Technology brief

Protected springs

Natural springs can provide water that is as clean as groundwater, but without needing to pump it up to the surface. However, this water can be easily polluted, which is why springs need to be protected. Technology can also make them more accessible to people.

WaterAid/Vlad Sokhin

Springs are common in mountainous areas and can provide safe water to remote rural communities

The water source

Water quantity

A spring forms when the top level of water underground – the water table – meets the ground surface.

The hydrogeology determines how much water flows. It may pour out of a single hole (the **'eye'**) or seep along a line.

Groundwater levels vary less than surface water and are much more constant than rainwater. Quantities may change seasonally as the water table slowly rises and falls but they will be fairly stable on a daily basis. The spring is fed by an aquifer (groundwater stored underground), which is recharged by rainfall. Springs near the top of a hill may only flow in the wetter months, as the aquifer is small. Low flowrates can be enhanced by improving the spring.

Springs are not always in a convenient location. Improving access at the source or piping the water to communities (usually through gravity water systems – see Gravity water systems technology brief) increases the amount of water available for people.

Water quality

Groundwater is a source of clean water, although it sometimes has a high mineral content. Near the surface, it can become polluted. And once it reaches the surface, the pollution risk increases. This is why **spring protection** is essential.

WaterAid

Steps to protect a spring

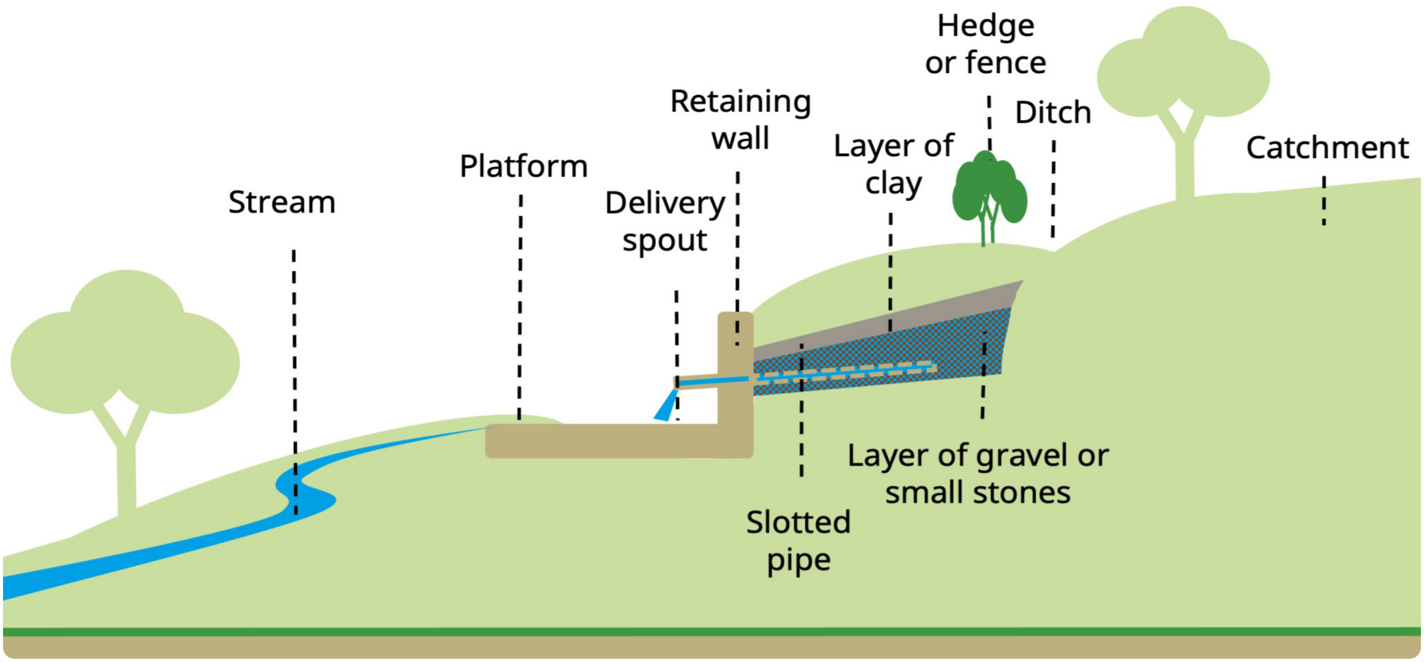
The various technical aspects of a protected spring are designed to prevent contamination, improve access or both. Unlike boreholes or gravity-flow water systems, springs can be improved in stages, with each element providing another contamination barrier or better access.

The **catchment** area above the spring captures the rainwater that feeds the spring. Polluting activities in this area must be limited, especially close to the spring. Building toilets and using agricultural chemicals should be banned. Livestock and people can be prevented from going uphill from the spring by fencing off the area. Surface runoff from the wider catchment area needs to be diverted away from the area above the spring with a ditch and/or a bund (raised mound).

Trying to scoop up water as it seeps into a pool is difficult and it will quickly get muddy. Digging into the hillside allows the water to be captured and channelled into a pipe. A retaining wall will hold back the soil and a platform will stop the area becoming muddy. The pipe needs to be set so it is slightly higher than water containers used locally. Too low and the containers will not fit, too high and water will be wasted. The platform should drain excess water back to the original stream.

The retaining wall and platform may appear to be protecting the spring, but the really important part is behind the wall. When the hole is dug to expose the spring, the area is carefully excavated. The water is allowed to flow to clear away the silt until the eye of the spring is found. The area around the eye is filled with small stones or gravel. This acts as a reservoir and allows the water to flow easily into a slotted pipe. This pipe has lots of holes in it to let the water through but keep the stones out. On top of this is a layer of clay or plastic sheeting. This is the main protection for the spring. It stops water from the surface reaching the eye of the spring. A sheet of plastic or layer of sand might be laid between the clay and gravel to stop the clay being washed down into the spring.

Most of the construction skills required to protect and maintain a spring are straightforward, but excavating the eye does need care as this cannot be inspected after the spring is protected, so experience and supervision are useful here.



Additional steps

To further improve water quality, activities around the spring should be limited. Bathing and laundry should take place downstream. This can be encouraged by building bathing shelters or laundry slabs close by – but downhill of the spring. Livestock watering should take place even further downhill.

If the spring is located close to the community, access to it can be improved. Steps and a path encourage people to approach the spring from below, reducing the chance of contamination. This makes access easier, especially in the wetter seasons, in the dark, and for people with limited mobility.

Springs are often connected to gravity water systems, where water is captured and piped downhill to a more convenient collection point from a reservoir or stand posts.

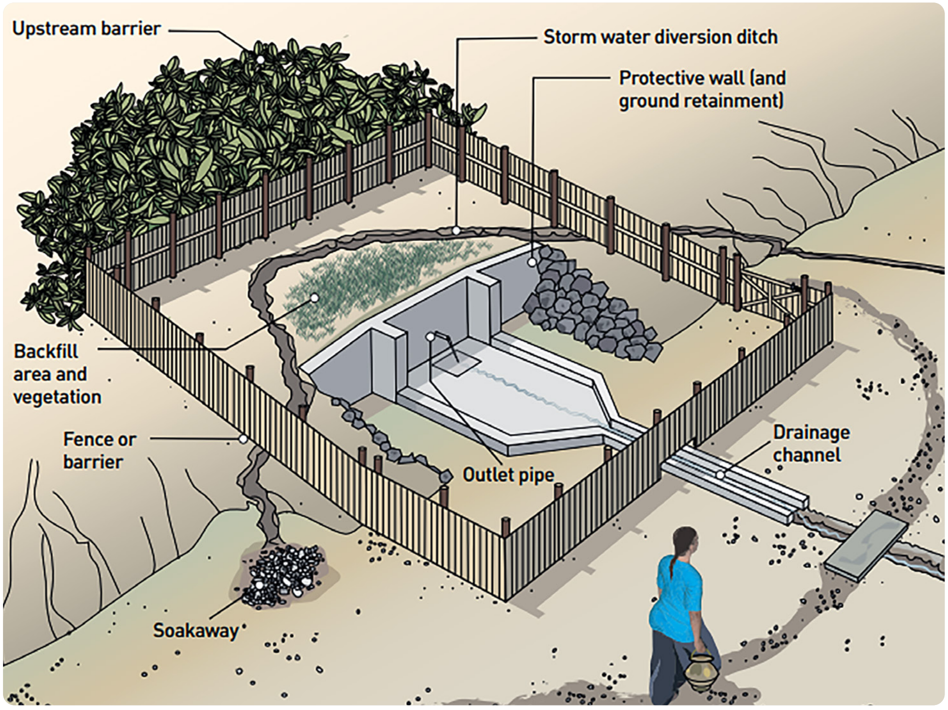
If the flow rate is low (especially in the drier seasons), queues will form. This wastes people's time and can reduce the amount of water used for hygiene practices. One way to increase the flow is to ensure all the spring water is captured when the eye is excavated. This is why this stage of construction needs careful observation. If the water is flowing from several eyes or seeps out along a line, then a long trench might be needed. This is filled with gravel as before and slotted pipes are put in. These form a Y shape with the arms of the Y going along the trenches and the base of the Y leading to the spout.

Adding a tank

Another way to increase yields is to build a tank. This fills up at night when water use is low. An overflow is needed for when the tank is full. The stored water is then used in daytime. Taps are included to stop the water draining away, and people need to know these taps should be turned off when not being used. Sometimes a tank with a porous rear wall is built instead of a retaining wall. Water then seeps in over a wide area. This is called a spring box.

Treating water

The water should not need treating if protection is in place. However, this protection is only as good as the weakest part of the system. The collection of water is a likely point of contamination. Hygiene education helps promote safe storage of water. If the quality is poor in the wetter months or people in the household have health issues (for example, HIV/AIDS), then household water treatment may be needed.



Key features of a well-protected spring source (WHO, 2020)

Issues to consider

Physical issues

The building materials used to protect a spring are commonly available. Mortar and stone or concrete are needed to construct the retaining wall and platform. Water-grade pipes should be used as they need to last a long time. If a perforated pipe is not available, a series of saw cuts along the pipe will work well. Taps are needed to manage water flows if a tank is used. Gravel, clay and materials for a fence may be available locally.

Environmental issues

The presence of a spring is essential. They are only found in certain areas, and have a fixed position. The spring should be naturally clean and run all year round. The flow rate should be measured during the dry season when at its lowest, to work out how many people can be supplied – ideally, flow records over several years should be used. Small springs are unlikely to be regularly measured, so ask people living nearby how often it dries up, if at all. Community members will have valuable knowledge on how the flow of the nearby springs has changed over the years, including whether springs have dried up or been affected by natural disasters, like earthquakes and landslides.

As the spring water needs to be kept clean, protected springs are generally not suitable for urban areas (unless water is piped from a large spring above the area) or where people live above the spring (unless water treatment can be provided).

The changing climate may make springs less reliable, so keeping flow records will be useful for monitoring the spring.

Economic issues

Springs are one of the cheapest water sources to develop, requiring only simple construction and basic maintenance, with low operational costs. The overall costs need to include the need to protect the catchment area above the spring, so farmers may need to be compensated in some way if their activities are restricted.

Social issues

Springs occur on a hillside, so access for people with limited mobility may be difficult. The design should consider accessibility – paths and steps can help but piping water to a convenient location is better.

There can sometimes be land ownership issues around springs, so this should be carefully investigated and discussed with communities before proceeding.

Often springs can only supply a limited number of people. They cannot be enlarged to meet the needs of a growing population, although adding extra storage may be useful to cope with peak demands.

Management issues

Protected springs are normally suitable for small communities rather than individual households or towns. In some locations, multiple springs can be connected to a gravity water system to provide more water. External support is needed to ensure the technology is appropriate. The operational cost can be low, but assistance may be needed for capital and replacement costs, especially where springs are piped to communities.

If a tank is used, people need to be educated to keep it shut when not in use. This tank will need cleaning occasionally.

The spring area does also need to be kept in good repair, so either community work or paying a caretaker is required.

Regular sanitary inspections can ensure continued protection of the water, especially looking at the area around the spring. This can be used to identify maintenance activities.

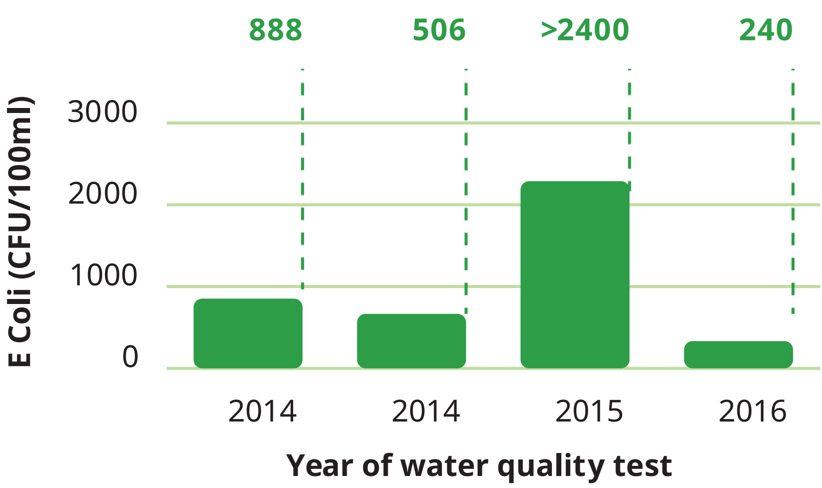
Case study – Protected springs in Timor-Leste

The mountainous geography of Timor-Leste means many communities rely on water from groundwater springs to meet their needs. WaterAid works with communities and local government authorities to protect these water sources and build systems to bring them closer to people's houses. However, poor water quality due to microbiological contamination is common where protection measures for springs are not well maintained.

An example of this is the small mountainous community of Toloa Boro, in Liquica district, where 33 households rely on a gravity water system fed from a spring, built in 2014. The community water management committee is responsible for maintaining the system. However, it was identified that they needed support as routine water quality monitoring of the water source indicated the presence of E.Coli bacterium at quantities greater than 2,400CFU/100ml. Discussions with community leaders indicated that the community was focused on the provision of a large quantity of water and water quality was poorly understood, and they faced barriers accessing materials for maintenance.

The Government of Timor-Leste has created policy and guidance for community-led water safety plans (WSPs); however, these have not been widely implemented yet. These plans can identify potential hazards to water contamination and encourage additional spring-protection measures, such as the construction of drains and fencing off of the springs.

In 2016, WaterAid and local partner NGO and municipal government staff tested the WSP approach with the community members of Toloa Boro. This included water quality testing, awareness raising in the community about why water quality is important, hazard identification and control measures, supporting the community to further protect the spring, and monitoring the impact. The improvement in water quality can be seen in the graph below, with E.Coli significantly reduced after implementing WSP in 2016.



- Top: Poorly maintained spring in Toloa Boro, Liquica
- Above: Community members improving the protection of their spring
- Left: Toloa Boro microbiological water quality results

Useful resources

For more information on protecting springs, see:

Meuli C and Wehrle K (2001). Spring catchment [online]. St. Gallen, Switzerland. SKAT. Available at: http://skat.ch/wp-content/uploads/2017/01/Handbook_Volume4.pdf.

For more information on sanitary inspection forms, see:

World Health Organization (2020). Spring source management advice sheet [online]. Available at: https://www.who.int/water_sanitation_health/water-quality/safety-planning/spring-source/en/

WaterAid is an international not-for-profit, determined to make clean water, decent toilets and good hygiene normal for everyone, everywhere within a generation.

Part of a series of WaterAid technology briefs available at www.wateraid.org/uk/technology

WaterAid (2021). Technology brief: Appropriate technologies for sustainable and inclusive water and sanitation services. London. Available at: washmatters.wateraid.org/publications/technology-resources

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