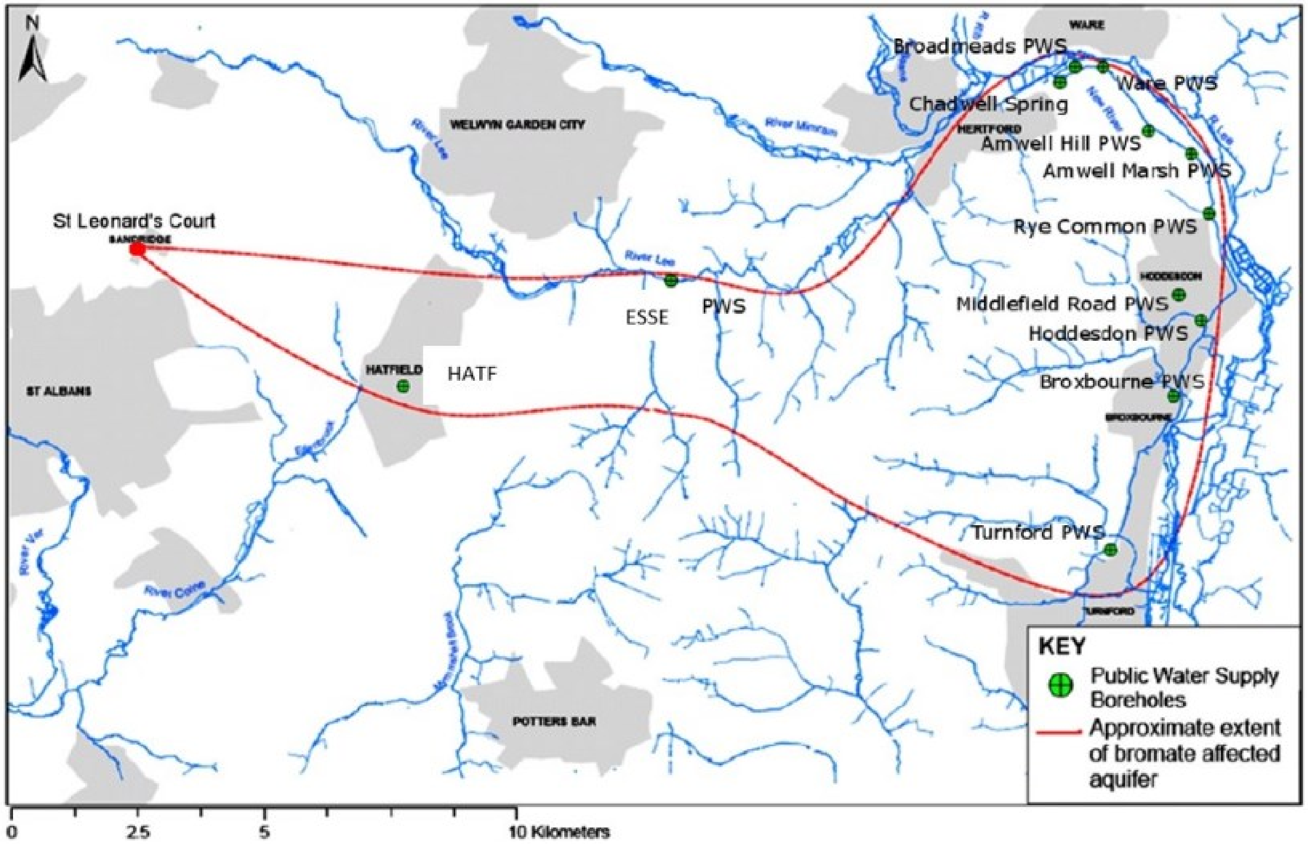

Figure 1
Location map showing the extent of the Herts Chalk aquifer affected by bromate contamination and the distribution of major public supply wells (adopted from Cook, 2010)

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D - Drainage Strategy

A. **Prevent new contaminants** (proceeding from new road drainage, new on site activity, construction works, effluent discharge etc…)**to infiltrate into the aquifer**

B. **Mobilise existing contaminants through flushing**

We look at:

- Historic land use
- New activity proposed on site
- Geology present on site (is it permeable, how infiltration is likely)
- Location and Distance from our nearest groundwater abstraction
- How much the new drainage will affect recharge / improve existing drainage strategy

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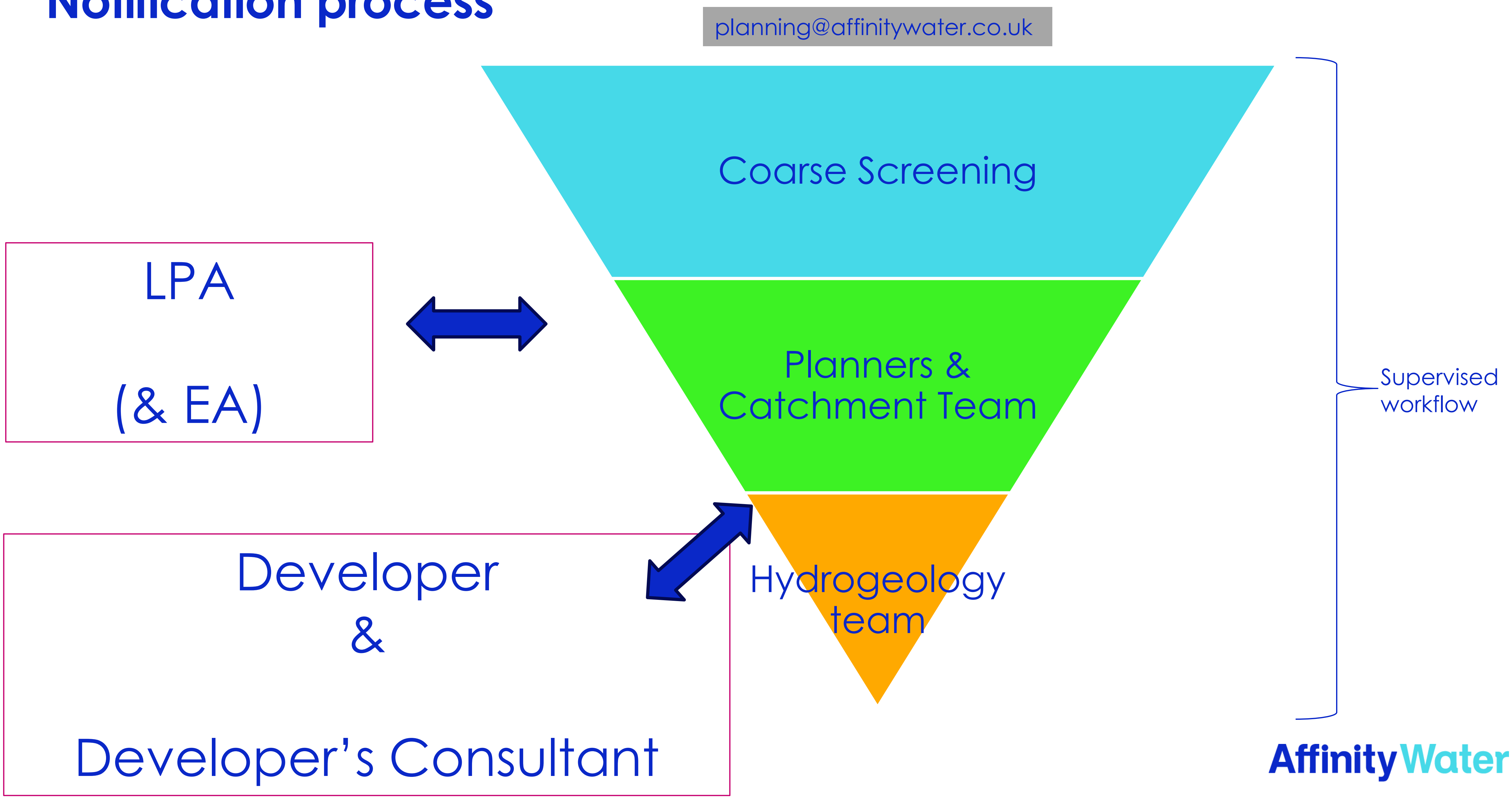
Notification process



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AfW Response to Planning Applications – GW perspective

- Where is it? How far and what location is compared to our PWS GW abstractions?

Far away enough and downgradient a PWS GW abstraction (SPZ3 or beyond)

- What was the historic land use (Phase I investigation)

Grassland, pasture

- What is the new land use?

Residential

- What is the drainage strategy?

Connection to stormwater and foul system

No Issues

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AfW Response to Planning Applications – GW perspective

- Where is it? How far and what location is compared to our PWS GW abstractions?

Very close and upgradient (SPZ1)

- What was the historic land use (Phase I investigation)

Gasworks

Object and Request Phase II – Liaise with Developer to approve RAMS for Phase II

Intrusive works for Phase II can also generate turbidity in the aquifer and mobilise existing contaminants

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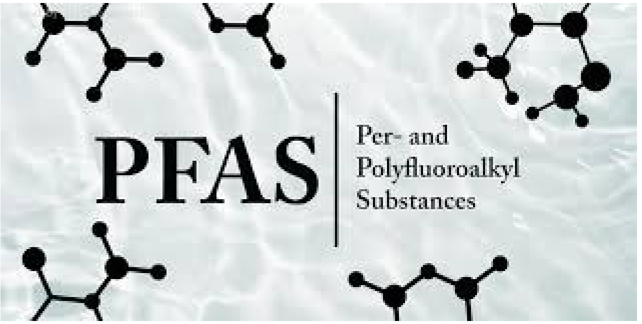
PFAS



- Until 2021 - in UK PFOS DWS = 1.0 ug/l and PFOA DWS = 5 ug/l
- Jan 2021– DWI introduced max concentration of PFOS and PFOA = 0.1 ug/l
- Jul 2022 – DWI extended to a suits of 47 PFAS DWS = 0.1 ug/l
- Dec 2023 – DWI asked Water Companies to reduce individual PFAS compound to 0.01 ug/l

DWI now requires Water Companies to
investigate the "extent of sources of PFAS in their catchments, raw and final water"
and the strategies should clearly detail the "trigger levels and actions required
to reduce the risk of PFAS in drinking water"

So from now on, for suspicious historic land use sites,
we would require developer to undertake some screening for PFAS in Phase II

Any Questions?

Home > Environment > Environmental principles policy statement

Department
for Environment
Food & Rural Affairs

Policy paper

Environmental principles policy statement

Updated 31 January 2023

Environmental principles: an overview

What are environmental principles?

The 5 principles in this policy statement, as set out in section 17(5) of the Environment Act, are internationally recognised as successful benchmarks for environmental protection and enhancement. When making policy, and where relevant, ministers will need to consider the:

- integration principle
- prevention principle
- rectification at source principle
- polluter pays principle
- precautionary principle

The UK government has already committed to these 5 principles through international instruments and processes.[footnote 1]

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