



Ground Source Heat Pumps

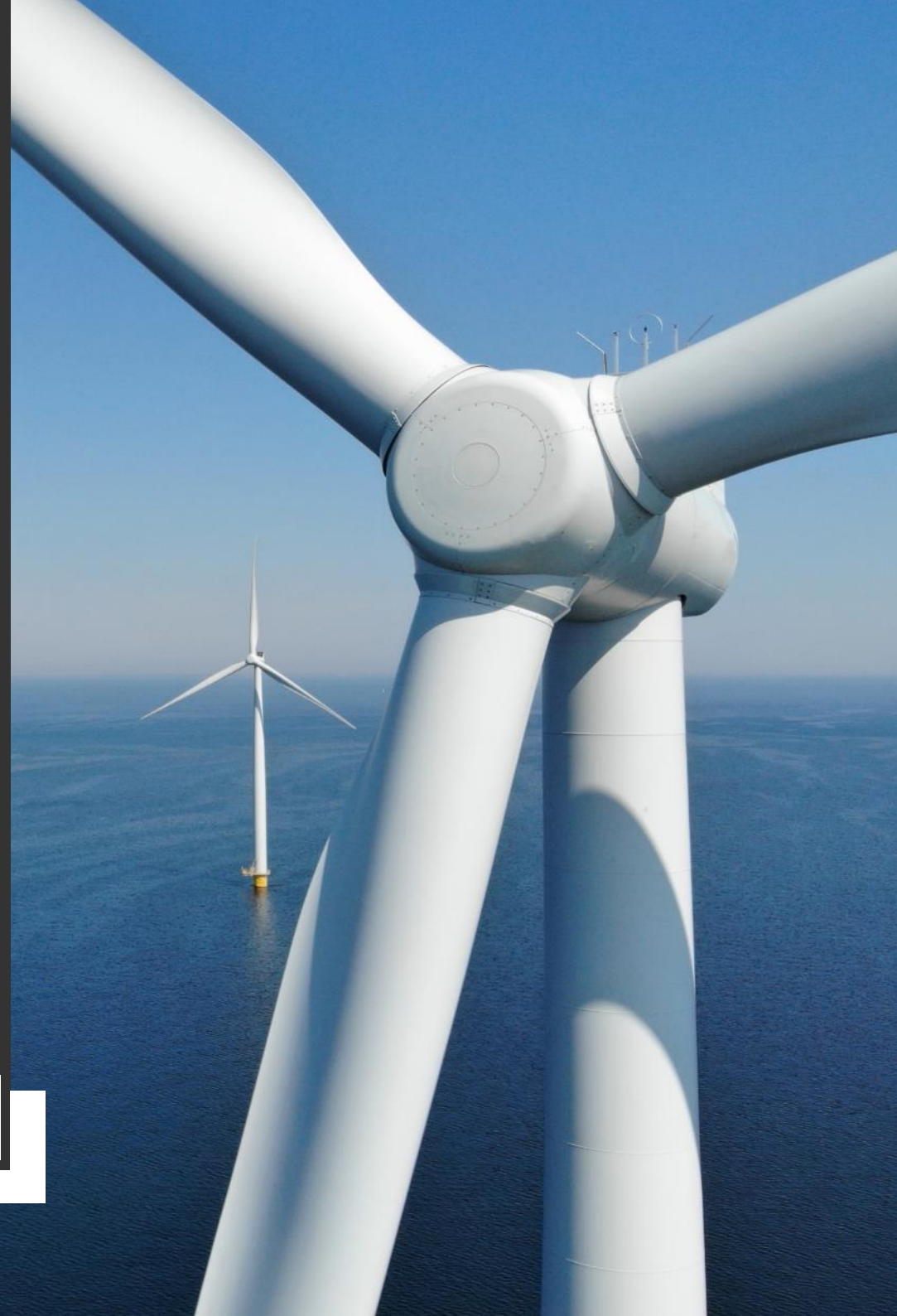
can they be used at contaminated sites?





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Introduction to Ground Source Heat Pumps

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How do Ground Source Heat Pumps work?



Ground Source Heat Pumps (GSHP or GSHC)

Thermal energy in ground or groundwater is extracted and amplified via an electrically powered heat pump

Can use simultaneously for heating and cooling within the same system

More expensive to install than conventional fossil fuel system

Running costs 30% of conventional electrical heating (pre cost of living crisis)

50-70% carbon reduction

Efficiency 300 to 400% (wrt electricity required to run them)

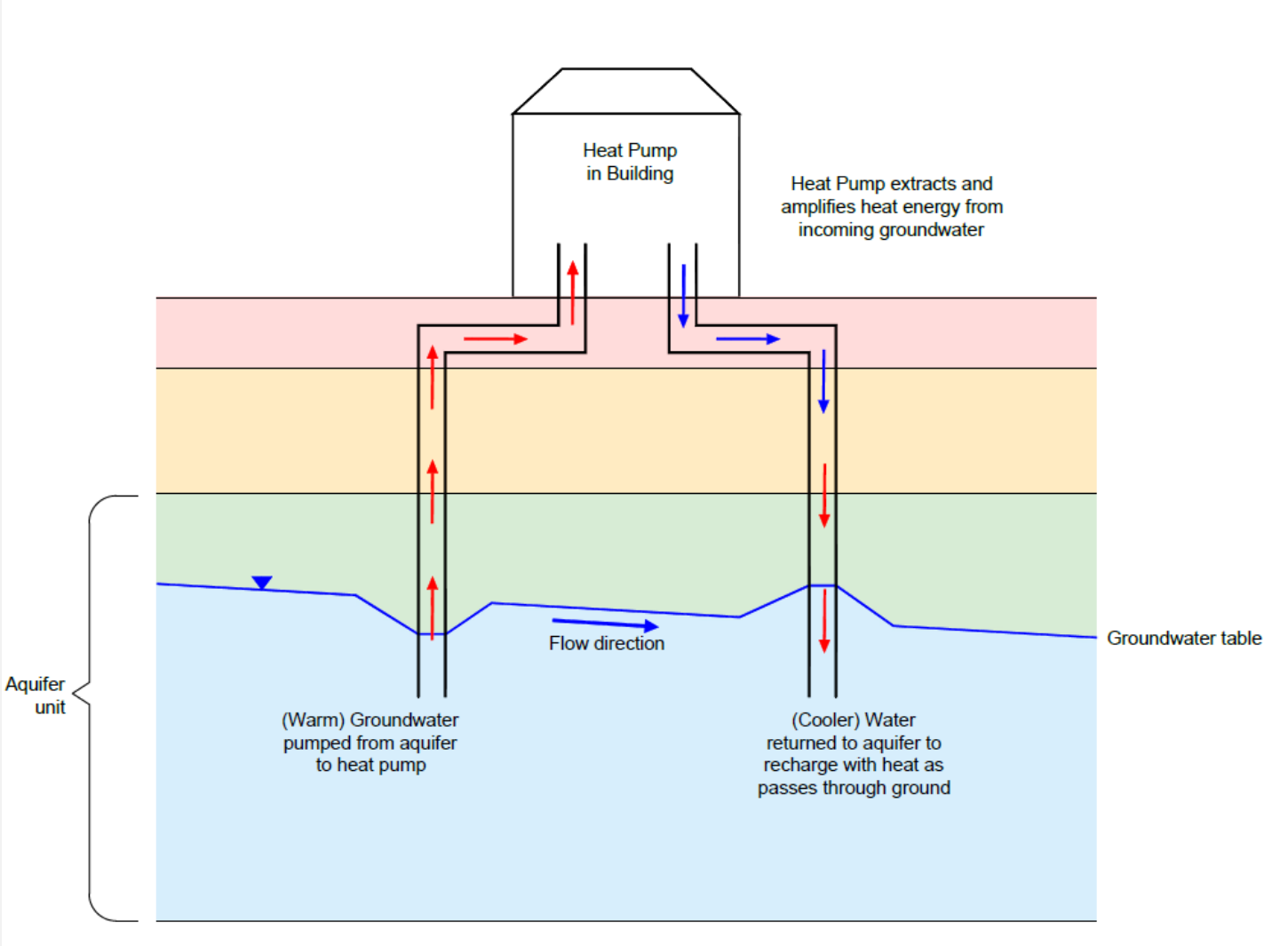
Open loop

Solar thermal energy from groundwater is extracted from an aquifer

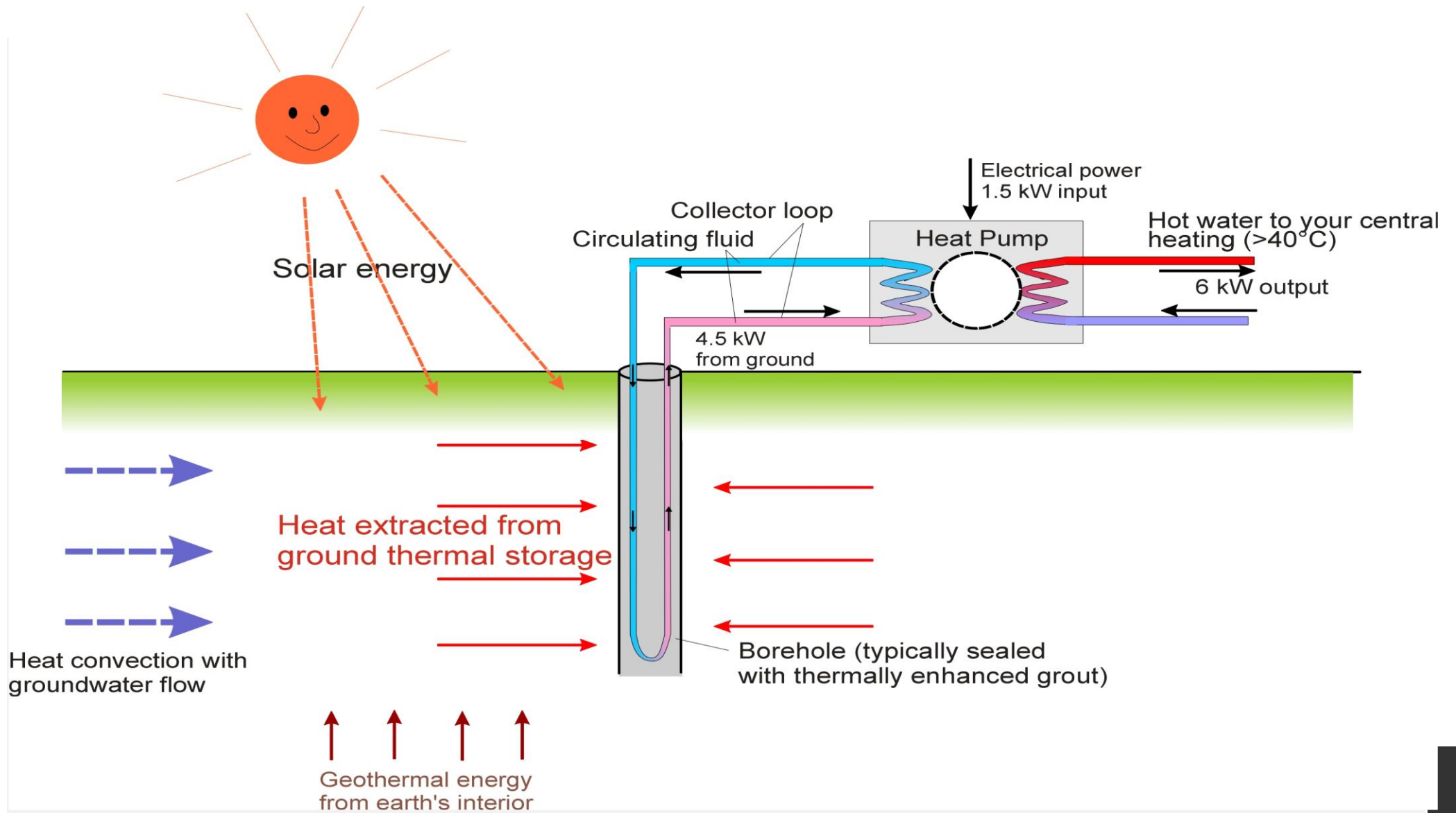
After use the water is either returned to the ground (non consumptive); or used as a private water supply or discharged to a sewer or watercourse (consumptive)

Beware of thermal interference – extraction and re-injection boreholes have to be adequately spaced

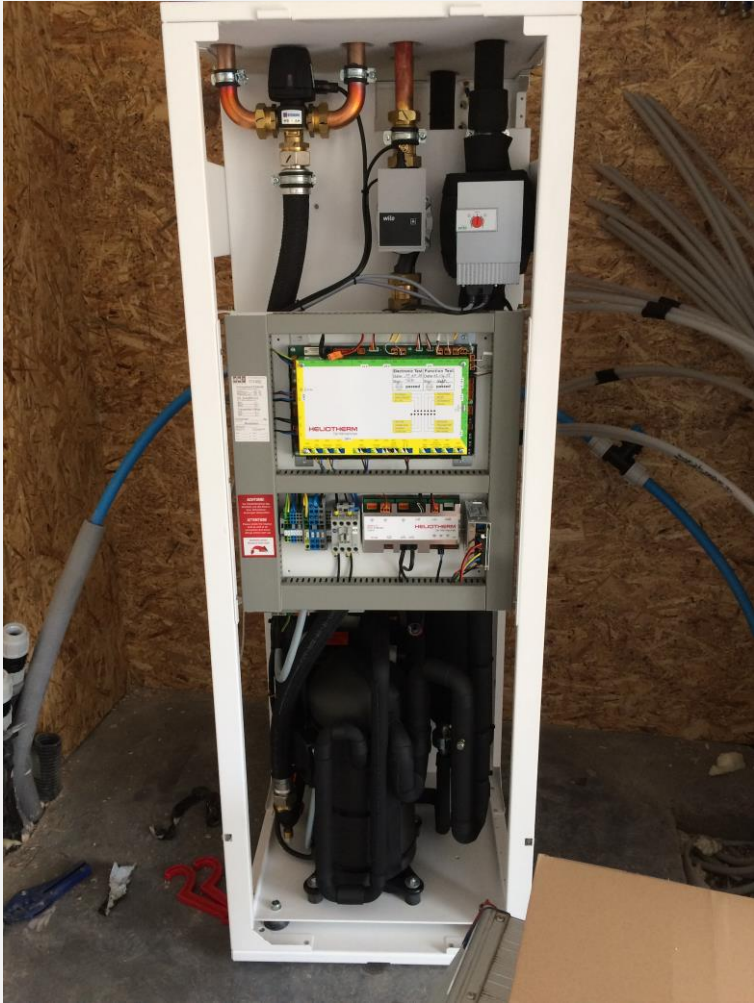
Open loop



Closed loop



Closed Loop



Photos courtesy of Iwan Jones (domestic vertical)

Closed loop - vertical



Geology impacts installation depth, drilling method, drilling costs and borehole thermal performance

Contain U-tubes of polyethylene pipe

Some systems utilise concentric pipes

Typically installed to depths of up to 250m but may be >500m

Closed loop - horizontal



Trenches 1 to 2m deep, typically 1m wide

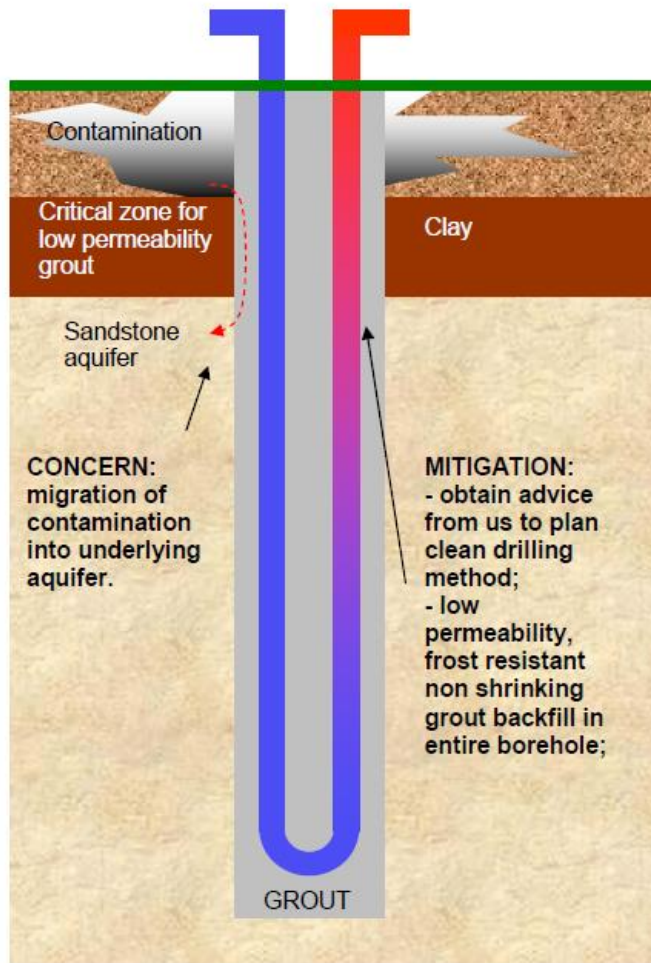
Usually excavated as a trench – sometimes an entire area is lowered, pipe laid and then re-covered

Various pipe geometries to suit space and application
(GSHPA website, 26/9/2022)

“for a newly built 3-bedroomed house of around 120 m² with a heat loss of around 6kW, two trenches of 30-40 metres in length would typically be required.....

the installed cost of a horizontal GSHP system is likely to be in the range £1,250 – £1,750 per kW of capacity, with that for a vertical borehole closed-loop system in the range £1,750 – £3,000 per kW.”

Risks



Boreholes can create connections between surface & deeper aquifers or aquifers

Driller needs to be competent

Drilling method & disposal of arisings

Low permeability, 'thermal grout'

Be aware of geology, drilling risks

Artesian groundwater flow etc

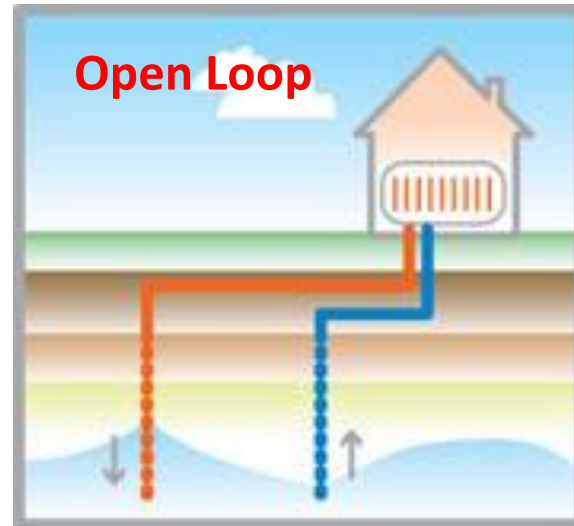
Start thinking about contaminated land



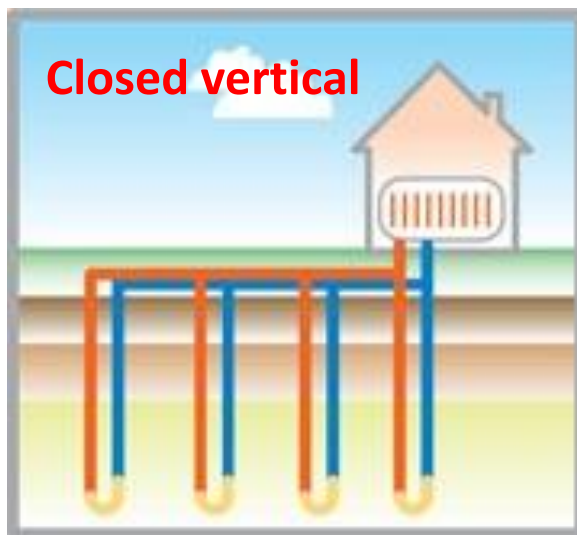
Legislation & Guidance



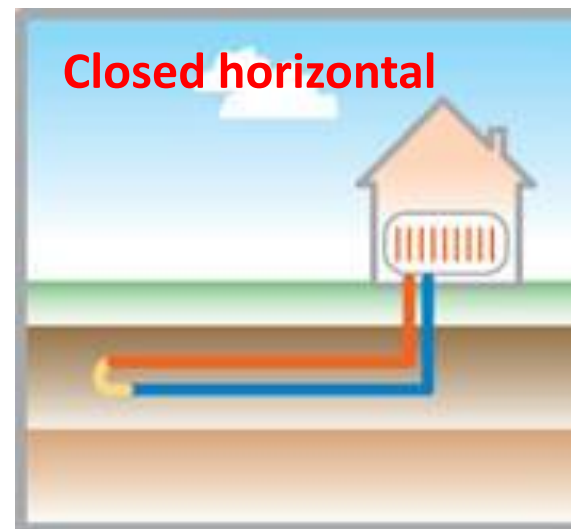
Ground source systems and regulation



EA regulates
all schemes
under
existing water
resource laws



EA not
involved.
Potential
involvement
with large
schemes via
planning



EA not
involved,
(too many
and low or
no impact)

Open loop: Legislation

Abstraction:

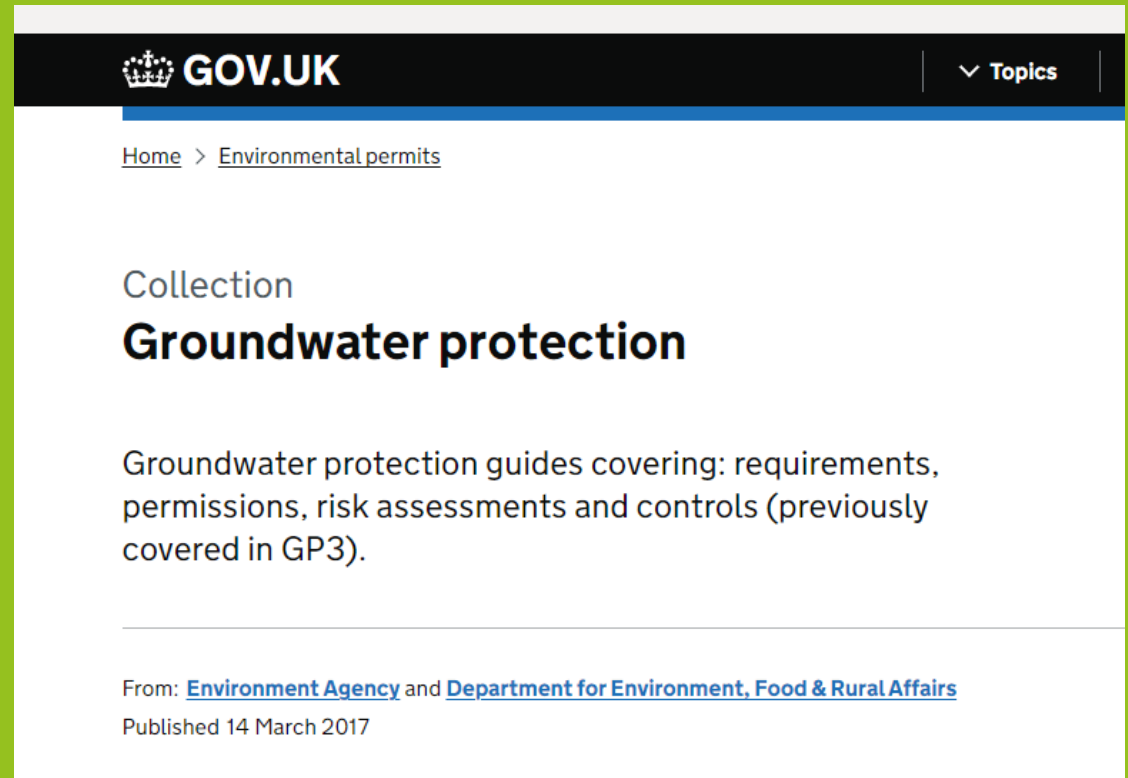
- Consent to investigate groundwater
- Licence for >20 cubic m per day

Discharge:

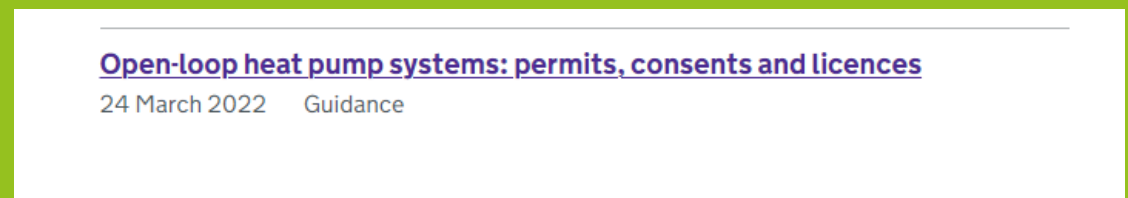
Bespoke environmental permit or an exemption

Heat transfer to groundwater is not currently regulated

However, discharge must be < 25°C and difference between abstraction and discharge no more than 10°C



The screenshot shows the GOV.UK website interface. At the top, there is a black header with the GOV.UK logo and a 'Topics' dropdown menu. Below the header, a breadcrumb trail reads 'Home > Environmental permits'. The main content area features the heading 'Collection' followed by 'Groundwater protection' in a large, bold font. A descriptive paragraph states: 'Groundwater protection guides covering: requirements, permissions, risk assessments and controls (previously covered in GP3)'. At the bottom of the page, it lists the source as 'From: Environment Agency and Department for Environment, Food & Rural Affairs' and the publication date as 'Published 14 March 2017'.



This screenshot shows a specific document page. The title is 'Open-loop heat pump systems: permits, consents and licences' in a bold, purple font. Below the title, the date '24 March 2022' and the category 'Guidance' are displayed.

Closed loop: Legislation

Nobody is 'regulating' your closed loop drilling.

There is no statutory permission for closed loop except in coal mining areas

Large closed loop schemes may be 'picked up' by the Environment Agency or Water Companies via the planning process

If the works cause contamination to controlled waters the client would be liable.

Inputs of pollutants may be considered a groundwater activity under the Environmental Permitting Regulations and may require a permit. Including leakage of thermal transfer fluid

Guidance



Environmental good practice guide
for ground source heating and
cooling

GEHO0311BTPA-E-E

Open-loop groundwater source heat pumps: Code of Practice for the UK

Harnessing energy for heating and cooling
from water in the ground



GSHP
association

CP3
2019

Contaminated land guidance: closed loop - vertical or horizontal beneath water table

Tick box		Check whether the proposed site is in these locations
Yes	No	
		Within a defined groundwater source protection zone 1 or within 50m from a well, spring or borehole used for potable supply?
		On land affected by contamination?
		Close ² to a designated wetland site?
		Within 10m of a watercourse?
		Close ¹ to other GSHC schemes?
		Adjacent to a septic tank or cesspit

- Employ professional hydrogeologist and/or groundwater engineer
- If contamination present carry out a risk assessment



Case Study



House builder, London: Requirements

Previously the site of a hotel and heavy industry

Open loop Ground Source Heat Pump(s) to supply 80% of a housing developments heating needs - district heating

Provide 1-1.5 MW of baseload energy. Total required 4 MW (peak)

Remainder to be supplied by air source or gas fuelled conventional heating

House builder, London: Site setting

Lithology	Depth of base (mbgl)	GQRA Contamination	
		Soil	Groundwater
Made ground: top soil or concrete underlain by clayey gravelly sand	3.8	Asbestos, metals, PAH, TPH	Ammonium, total phenols, PAH, TPH and metals
Alluvium: stiff CLAY with silt	>4.7	Metals, PAH. TPH	
Alluvium: River Terrace Gravels – silty, sandy GRAVEL	>5		
Thanet Formation- SAND with gravel and cobbles	11.7-13.5		none
White Chalk	[Dissolution feature at top, fractures]	Not tested	

House builder, London: Sources and receptors

Sources: Contaminated soil and groundwater

Receptors:

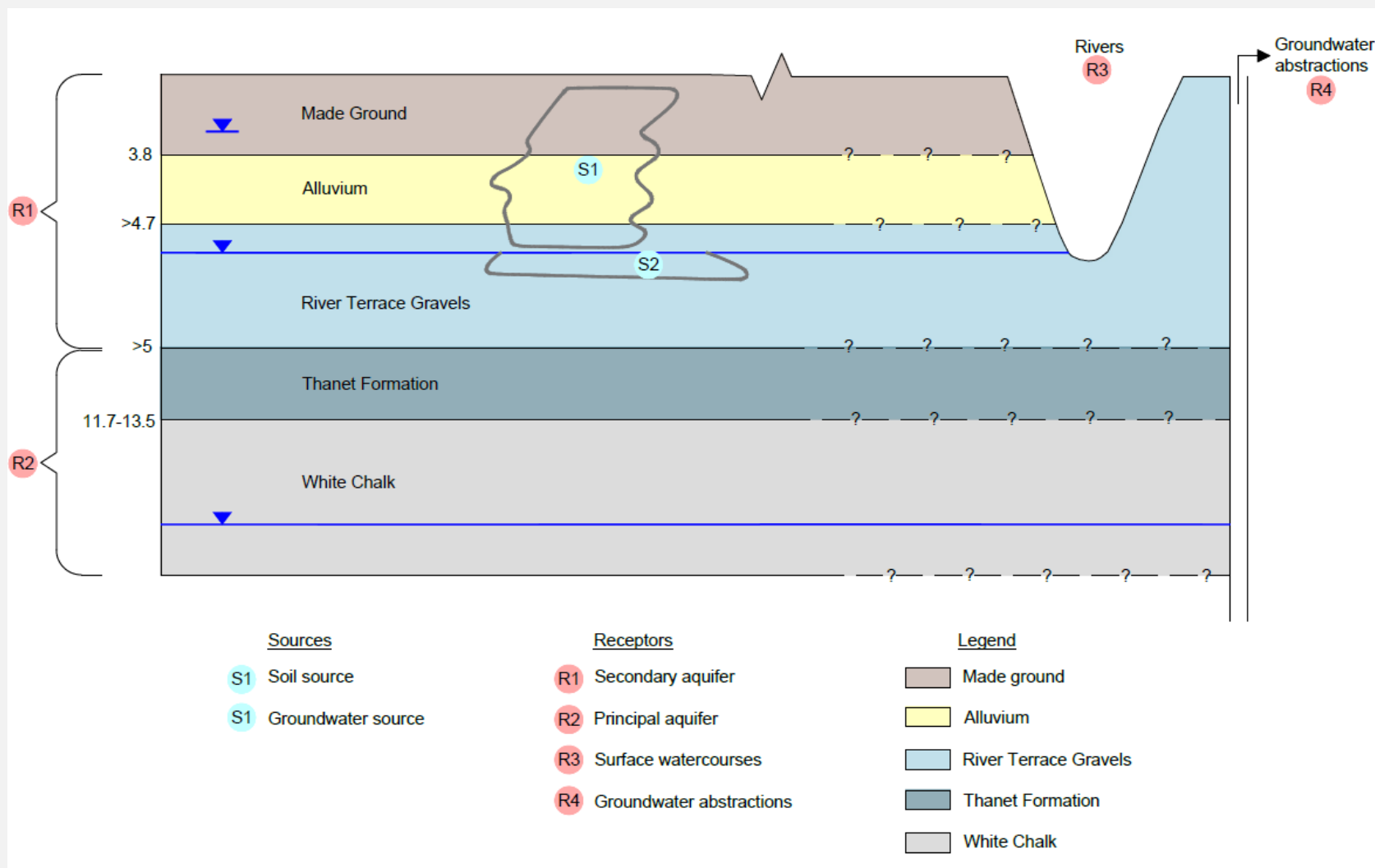
Groundwater:

- Alluvium Secondary undifferentiated aquifer
- River Terrace Gravels and Thanet Sands Secondary A
- Chalk principal
- 2 groundwater abstractions 385m NE for general use. No SPZ within 1 km

Surface water:

- Unnamed stream 35m NW
- River Thames 750m N

House builder, London: Conceptual Site Model



House builder, London



Ground Source Heat Pump Association

Good practice guide for ground source heating and cooling

September 2017
Version 2

© GSHPA 2017
Email: info@gshp.org.uk

www.gshp.org.uk

Regulation: YES

- Vertical open loop
- Principal aquifer
- Contamination present

See GSHP Association, Good practice guide for ground source heating and cooling

House builder, London: Open loop vertical ground source heat pump - solution

Initial 2 boreholes 135m deep

Preliminary risk assessment carried out

Clean drilling

Upper borehole section was augured to remove any potential contamination

Temporary steel casing to seal from surface to below the clay (about 7m)

Drilled to the top of the chalk with a closed water conditioning /circulation system

Steel casing installed and grouted back to surface and temporary casing removed

The drill water was disposed of, and fresh water used to drill the chalk section

Best practice was followed so EA were “hands-off”



Concluding remarks



Concluding remarks

GSHP - important role in net zero goals

GSHP can be used at contaminated land sites:

Open loop regulated

Closed loop little regulation, therefore closer subcontractor supervision needed

Q. How can the contaminated land industry support the GSHP industry?

Involve a competent hydrogeologist and/or groundwater engineer

Carry out a risk assessment for contaminated land and drilling risks

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