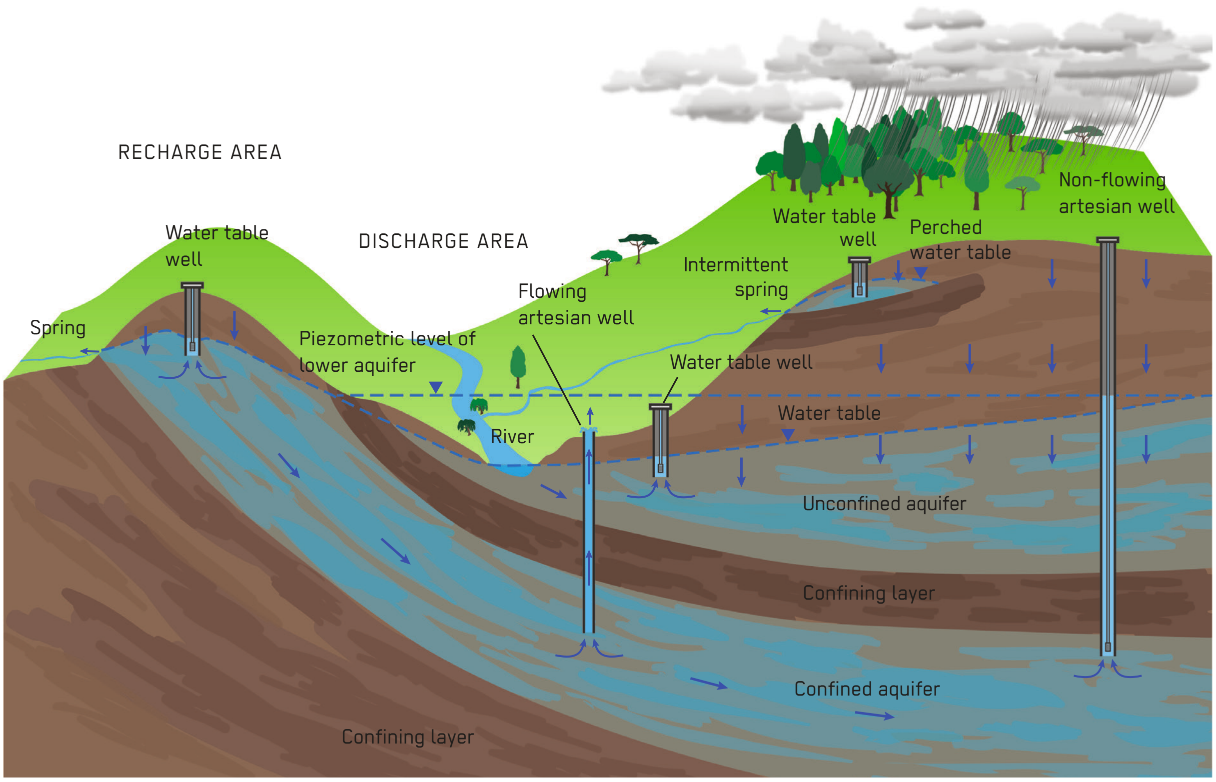
Groundwater



Groundwater originates from both surface water, such as rivers or lakes, and via precipitation that infiltrates the surface. This infiltration is mostly natural, though can be enhanced through managed aquifer recharge techniques. Once in the ground, water collects in the spaces between particles and can flow slowly. This saturated area that allows water movement is called an aquifer, which can be either unconfined (open to atmospheric pressure) or confined (under greater pressure than atmospheric pressure). Groundwater is useful in all phases of an emergency.

Groundwater can flow at different speeds depending on the permeability of the aquifer, although the flow is overall much slower than surface water. The volume of Groundwater within an aquifer depends on the porosity of the rock or soil, though the presence of a lot of water does not necessarily mean it can all be abstracted (as in clay aquifers). In an unconfined aquifer, the water table is equal to the top of the saturated layer since it is open to atmospheric pressure, and the water will remain at this level when accessed by a well. In confined aquifers, which are effectively pressurised between two layers of lower permeability rock or sediment, the water is not open to atmospheric pressure and will rise up in the well to where it is equal with atmospheric pressure. This is known as the piezometric level, and can be below or above ground level. When the piezometric level is above ground level, the well will continue to flow without the need of a pump and is known as an artesian well.

Due to the protection and filtration provided by the overlying soil and rock, Groundwater is often of a much higher quality and requires less treatment than surface water. However, Groundwater quality can vary according to location, depending on the local and regional geology and the proximity of contamination sources. Groundwater quality may also deteriorate depending on how the water is withdrawn and any protection measures that are in place. Whilst nearby wells or trial borings can give an indication of Groundwater quality, the final quality of the accessed Groundwater can only be determined once drilling reaches the Groundwater at the well site.

Microbiological contamination of Groundwater is generally more of a concern in shallow aquifers near either point or diffuse pollution sources (e.g. on-site sanitation systems). Here, the risk of contamination depends largely on various factors that impact the time it takes the water to travel between the pollution source and the abstraction point, where longer times generally produce a better microbiological quality. Although 30 metres is often taken as a rule of thumb for safe lateral distance from a pollution source, it can vary considerably depending on site conditions (particularly the soil type). Outside of emergency conditions, Groundwater withdrawn using simple methods (e.g. a handpump) is often used without treatment. In emergencies, however, Groundwater is generally chlorinated as a standard practice **(T.6)**, regardless of the extraction method. This is to protect against any microbiological contamination in the aquifer itself, and from recontamination of water during transport and storage in the household **(H.1)**, which becomes increasingly important in densely populated settings (e.g. an existing handpump within a refugee camp).
Chemical contamination can occur in different regions and conditions, and the source can be natural or artificial. Groundwater will contain chemicals naturally present in the aquifer or in other contact points, such as the sea. These dissolved solids can affect taste and odour, which can result in some people seeking alternative, and possibly unsafe, sources. Natural contaminants, such as arsenic, nitrate and fluoride, as well as those from artificial sources, such as agricultural or industrial pollution or metal corrosion in acidic Groundwater, can also directly impact human health.
The quantity of Groundwater can vary significantly and depends on the actual aquifer yield and seasonal fluctuations, although this often less pronounced than for surface water. Regardless, good well design can help maximise the potential and efficiency of abstraction **(see I.8)**. In the long term, the total water abstracted from an aquifer for all the different needs it satisfies (including existing withdrawals as well as springs, rivers and wetlands) should not exceed the total water entering the aquifer. This can be calculated through a water balance estimation that considers the climate and catchment area, both of which affect the water that recharges the aquifer, as well as the total demand on the aquifer. This is of particular importance if large volumes of water are to be abstracted. Where this is not considered, over-abstraction can draw down water levels in other wells, which in turn leads to higher pumping costs and reduced yields, as well as the drying out of springs and wetlands, water quality deterioration, conflicts, and in coastal areas, the irreversible salinisation of water.

Applicability: Groundwater is a reliable water source in all phases of an emergency. In the acute response phase, deeper Groundwater is most likely going to be accessed through existing boreholes or wells that, if needed, can be quickly fitted with submersible pumps to pump large quantities of water to a tank. It is possible to construct new wells accessing Groundwater in the acute phase, but these are most likely to be jetted wells or a similar technology, which can access shallower aquifers to reach water quickly **(see I.8)**.

Operation and Maintenance: The over-abstraction of Groundwater can cause environmental damage (e.g. Groundwater 'mining', where ground subsides or the draining of wetlands). Especially for large abstraction requirements, systematic Groundwater level monitoring should be conducted, and provisions for this must be made at the time of borehole construction.

Health and Safety: Groundwater is generally of a better quality than surface water, especially in terms of the microbiological risk. Regardless, it should still be checked regularly, as variations can have health impacts..

Social and Environmental Considerations: Groundwater is generally well accepted as a water source, though this does depend on the taste, odour and physical characteristics. Even though Groundwater tends to be free from microbiological and chemical contaminants, it can still be rejected on aesthetic grounds, which can cause people to revert to unsafe water sources. It is therefore important to follow maximum guideline limits set for all water quality parameters, even if they are not a direct risk to human health.

Strengths and Weaknesses:

(+) Is more likely to be free of pathogens (disease-causing organisms) compared to surface water
(+) Maintains a constant temperature
(+) Not immediately affected by drought

(−) Chemical or physical qualities (e.g. dissolved solids, odour) may be off-putting to users, causing them to resort to unsafe sources
(−) Total water available is limited by the aquifer yield, recharge capacity and borehole design
(−) Challenging to assess water quality or quantity without existing boreholes
(−) Accessing most types of Groundwater requires constructing wells and pumping systems, which requires specialist knowledge and can be expensive
(−) Over-abstraction can cause environmental problems that impact other users and potentially the water quality

→ **References and further reading material for this technology can be found on page 212**