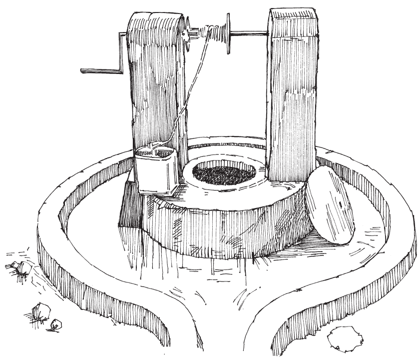
Cleaning wells after seawater flooding

Many people living in coastal regions rely on shallow groundwater for their water supply. Seawater flooding after a severe storm or tsunami can damage wells and contaminate the groundwater. This technical note provides advice for rehabilitating wells in such circumstances. It should be used in conjunction with Technical Note 1 which provides general information about rehabilitating wells after a disaster.



Rehabilitation and cleaning of wells

The aims of cleaning shallow open domestic wells after a natural saltwater flooding event are to:

- facilitate provision of safe unpolluted water for drinking and other domestic purposes;
- minimize the potential for irreversible damage to the coastal aquifer;
- minimize the potential for saltwater intrusion (drawing saltwater into the well); and
- minimize the collapse or destruction of the well.

Figure 15.1 outlines a simple three-step procedure for cleaning and rehabilitating saltwater-contaminated shallow open wells in emergencies.

Step 1: Removing debris and excess salinity

As soon as possible after the flooding event the following actions should be taken:

1. Remove debris, waste and polluted water pools close to the well (Figure 15.2).
2. If the well has been damaged, and shows cracks in the walls or apron or if it has been undermined by erosion, the well should be abandoned, replaced, or rehabilitated (Figure 15.3).
3. Remove floating debris inside the well manually, using a sieve or bucket (Figure 15.4).
4. Use a sludge pump to remove sludge and loose sediment that has accumulated at the bottom of the well.

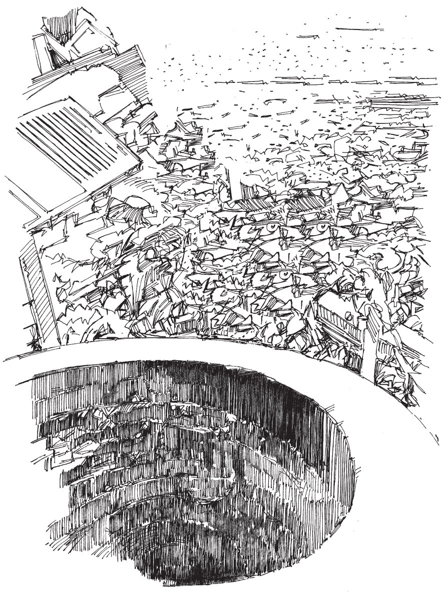


Figure 15.2.
Remove debris and waste close to the well

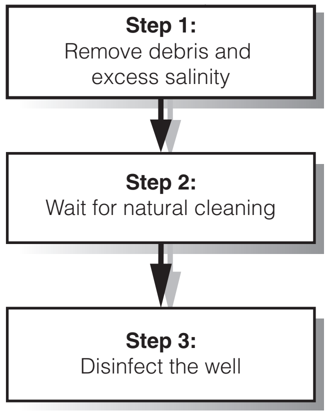


Figure 15.1. Steps for cleaning a saltwater-contaminated well

The well should not be pumped out repeatedly in an attempt to lower the salinity.

If the well smells of oil or petrol or has a greasy film or shine on the surface, the well should not be used.

5. Calculate the volume of water in the well (Box 15.1). Slowly remove the water using a pump or bucket (Box 15.2) taking care not to pump so quickly that the well empties. Pumped water should be discharged to

the sea, or alternatively into a nearby river or stream. Construct a drainage canal downstream of other freshwater wells to avoid recirculation of the contaminated water. At this point, the well water may become unclear for up to a day, after which the well water can be used for household purposes, *but not for drinking.*

Figure 15.3.
A damaged well, showing cracks in the walls

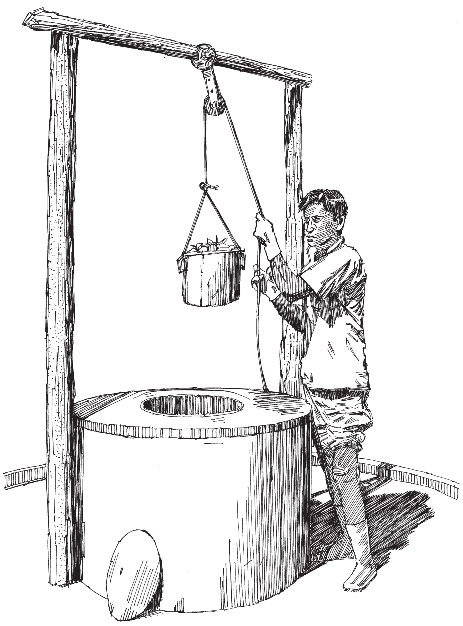


Figure 15.4.
Removing debris using the bucket

Step 2: Natural cleaning

Leave the well without further intensive pumping until the salinity drops to a level acceptable for drinking. This level should be based on the judgement and preference of the community and not on strict water quality standards.

The period required for natural restoration of freshwater conditions may be long, depending on rainfall conditions and subsurface characteristics. It could be as long as one to two years.

In the interim period, the well may be used for domestic purposes, such as washing and cleaning, but other sources of water for drinking should be sought.

Step 3: Disinfection

When the salinity of the well water has reached tolerable levels for drinking, the well should be disinfected.

WHO endorses the disinfection of drinking water in emergency situations. There are various ways of doing this but the most common is chlorination as it leaves a residual disinfectant in the water.

Chlorine has the advantage of being widely available, simple to measure and use, and it dissolves easily in water. Its disadvantages are that it is a hazardous substance (to be handled with care) and that at commonly applied concentrations it is not effective against all pathogens (e.g. cysts and viruses).

The chlorine compound most commonly used is high-strength calcium hypochlorite (HSCH) in powder or granular form as it contains 60 to 80% chlorine. Also used is sodium hypochlorite in liquid bleach or bleaching powder form. Each chlorine compound has a different amount of usable chlorine depending on the quantity of time the product has been stored or exposed to the atmosphere and the way it is made. Technical Note 1, Box 1.2 outlines methods for calculating appropriate chlorine doses for HSCH granule chlorine. Stir the water in the well thoroughly with a long pole and then allow the water to stand for at least 30 minutes. Further details on chlorination are given in Technical Note 11.

Precautions

Repeated chlorination of wells should be avoided as chlorine residual may contaminate the aquifer and present health problems, such as skin rashes when the water is used for bathing. Permanent disinfection of the well water cannot be guaranteed by chlorination because a background source of contamination may exist in the surrounding groundwater.

Use of alternative drinking-water sources

It is important to consider carefully the switch from using a well to other drinking-water sources during a flooding event. It may be a better solution to have people use slightly saline but disinfected well water rather than freshwater from unprotected sources. It is important to convey the message to consumers that salinity is not a threat to health if the taste is tolerable. In the short-term, freshwater can be imported by tanker (Figure 15.5) whilst care is taken to properly and consistently disinfect an alternative water supply.

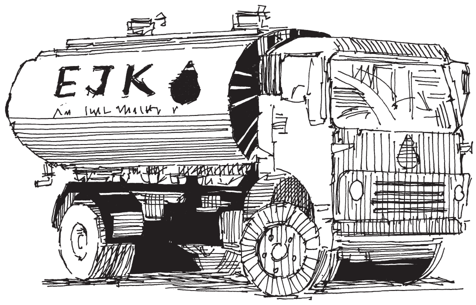


Figure 15.5.
Water tankering (see Note 12)

Protection of groundwater

After seawater flooding, it is important to avoid further saltwater intrusion into freshwater sources. Some simple precautions include the following:

- Wells that were clear but are becoming salty should be pumped less or abandoned temporarily. Freshwater should be sought from neighbouring wells that are clear.
- Intensive pumping should be avoided as it may cause the well to become saline. Similarly, new high-production wells should be dug away from the coast and other sources of pollution.
- Deep wells (greater than 5m deep) and wells pumped with motorized pumps should be regularly monitored for salinity as they stand a greater risk of pollution from saline water.
- Existing wells should not be deepened and new deep wells (over 10m) should not be dug in coastal areas with the intention to draw freshwater from an underlying aquifer.
- Stagnant water bodies close to he wells should be kept clean of debris. If pollution is suspected from, for example, the observation of an oil film on the surface of the water, then the water should be drained to the sea.
- In other cases, stagnant water should not be drained in an attempt to remove the salt. Rather, channel rainwater to depressions in order to increase the flushing and cleaning of the groundwater.
- In some parts of the world, certain anopheline mosquito vectors of malaria prefer to breed in brackish water. The assumption that standing brackish water poses no malaria risks is therefore incorrect.

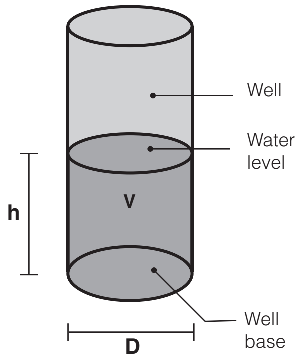
Box 15.1. Calculating the volume of water in the well

Calculate the volume of water in the well using the formula:

$$V = \frac{\pi D^2 h}{4}$$

Where

V = volume of water in the well (m^3)
D = diameter of the well (m)
h = depth of water (m)
π = 3.142



Box 15.2. Over-pumping of well

When a coastal area is flooded, wells and surroundings are penetrated by saltwater. Pumping out a well alone does not solve the problem, as saltwater is also present in the soil and aquifers below. The best and quickest remedy for restoring the well to its previous condition is natural flushing from rainfall and from freshwater infiltration into the ground from natural or constructed freshwater ponds, dams or other retained sources of rainwater.

Excessive pumping (more than the total volume of water in the well) exacerbates the salinity problem by slowing down natural rehabilitation. It also wastes time, human resources and energy.

Box 15.3. Health aspects of salinity in drinking water

Salt in drinking-water is not a risk to human health at the level that people normally find it acceptable to drink. As such, there are no health-based guidelines or standards to adhere to. What is acceptable to the community depends very much on individual tastes and habits. A well, therefore, may be used for non-drinking purposes such as washing (below left) and later for drinking-water when people find the taste acceptable (below right).

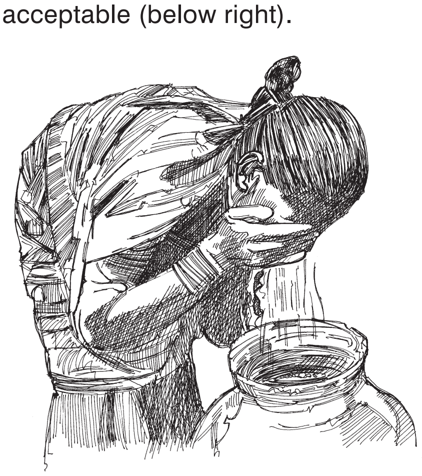


Figure 15.6. Devastation of the 2006 Asian Tsunami in Sri Lanka left many wells contaminated with saltwater

Further information

Goswami, R.R. and T.P. Clement (2007) *Technical details of the SEAWAT model simulation results used to develop well cleaning guidelines,* Technical Summary Report. Department of Civil Engineering, Auburn University.

Villholth, K.G. (2007) 'Tsunami impacts on groundwater and water supply in eastern Sri Lanka', *Waterlines.* 26(1).

WHO (2010) 'Cleaning and disinfecting wells in emergencies'. Technical Note 1

World Health Organization

Water, Sanitation, Hygiene and Health Unit
Avenue Appia 20
1211 Geneva 27
Switzerland

Telephone:	+ 41 22 791 2111
Telephone (direct):	+ 41 22 791 3555/3590
Fax (direct):	+ 41 22 791 4159
Email Coordinator:	bosr@who.int
URL:	www.who.int/water_sanitation_health

Prepared for WHO by WEDC. Author: Karen Vilholth, IWMI (International Water Management Institute)
Series Editor: Bob Reed. Editorial contributions, design and illustrations by Rod Shaw
Line illustrations courtesy of WEDC / IFRC. Additional graphics by Ken Chatterton.

Water, Engineering and Development Centre Loughborough University Leicestershire LE11 3TU UK
T: +44 1509 222885 F: +44 1509 211079 E: wedc@lboro.ac.uk W: http://wedc.lboro.ac.uk