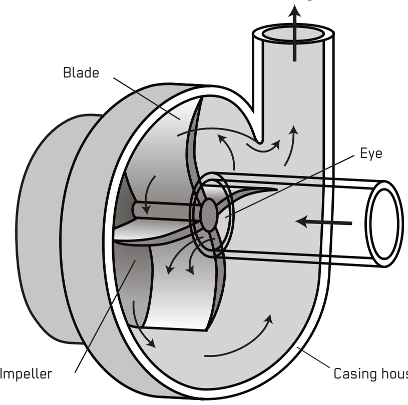
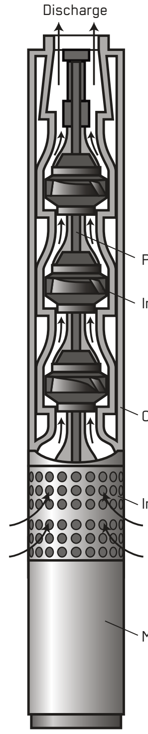
Radial Flow Pump

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





A Radial Flow Pump (also known as a centrifugal pump) is a velocity pump where a rotating impeller displaces varying amounts of water per rotation depending on the speed of rotation, which throws water outwards at right angles to the shaft. The pump is useful for all phases of an emergency.

Radial Flow Pumps function by forcing water towards the outer edge of a rotating impeller, where the discharge is captured by the pump casing and the kinetic energy is converted to pressure energy before leaving the pump. When this happens, a negative pressure zone is created at the inlet of the pump chamber, which in turn draws water into the pump. These pumps can be driven by electricity (grid or solar) or directly by diesel/petrol engines, and they can be situated at ground level (suction pumps) or submersible.

Design Considerations: Radial Flow Pumps can operate over a range of depths up to around 400 metres, with flow rates up to 280,000 L/hour at lower heads. In general, they are good for higher flow requirements, as their mechanical efficiency increases with higher flows. For borehole pumps, a non-return valve is generally installed after the impellers. An important design consideration of velocity pumps is that the water flow can vary significantly with differences in head, meaning that careful design is needed to meet flow requirements. This entails creating a system curve based on the total elevation to which water must be transported plus any additional energy (frictional) losses in the pipe at different pumping velocities **(see S.7)**. Based on this, a pump is chosen where the pump curve intersects the system curve at the desired flow rate. Pump operating points then also need to be efficient. A pump that operates at an inefficient flow rate can develop multiple issues that decrease pump life (e.g. wear and tear on seals and bearings, or cavitation). Pump choice should also match the electricity supply on site (single or three-phase). If this type of pump is driven using

solar power, a Variable Frequency Drive (VFD) is needed **(see S.10)**. Seeking the correct pump expertise is therefore essential to ensuring an efficient pump choice.
Single impeller (single stage) pumps are available, where the operational head of the pump is determined by the impeller type and speed. Where pumping to higher heads is required, (e.g. in boreholes), several impellers can be built in series within one pump (called multi-stage), or single-stage pumps can also be linked in series to double the head of the pump curve. Pumps can also be set up in parallel, with two or more pumping into one pipe. Here, the flow of the pump curve is doubled, which increases the volume that will flow depending on where it intersects the system curve. Borehole pumps have the motor situated below the water intake, and the motor is cooled by a portion of the flow that is diverted past the motor. Where this does not occur (e.g. below screens in a borehole or in a large diameter well), a shroud should be used to first direct water past the motor.
Radial Flow Suction Pumps that are directly coupled on a skid with a combustion engine are often used as a general-purpose pump in emergencies. For such pumps, there is a maximum height to which water can rise in a pipe depending on atmospheric pressure, which itself varies with altitude **(see A.2)**. Another design consideration for motorised suction pumps is to ensure that sufficient pressure is maintained at the suction port to prevent premature pump wear due to cavitation **(see A.5)**.

Materials: Materials needed include the pump stages, a pump motor or engine, and the rising main (can be various materials, but galvanised iron is often used).

Applicability: Radial Flow Pumps are often used in emergencies mainly because they are widely available, although they do require a more detailed pumping design especially for boreholes **(see I.8)**. They are suitable for different water types depending on the pump design. Some single-stage pumps are designed to pump solids, whilst multi-stage borehole pumps tend to have less space between the impeller and casing, so solids can damage the pump. They are used for both drinking and non-drinking water applications.

Operation and Maintenance: Radial Flow Pumps installed at ground level are easier to maintain, as everything is easily accessible. However, many pumps are submersible, meaning that all pipes must be removed to repair or to replace the pump itself. Repair and maintenance will be increasingly likely where pumps have not been sized correctly for the piped system (e.g. operating inefficiently) or are not sized or positioned correctly for a borehole (e.g. excessive velocity across a screen pulls in particles that degrade the pump, **see I.8**). Pump repair should be carried out in a specialist workshop, so the O&M strategy is to have spare pumps on hand in case of a problem. Metal is used for part of this type of pump; where these components contact groundwater with a pH of 6.5 or less, corrosion is likely to occur, which means more frequent replacement of affected parts. For this pump type, the galvanised iron riser main is more at risk than other metal parts, which are made from stainless steel.
In emergencies, the main operational issues with Radial Flow Suction Pumps come from problems with the suction main. These pumps cannot pump air, so any leaks or airlocks in the suction main may prevent the pump working. When starting pumping, the pumps should be primed, ensuring that the suction pipe is connected to the pump with the rubber washer (if not, air leaks into the system) and that there are no holes in the suction pipe.

Health and Safety: Electrical connections from the pump to cable should be correctly spliced with waterproof resin to prevent electric shock or electrocution. This is particularly important where pumps are used to dewater a structure when a person is present (e.g. a protected dug well during construction). Chemical water quality can also become an issue with some metal pumps. Where groundwater has a pH of 6.5 or less, iron leaching from the pipes can cause an indirect health risk, and lead can leach out from certain welds and fittings regardless of pH, causing a direct health risk **(see A.2)**.

Costs: Radial Flow Pumps are relatively inexpensive, with costs starting at 100 USD, and there is a broad range of competing brands and models. Cost increases with increasing flow or head requirements.

Social and Environmental Considerations: Generally, these types of pumps are well accepted by people. A risk of overexploitation of (ground)water resources should be taken in consideration when using this type of pump. For motor driven pumps, major environmental considerations relate to use of consumables (lubrication, oil, chemicals) and power sources. A plan for the appropriate containment and disposal of consumables should be in place. The pump may also be driven with solar power **(see S.10)** to limit the environmental impact of its operation.

Strengths and Weaknesses:
(+) More resistant to aggressive groundwater (through having more stainless steel)
(+) Some pump types can cope with pumping solid particles
(+) Readily available in most countries
(+) Can be safely run against a closed valve for short periods of time

(−) Flow rate changes significantly with increase in head, so a good pumping system design is needed to ensure efficient pumping and lower O&M, yet it is something few people have been trained to do

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