INTRODUCTION

Sealing (grouting) a casing involves filling the annular space between the casing and the drilled hole with suitable slurry of cement or bentonite. Boreholes are sealed to:

- seal the annular space between the casing and the borehole,
- maintain aquifer pressures and prevent the transfer of water between zones,
- seal off aquifers containing poor-quality water,
- protect the integrity of the casing from corrosive soils and waters,
- prevent surface water run-off or shallow subsoil contamination or pollution from reaching the aquifers,
- prevent uncontrolled flow at the surface in artesian wells,
- isolate the targeted production zone from other formations.

Research has shown that the absence of a borehole seal results in contamination of the well from surface contaminants. In addition, the unsealed well can result in the contamination of a sealed nearby well, as the contaminants move with the water from all directions toward the well intake (Fig 1). The same applies to decommissioned or abandoned wells that are not sealed and become contamination pathways into aquifers.

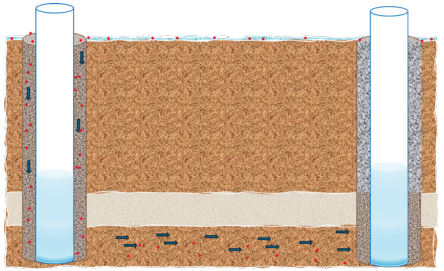


Figure 1: An illustration of how contaminants move through an unsealed or improperly sealed well to a sealed well

EFFECTIVE SEALING

To be effective, a seal must provide a continuous dense lining that completely
surrounds the casing. To achieve this:

- The hole must have been drilled large enough to provide **adequate clearance** between the borehole wall and casing, that is, the annular space should be a minimum of four (4) inches in diameter greater than the outer diameter of the casing.
- **The hole should be conditioned** before cementing to ensure free circulation, low circulation pressures, full return of circulation and hole formation stability.
- **The casing should be centered** in the hole by means of mechanical centralizers.
- **The annular space needs to be calculated**, and allowance should be made for washouts and formation losses.
- **Direct contact between the cement grout and drill fluid should be avoided.** Common drilling practice is to pump a volume of clean water ahead of the grout to provide a spacer between the cement grout and the drilling fluid, or to use a neat-fitting, drillable bottom plug.
- **Grout should be placed or pumped** into place **as quickly as possible.**

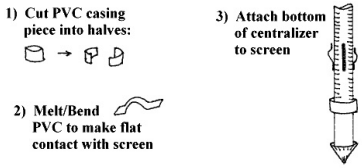


Figure 2: Demonstration of how to make centralizers on site.



Figure 3: Manufactured centralizer

Before sealing, the annular space should be tagged to confirm a clear hole. The seal level should be measured and monitored as grouting is taking place.

GROUT TYPES & MIXING RATIOS

There are 3 types of grout that can be used to seal boreholes. One sack of cement has a solid volume of 12.8L.

Grout Type	Yield/Mixing	Pouring
Neat	50kg cement + 23L water = 35.8L of cement slurry	Poured or pumped into the annulus
Bentonite	Chips or pellets	Poured slowly (2 min per bag) over a mesh sieve to take out fine materials that can cause sticking in the annular space.
Bentonite-Cement (3-5% bentonite, cement and water)	50kg cement + 29L of water + 1.6-2.7kg of bentonite = 42L of slurry	Poured or pumped into the annulus

*Bentonite to be used is based on API grade bentonite. High yield bentonite containing polymers is not API grade and can adversely affect a cement grout mix. It is best to mix the bentonite and water first then add the cement.

Clean water should be used to make cement grout. Its consistency should be thin enough to allow it to be poured but not to watery or the cement will settle out of the slurry

ANNULAR VOLUME FORMULAS

The volume of the grout required should be determined before sealing to ensure a continuous dense lining is place around the casing. The formulas below can be used:

Imperial

$$\text{Annular volume in gallons} = \frac{\left(Dh^2 - Dp^2\right)}{24.51 \times \text{depth}}$$

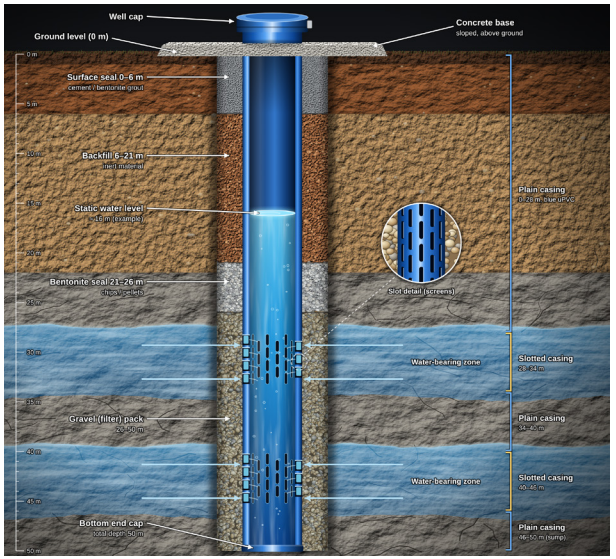


Metric

$$\text{Annular volume in litres} = \frac{\left(Dh^2 - Dp^2\right)}{1273 \times \text{depth}}$$

Where **Dh** is the diameter of the borehole and **Dp** is the outer diameter of the casing

AN EXAMPLE OF A PROPERLY SEALED BOREHOLE



CONCLUSION

- A successful seal starts before the first turn of the bit.
- The length of the borehole section to be sealed varies according to local regulatory codes or standards. It is important to know the local regulations. If absent, international best practices can be adopted.
  - Not less than 5 m surface seal – Australian drilling standards
  - **A minimum of 6 m surface seal is preferred.**

Attention should be given to the annulus of the borehole. If the annulus space is limited, tight places and "dead spots" result where casing that is not properly centered touches the wall of the hole and causes channeling of the slurry.