



# **SEPA's requirements for activities related to geothermal energy – Consultation**

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# 1. Purpose and Scope

This guidance is directed at anybody planning to install a geothermal energy system. It is designed to help developers understand what authorisation is required by SEPA for controlled activities<sup>1</sup> associated with geothermal energy systems.

This document:

- describes the types of geothermal energy systems commonly in use in Scotland;
- describes the potential risk to the water environment from them; and
- sets out the authorisation required under The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR), which is administered by SEPA.

Other permissions may also apply e.g. from the Coal Authority or Planning Authority. However this aspect is not covered in this document.

This guidance does not cover activities associated with the extraction of thermal energy from other water sources e.g. water in lochs or the sea.

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<sup>1</sup> Under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 (CAR)

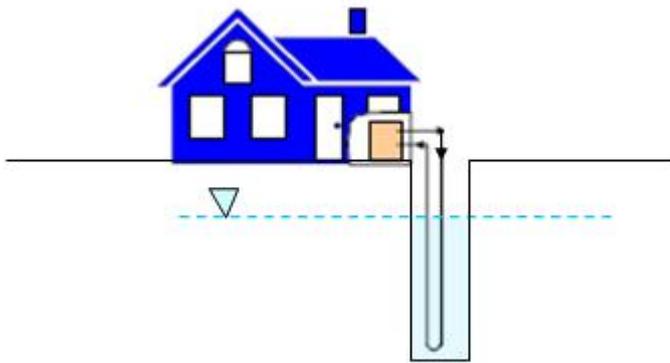
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## 2. Types of Geothermal Systems

Geothermal energy is broadly defined as energy from the interior of the earth used for heating or cooling.

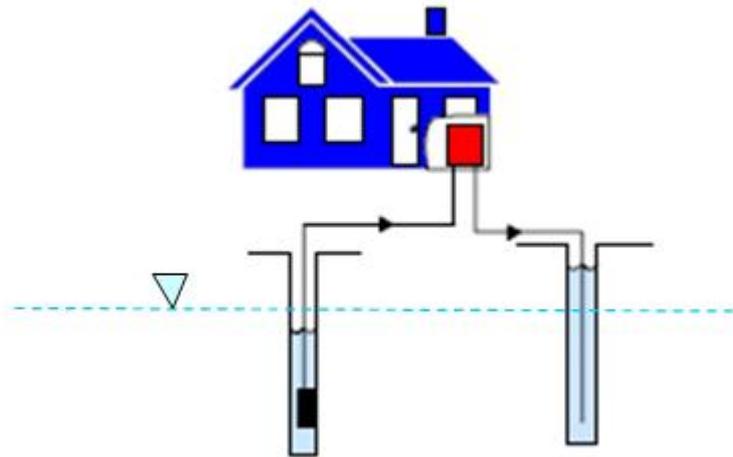
Many schemes that involve the extraction of heat from the ground involve drilling a borehole(s). Most of these boreholes are to depths of less than 200m. Some involve drilling deep boreholes (great than or equal to 200m depth). Some schemes don't require borehole construction and instead involve laying pipework at depths of a few meters.

Some systems do not involve abstraction or discharges to the water environment. These are termed '*closed loop groundwater geothermal systems*'. They work by circulating a fluid around a closed system with one part of the circuit in groundwater and one part connected to a heat pump in the building(s) to be heated or cooled (Figure 1). The fluid in the system uses groundwater as a heat source or a heat sink.



*Figure 1: Example of a closed loop geothermal system. Taken from Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004*

Other systems involve abstracting groundwater, which is used as a heat source or sink in a heat pump, and then the water is returned to the water environment. These are termed '*open loop geothermal systems* (Figure 2)



*Figure 2: Example of an Open Loop geothermal system Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004*

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## 3. Potential Impacts on the Water Environment from Geothermal Systems

Geothermal energy schemes can involve the following key activities:

1. Construction and operation of a borehole or boreholes;
2. Abstraction of groundwater;
3. Subsequent return of the abstracted groundwater to the water environment.

The risks posed by geothermal activities will depend on the activities involved and are described below.

### **Borehole construction and operation**

Borehole construction can pose a risk to the water environment by:

- the introduction into groundwater of drilling fluids or other potentially polluting construction materials;
- the connection of groundwaters with differing water qualities;
- creating a pathway to allow deep poor quality groundwater or any methane present within the strata to reach surface receptors such as rivers or water supplies;
- the creation of a pathway to allow surface pollutants to enter groundwater; and
- the loss of groundwater via uncontrolled artesian flow.

### **The abstraction of groundwater**

The abstraction of groundwater can pose a risk to the water environment and other water users by:

- reduction in flow to surface waters and other surface ecosystems;
- intrusion of saltwater or other intrusion;
- impacts on other water users.

### **The discharge of abstracted groundwater**

The discharge of the abstracted groundwater can pose a risk to the water environment by:

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- the introduction of pollutants to the water environment either by their addition or by discharging the abstracted water into groundwater or surface ecosystems with a differing natural water quality.

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## 4. Regulatory Control

Depending on the type of geothermal energy scheme this can involve the following activities which may require control under [the Water Environment \(Controlled Activities\)\(Scotland\) Regulations 2011](#) (CAR).

1. Construction and operation of a borehole or boreholes;
2. Abstraction of groundwater;
3. Subsequent return of the abstracted groundwater to the water environment;

The level of authorisation under CAR is described further in [Controlled Activities Regulations: A Practical Guide](#).

If you are removing and managing radioactive scales and precipitates from equipment associated with boreholes > 200m in depth then the Radioactive Substances Act (RSA) may also apply. Therefore, where this is the case, you should sample the waste to determine if the substance extracted from the borehole exceeds the concentration of those radionuclides specified in RSA<sup>2</sup>. Borehole construction or water abstracted for geothermal purposes does not fall under RSA.

### **Borehole construction and operation**

#### Boreholes <200m deep

The construction of boreholes < 200m in depth are normally authorised via CAR General Binding Rule 3 (GBR). The borehole should be grouted throughout its length to comply with the GBR and to prevent:

- pollution;
- unacceptable mixing of water between layered aquifer systems; or
- loss of water from artesian aquifers

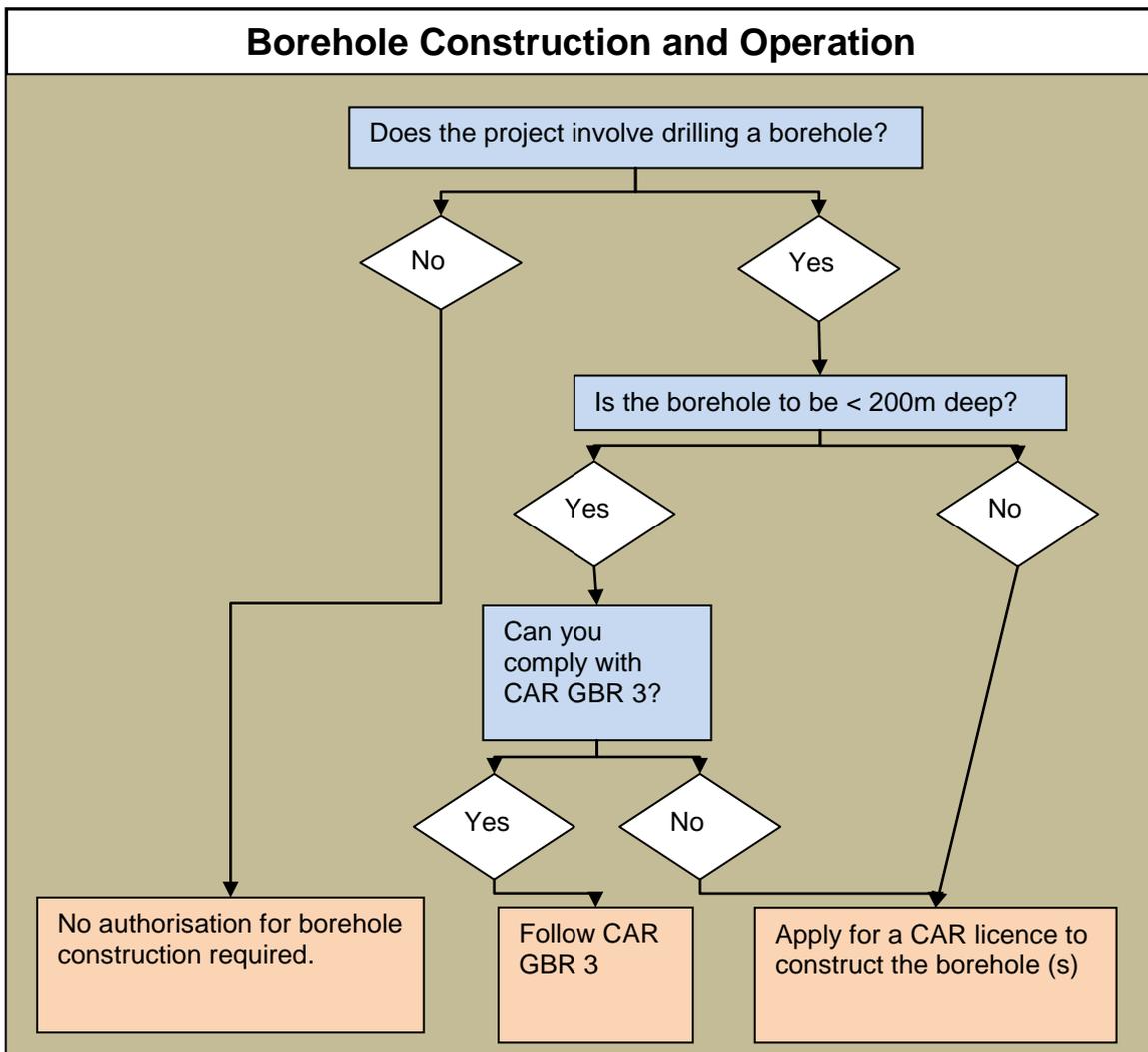
Efficient heat exchange can be achieved by the use of thermally transmissive grout.

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<sup>2</sup> For more details see the Government guidance on the scope of and exemptions from the radioactive substances legislation in the UK (September 2011) <https://www.gov.uk/government/publications/guidance-on-the-scope-of-and-exemptions-from-the-radioactive-substances-legislation-in-the-uk> or Joint Regulators guidance for NORM industrial activities on how to comply with the radioactive substances exemption regime <http://www.sepa.org.uk/regulations/radioactive-substances/guidance-and-reports/>

## Boreholes >200m deep

The construction and operation of boreholes to depths of greater than or equal to 200m require a CAR licence<sup>3</sup>.



## **Abstractions and return of the abstracted water**

### Closed loop systems

There are no abstractions or discharges to the water environment from a closed loop geothermal system and therefore no authorisation for these activities from SEPA will be required.

### Open loop systems – where GBR 17 applies

Open loop systems abstract groundwater and discharge the water back into the water environment. If an open loop system:

- returns water to same geological formation from which it was abstracted; and

<sup>3</sup> See the [CAR Practical Guide](#)

- 
- the chemical composition of the abstracted water has not been altered, by for example addition of chemicals from a cooling process,

then the abstraction and discharge can be authorised by GBR 17.

#### Open loop systems – where GBR 17 does not apply

GBR 17 cannot be used if the GBR conditions can't be complied with, for example, if the abstracted water is returned to another part of the water environment such as a surface water body.

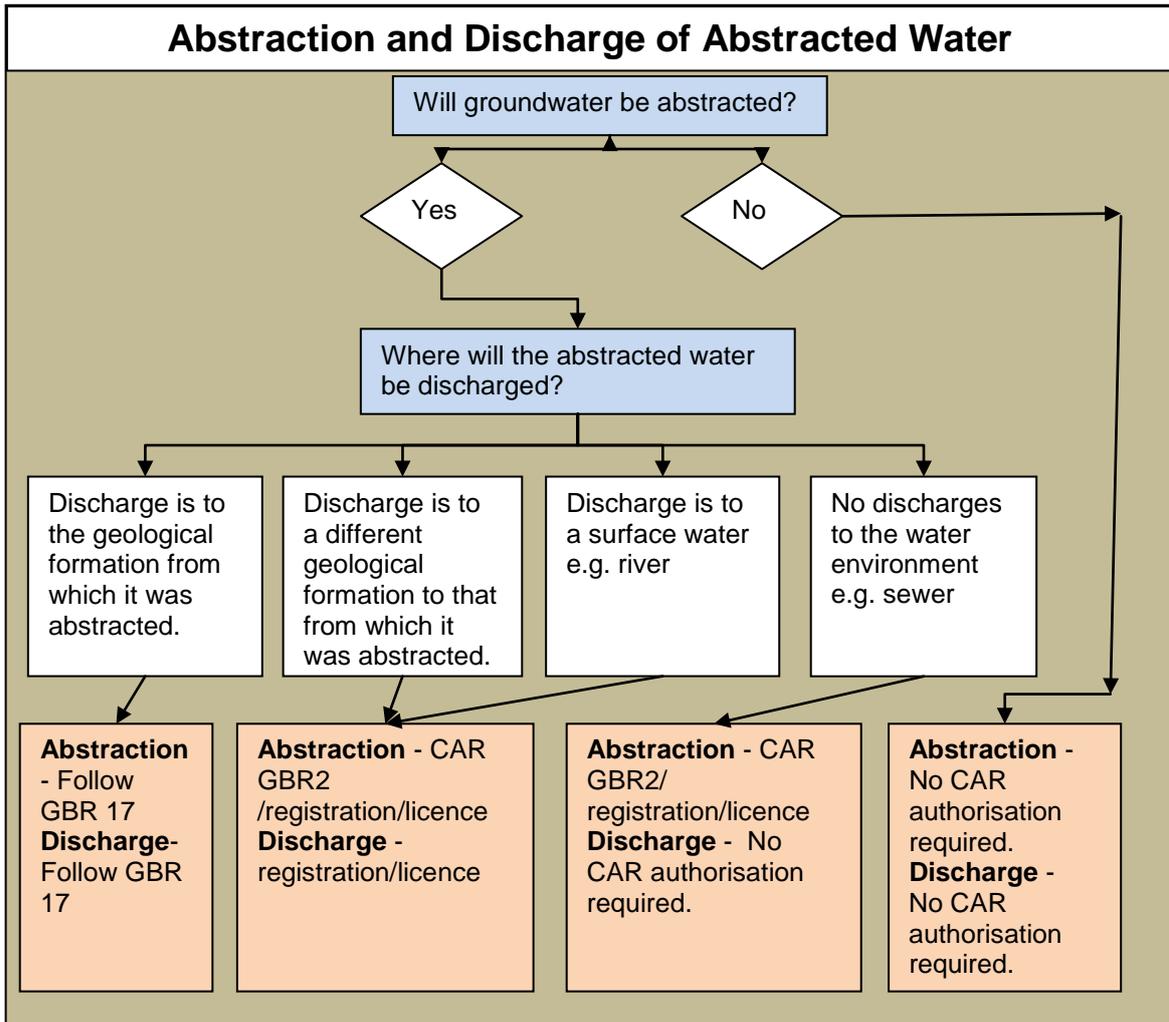
In these cases, where GBR 17 does not apply, the abstraction may be authorised by:

- GBR 2 if it is less than  $<10 \text{ m}^3/\text{day}$ ;
- either registration or licence for abstractions of  $\geq 10 \text{ m}^3/\text{day}$ .

An application to SEPA for a CAR authorisation for the discharge (registration or licence) will be needed. The discharge should be assessed in line with [WAT-RM-05: Regulation of Trade Effluent Discharges to Surface Waters](#) or [WAT-RM-06: Regulation of Trade Effluent Discharges to Groundwater](#). Information on thermal surface water status boundaries is set out in the [Standards Directions 2014](#). [WAT-SG-85: Application of Standards to Thermal Discharges](#) also provides further details. Best practice would be to avoid the addition of any substances (including chemicals) to the abstracted water.

The impact on other receptors such as wetlands and abstractions also needs to be taken into account. Where an abstraction is impacted the use made of the abstracted water will be a key factor when deciding what temperature or chemical change is acceptable.

Note that whilst SEPA would consider the impact of changes in heat on the water environment in relation to whether this is causing pollution, it does not regulate the availability of heat as a resource.



## GBR 17

The rules relating to GBR 17 can be found in the [CAR Practical Guide](#). GBR 17 allows for the 'abstraction and subsequent return of groundwater for the purpose of extracting geothermal energy from the abstracted water'. SEPA considers that:

- A map showing the location of the abstraction and discharge and borehole logs should be kept by the owner/operator to demonstrate compliance with Rule (a).
- any volume of water may be abstracted but the volume of water abstracted and not returned must not exceed 10m<sup>3</sup> per day;
- Rule (c) means that nothing can be added to or removed from the abstracted water which would alter the chemical composition.

Drilling of the borehole is covered by GBR3 provided the rules are complied with and the borehole is <200m deep.

## References

- [WAT-RM-05: Regulation of Trade Effluent Discharges to Surface Waters](#)
- [WAT-RM-06: Regulation of Trade Effluent Discharges to Groundwater](#)
- [WAT-SG-85: Application of Standards to Thermal Discharges](#)
- [Controlled Activities Regulations: A Practical Guide](#)
- Geothermal (Ground-Source) Heat Pumps A World Overview, J. Lund, B. Sanner, L. Rybach, R. Curtis, G. Hellström, GHC Bulletin, September 2004
- [The Scotland River Basin District \(Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values\) Directions 2014](#)
- [The Solway Tweed River Basin District \(Surface Water Typology, Environmental Standards, Condition Limits and Groundwater Threshold Values\) \(Scotland\) Directions 2014](#)
- [Water Environment \(Controlled Activities\)\(Scotland\) Regulations 2011](#)
- [Regulatory Guidance : Geothermal heat in Scotland](#), Scottish Government, January 2016

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