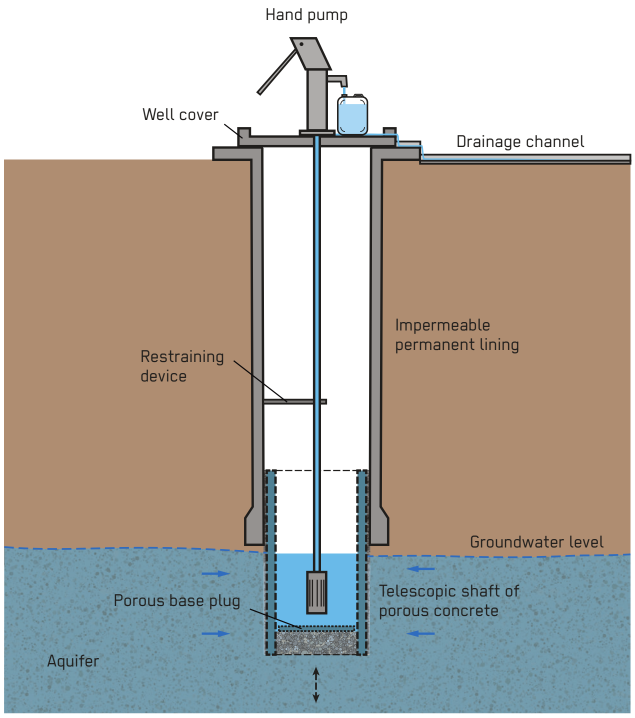
Protected Dug Well

Response Phase	Application Level	Management Level	Objectives / Key Features
** Acute Response ** Stabilisation ** Recovery	** Household ** Neighbourhood City	** Household ** Shared * Public	Extracting shallow groundwater, dug by hand
Local Availability	**Technical Complexity**	**Maturity Level**	
*** High	* Low	*** High	



A Protected Dug Well is a large-diameter structure dug by hand that is lined and covered and allows for water abstraction using a pump. New wells are not normally considered in the acute response phase, but any existing wells can be rehabilitated quickly to provide water.

Protected Dug Wells are normally around 20 metres deep, although some traditional hand-dug wells are much deeper. Variations of dug wells include riverbed wells (capped well lining below a riverbed surface; water accessed with offset suction pump) and infiltration wells (capped well lining in the water table and backfilled above).

Design Considerations: The well shaft below the water table (the intake) must allow water to enter the well. The easiest way this can be achieved is by using porous concrete blocks or rings for the lining, and leaving the base open or lined with gravel layers and/or a porous concrete plug to prevent sand/silt build up and bottom heave (which can happen when water is withdrawn, reducing pressure on the bottom material and causing it to flow upwards). Normally, this porous intake extends between 1–4 metres below the water table, where the depth achieved is dependent on the permeability of the aquifer compared to the rate of de-watering. The well shaft above the water table is normally lined to just above ground level (typically with concrete, though other materials can be used). This lining is not porous, and should also be continuous, so that any water infiltrating from the surface cannot short-circuit back into the well (this can be an issue where gaps between concrete rings are not sealed).
Protected Dug Wells in shallow aquifers tend to be affected by infiltration from rainfall more quickly compared to deeper aquifers, and water table fluctuations of up to several metres between seasons is possible. Shallow well construction should therefore be planned for the end of the dry season. However, this is not always possible in practice, and it is thus recommended to use a design that easily allows for subsequent deepening. For this, the best practice is to include a permanent non-moveable lining for

the well shaft above the water table, with a smaller-diameter telescopic lining that can then be 'caissoned' (sunk while digging) into the water table. This allows the well to be easily deepened at a later date. An additional strategy for wells that seasonally run dry is to use managed aquifer recharge techniques to increase water.

At ground level the well is protected using a slab over the well, a pump, an apron (concrete drainage pan around the well) and a drainage channel (takes spillage water away from the well shaft). In flood-prone areas, the well shaft can also be extended above ground as a headwall to prevent floodwater from entering. Even if shallow wells are protected, there is always the risk of contamination in shallow groundwater, and risk analysis should normally be made. In an emergency however, this will not be a problem when water is chlorinated and is really only an issue when the well is converted to handpump use.

Materials: A Protected Dug Well can be built using local materials. Concrete is often used for most parts of the structure, although the lining can be built using other materials. In addition, some organisations have emergency well digging kits that include a prefabricated lining. A pump is also needed. In the acute response phase, a handpump can be converted to a submersible pump which would also require a power supply, and the water will need to be chlorinated.

Applicability: Protected Dug Wells can be made in most types of ground (except solid rock). However, they can take quite a long time to construct since a wide excavation must first be dug and then lined by hand, meaning that new dug wells are not normally an option for water supplies in the acute response phase. However, existing wells can often be upgraded or rehabilitated in the acute response phase to provide water quickly, typically using a submersible pump and water distribution systems. In these cases, a pump test will be needed to determine the safe yield before upgrading the extraction method. In cases where the well is low yielding and yet in a sandy aquifer, it can be possible to increase the yield quickly by jetting a screen into the bottom of the well to increase water flow into the main well compartment.

Operation and Maintenance: O & M involves ensuring that spillage and other water from the surface cannot short-circuit into the well (e.g. preventing ponding of wastewater, checking the slab and apron for cracks) and using a fence to keep out grazing animals). Occasionally the well might have to be deepened or may require the sand and silt to be removed, which can accumulate over time. Wells may also require disinfection following a contamination event (such as flooding). On occasions where wells have been flooded by seawater, additional pumping will not help, and more time is required (up to two years) for any saline water that has contaminated the aquifer to infiltrate deeper. Overall, though, most of the maintenance burden will likely be related to the pump itself.

Health and Safety: The main risks occur during excavation: collapsing walls, things falling into the excavation during digging, people falling in, worker fatigue, non-robust equipment, lack of ventilation, electrocution, crushed limbs from heavy rings and geared winches. Risks can be mitigated by: avoiding the need to lift heavy things through choice of construction method (using in-situ permanent lining and concrete blocks for the telescopic lining), fencing the well site, having a rescue plan in case a worker collapses, ensuring all diggers wear a construction harness for quick extraction, having a ventilation system during excavation (e.g. temporary 100–150 mm PVC pipe from base of hole to above ground level, attached to the crossbar), ensuring all pumps/generators are downwind and never lowered into the excavation, and fitting submersible pumps with circuit breakers.

Costs: Comparing a hand-dug well and a drilled well where labour is reimbursed, the projected cost per metre for a dug well can be more than for a drilled well, but the overall cost will most likely be less since the dug well will be shallower.

Social and Environmental Considerations: Protected Dug Wells are usually accepted in many areas, as they are the traditional way of abstracting water. However, some aquifers can have significant mineral levels, which can affect taste and acceptability. Shallow wells can also dry up and be more prone to drought, especially those within perched aquifers with limited recharge, but they can also be very responsive to climate change adaptation activities, such as check dams to slow down runoff.

Strengths and Weaknesses:

- (+) Works well for low-yielding aquifers (due to storage ability)
- (+) Can be deepened later, access still possible if pump breaks down
- (+) Lower overall cost for construction compared with mechanical drilling
- (+) Provides good option for certain soil types where manual drilling is not possible
- (+) Greater probability of hitting a useable aquifer (compared to deep wells)

- (−) Takes more time to construct a dug well
- (−) Limits maximum water possible because there is a limited depth to which one can sink the shaft
- (−) Has significant health and safety risks – not good for inexperienced workers
- (−) More susceptible to microbiological contamination compared to drilled wells

→ **References and further reading material for this technology can be found on page 215**