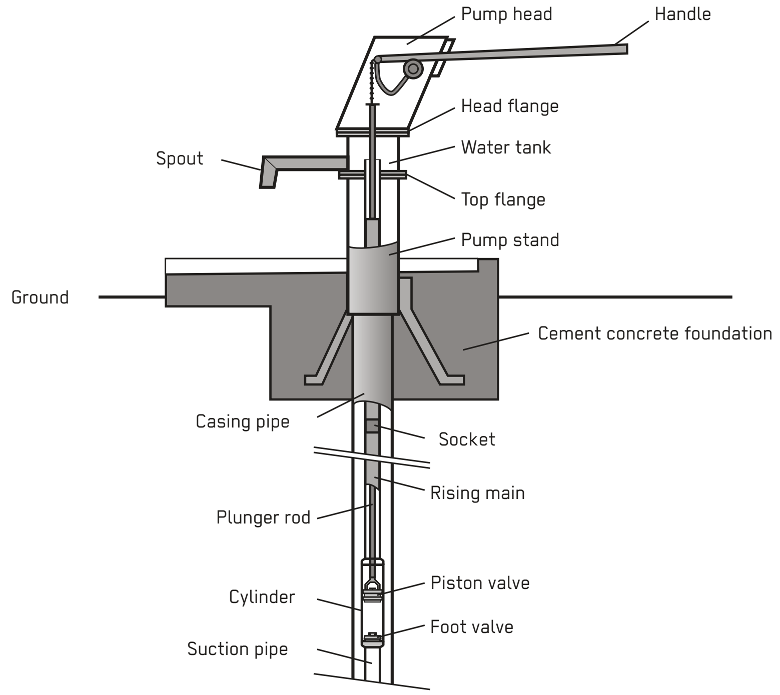
Deep Well Piston Pump

Response Phase	Application Level	Management Level	Objectives / Key Features
Acute Response * Stabilisation ** Recovery	* Household ** Neighbourhood City	Household ** Shared ** Public	Positive displacement pump, medium to deep lift pump, water column lifted with mechanical assistance
Local Availability	**Technical Complexity**	**Maturity Level**	
** Medium	** Medium	*** High	



A Deep Well Piston Pump is a positive displacement pump that displaces a fixed amount of water per cycle. Water is lifted from depths of up to 90 metres with the aid of additional levers or gears. The pump is rarely suitable in the acute phase of an emergency and is instead better for long-term water supply in rural areas with low population densities.

Most Deep Well Piston Pumps are manually operated lever-action handpumps, although flywheel action designs also exist. These pumps function using reciprocating action through a connection from the lever or gear via pump rods to a piston in a cylinder situated underwater. Here the presence of non-return valves ensures water is lifted in the rising main.

Design Considerations: When pumping from over 15 metres in depth, the weight of the pump rods and water column become too much to lift directly, so an additional form of mechanical advantage is needed to make it easier to lift the water column. This is the main feature of deep well handpumps. For depths of up to 45 metres, mechanical levers are generally included in the design (e.g. India Mark pumps, or Afridev design), while for depths of up to 90 metres, either gearing mechanisms (e.g. Duba Tropic pump) or heavy-duty counterbalanced lever systems (e.g. India Mark Deepwell) are used, both in conjunction with cylinders designed for higher pressures. Deep Well Piston Pumps can be used for shallower groundwater, but some designs rely on the weight of the pump rods for the downstroke (e.g. India Mark pumps) so may not perform as well. Flow rates tend to vary between 600–900 L/hour at 40 metres depth for conventional lever pumps depending on the design, which is reduced somewhat for depths of up to 95 metres.

These pumps work using a reciprocating piston within a cylinder. The cylinders can be larger than the rising main (so removing a piston or foot valve requires removing the entire rising main pipe, for example with the India Mark 2) or can have an open top design (where piston/valve removal is possible while keeping the rising main in place, for example with the India Mark 3, Afridev, or Blue Pump). In the latter case, the rising main must have a large enough diameter for the piston and foot valve to pass, which can increase the pipe weight. This has been solved using plastic pipe for the rising main (e.g. India Mark 3 pump or Afridev) and by doubling up the casing to act as rising main (e.g. Blue Pump for a new borehole).

Materials: Materials needed include the pump head, lever or gearing mechanism, rising main (can be plastic), pumping rods (sometimes made with stainless steel) connected to a piston with a non-return valve within a cylinder with foot valve. This type of pump tends to be produced at a few production sites in a few countries and exported, though there have been some attempts at local production.

Applicability: Even though Deep Well Piston Pumps service higher numbers of users than other handpumps, they are still more suited to providing drinking water to rural communities with fewer users per pump rather than for emergencies and/or urban settings with dense populations where manual water extraction from a single shared source may not meet the volume demand **(see S.8)**. It is also essential wherever possible to introduce pump models that are already in use and for which a spare parts market exists.

Operation and Maintenance: O&M can be demanding for Deep Well Piston Pumps as they are designed for greater depths, requiring a more robust pump construction that adds more weight, which in turn requires the use of heavy lifting equipment. Greater depth also means that more equipment must be removed during maintenance, which requires more time and skill. The moving parts, such as levers or gears, also require more regular maintenance and replacement. In certain settings where pumps are heavily used, breakdowns can be expected every three to four months (e.g. for India Mark and Duba pumps) or even monthly (e.g. for Afridev). Some pumps, though, aim to prolong the functionality between breakdowns (12–36 months for the Blue Pump).
Since maintenance will be needed at some point in time for every pump type, certain aspects of a pump can facilitate that maintenance. A design that requires fewer tools for maintenance procedures can help (e.g. Afridev), and if the rising main does not have to be taken out to reach the piston, foot valve or cylinder, the process is easier (e.g. Afridev, India Mark 3 and Blue Pumps). Plastic or metal can be used for the rising main, while metal is used for pumping rods, pistons and cylinder assemblies. Where metal components are used in conjunction with groundwater that has a pH of 6.5 or less, corrosion is likely. This means more frequent replacement of affected parts, especially pump rods and pipes, though the damage can be mitigated by using stainless steel for the pumping rods or cylinder (e.g. Blue Pump) and plastic rising pipes where possible (e.g. Afridev, Blue Pump, India Mark 3), although this may also increase the cost. The frequency of O&M also depends on the quality of local spare parts, which may be poor even where a pump design has been standardised. Added to this is the reality that pumps are not maintained as they should be, usually for various reasons separate from the pump technical design **(see S.8)**. One approach to address this that has been tried for Blue Pumps has been to employ professional regional repair mechanics carry out the repairs rather than the communities.

Health and Safety: One health issue can be over-exertion, even where the pumps have a mechanical advantage. Chemical water quality can become an issue with some metal pumps. Where groundwater has a pH of 6.5 or less, the solubility of iron from pipes is increasingly likely and can cause an indirect health risk, and lead can leach out from certain welds and fittings, regardless of pH **(see A.2)**.

Costs: Deep Well Piston Pump capital costs can vary significantly. For depths of 50 metres, costs range from less than 1,000 USD up to 5,000 USD. Ongoing repair and maintenance costs tend to be between 60–150 USD per year per water point, which is higher than for shallower well pumps. Costs per pump can be much higher (300–600 USD) where maintenance is done centrally and pumps are remote.

Social and Environmental Considerations: Generally, these types of pumps are well accepted and meet the needs of users. As most of these pumps are operated manually, they represent an environmentally friendly water extraction option with limited risk for over-exploiting the water source used for pumping.

Strengths and Weaknesses:

(+) Design is well proven and robust, suited to many users
(+) Can manually lift from deeper depths

(−) Has lower flow rate at deeper depths
(−) More difficult to access the piston/valves on some designs
(−) Greater O&M requirement than other handpump types
(−) Manual versions can be heavy to operate

→ **References and further reading material for this technology can be found on page 216**