BURHANI FOUNDATION
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WELL REJUVENATION

STANDARD OPERATING PROCEDURE

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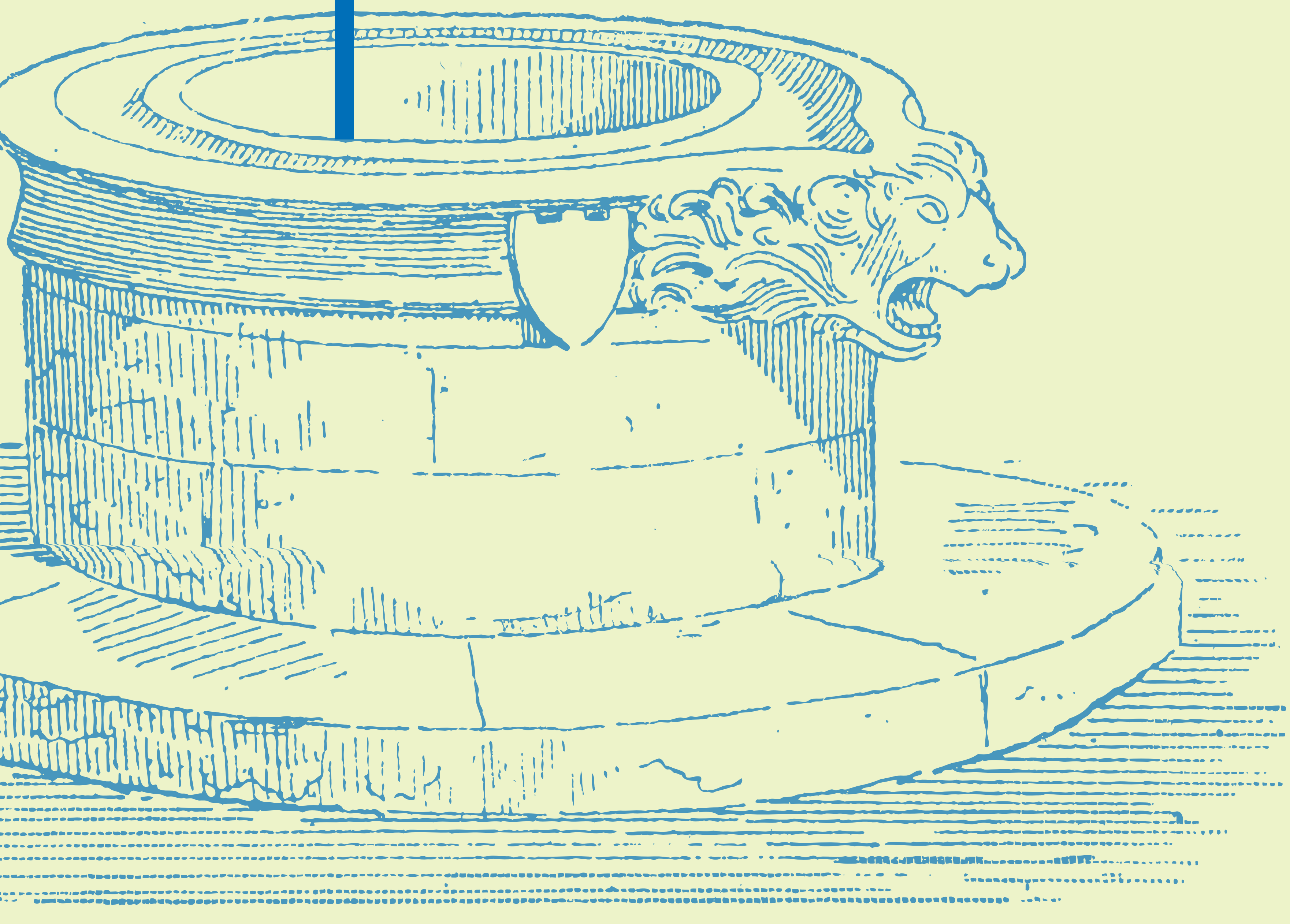
TABLE OF CONTENTS



IMPORTANCE OF WELL REJUVENATION

Clean water is necessary for survival and drinking adequate amounts improves health and acts as a detoxifier. Access to clean water is essential for a good quality of life.

Groundwater is an important source of freshwater and wells have been used throughout history for access to it.

Wells can deteriorate over time, but they can be made usable again through rejuvenation, which is a process that can be done with simple and basic procedures, without costly equipment or specialized labor.

COMMON PROBLEMS & SOLUTIONS

1. AQUIFER PROBLEMS

- Water Quality

Contamination of the well surroundings can lead to poor water quality. Garbage pits, latrines, and industrial outlets can contaminate the groundwater if they are near the well. It is important to prevent or treat these harmful substances before they reach the aquifer. Excessive use of fertilizers and chemicals can also harm the groundwater.

- Acidity

Soil microbes, tree roots, and rock formations can generate acids that make nearby water acidic, often caused by industrial pollution. Acidic water can corrode plumbing systems and release toxic metals. New methods have been developed to treat acidified groundwater, such as injecting soda ash or sodium hydroxide to raise the pH to neutral. These methods do not cause hardness issues in treated water.

Most common systems used to treat acidic well water are:

1. Calcite Neutralizers
2. Calcite & Corosex Blend Neutralizer
3. Upflow Neutralizer
4. Soda Ash Feed Pump Injection System

- Turbidity, High TDS, Unsafe water for drinking

TDS stands for Total Dissolved Solids in water. Water with high TDS could be safe for usage and cooking. High TDS water can alter the taste if used in cooking. Specific minerals which are dissolved in water can be harmful for human consumption for eg Lead. Turbidity can be treated by installing RO water purifiers or by forcing water through a cloth with microscopic holes to filter the drinking water.

If you have no way of measuring the turbidity, you can use the approximate method below suggested by WHO in the event of an emergency :

1. Take a large clean bucket or bin, with a fairly dark inside colour and at least 50 cm deep.
2. Drop in a coin of 2 or 3 cm, pour in the water to be analysed and stir.
3. Leave it to settle.
4. Is the coin visible?
5. If yes, this means that the NTU is less than 10.
6. If not, measure the approximate height of the water that is transparent.
7. If this is less than 32 cm, the NTU is probably greater than 20. Filter the water and measure again.
8. If this is between 32 and 50 cm, the NTU is probably between 10 to 20. It is advisable to filter the water.

- Salinity / Hardness

Extracted saline water can be used for industrial or farming purposes. Salinity can be caused by mining activities or chemical leaching or industry pollution. One solution is to empty the well 2-3 times and check if the salinity decreases. Another solution is to use an RO filter to make the water drinkable, but it may not be economical for large-scale irrigation. Water softeners can also be implemented, but they have limitations. If the groundwater is naturally highly saline, there may not be many treatment options. One possibility is to mix it with fresh water to reduce the salt concentration and make it usable for drinking.

- Low Water Table / Depletion of the reservoir

Lowering of the water table can be caused by drought or low rainfall. Rainwater harvesting is a recommended solution, as it allows more water to flow into the ground and prevents runoff. Another solution is to increase the depth of the well. If an aquifer is depleted, it is advisable to consult an expert for hydro mapping and identifying possible solutions specific to the region.

2. POOR CONSTRUCTION

Drilling fluids and muds left from poor well development

Plugging with natural silt and clay

Debris fills screens and gravel pack

Poor well development leads to inefficient wells

Early clogging = early failure

Note: Incase of technical problems or hardware issues, it is recommended to approach an expert or a contractor who can examine the condition thoroughly and advise you on the same.

3. POOR MAINTENANCE

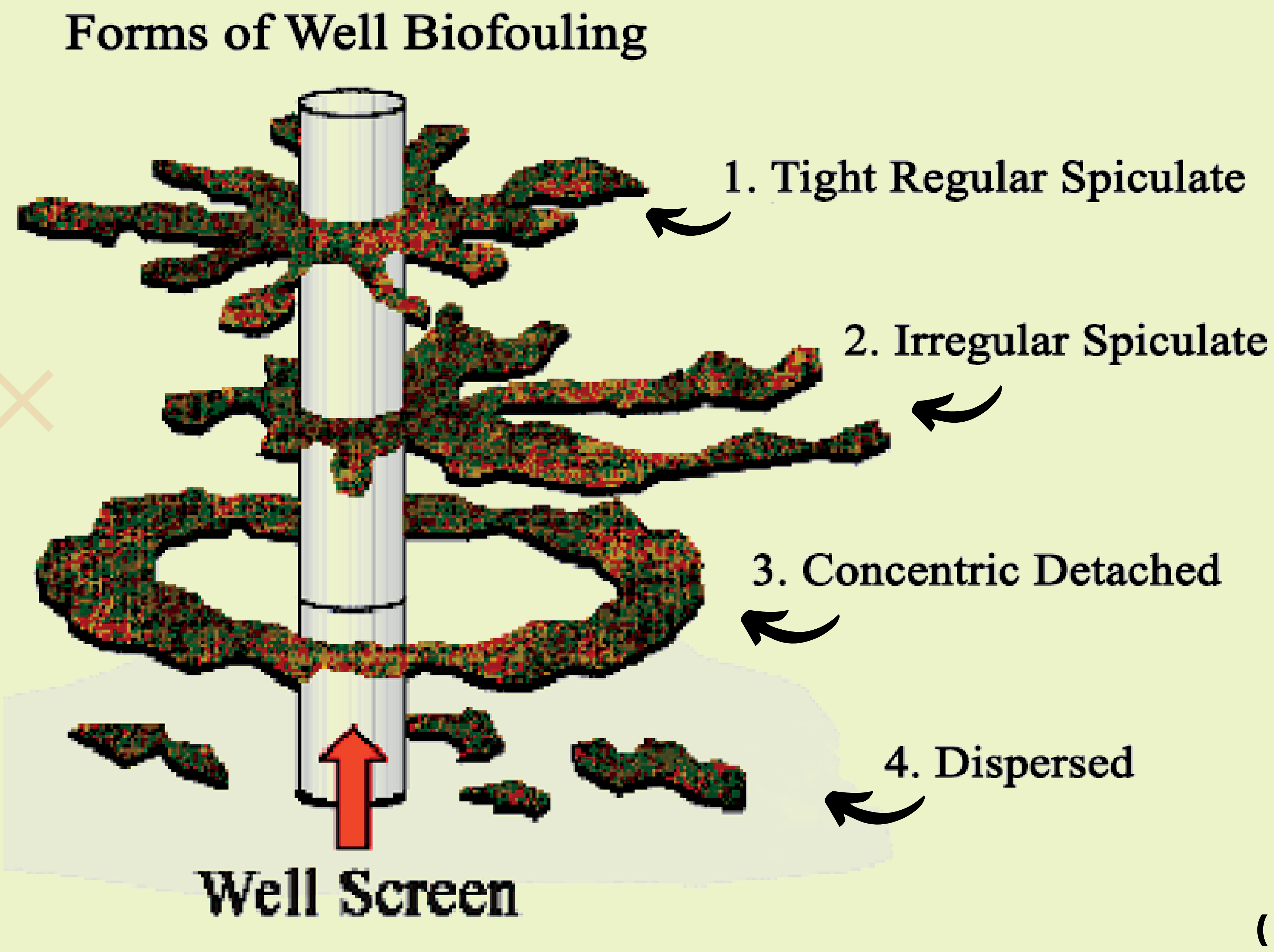
Stagnant water around the well can be unpleasant, a potential source of pollution and a breeding ground for mosquitoes. It is recommended to cement the ground around the well with an edge and a runoff channel to prevent surface water, insects and rodents from entering the well. To protect the well, it is important to put a fence around it. To prevent the water from being stagnant, construct drainage area around the well.

4. BIOFOULING & MICROBIOLOGICAL GROWTH

The presence of oxygen in the upper reaches of the well and deep in the water column due to pumping can lead to the growth of aerobic bacteria, which can cause clogging by producing slime and trapping oxidized iron, manganese, and other minerals such as calcite.

Wells can become contaminated with bacteria if they were not built properly, if work is done on the well or if there are nearby sources of animal or human waste.

Biofouling is an inevitable process that starts as soon as a well is placed in the ground, but it can be delayed and restricted by taking proper measures



(Fig 1.1)

Iron biofouling (Fig 1.2) is a type of biofouling that consists of biofilms made up of living and dead bacteria, their byproducts, and embedded metal hydroxide particles. "Iron bacteria" is one type of biofouling. It can build up quickly compared to mineral encrustation and not only cause problems in wells but also colonize tanks and water treatment devices.

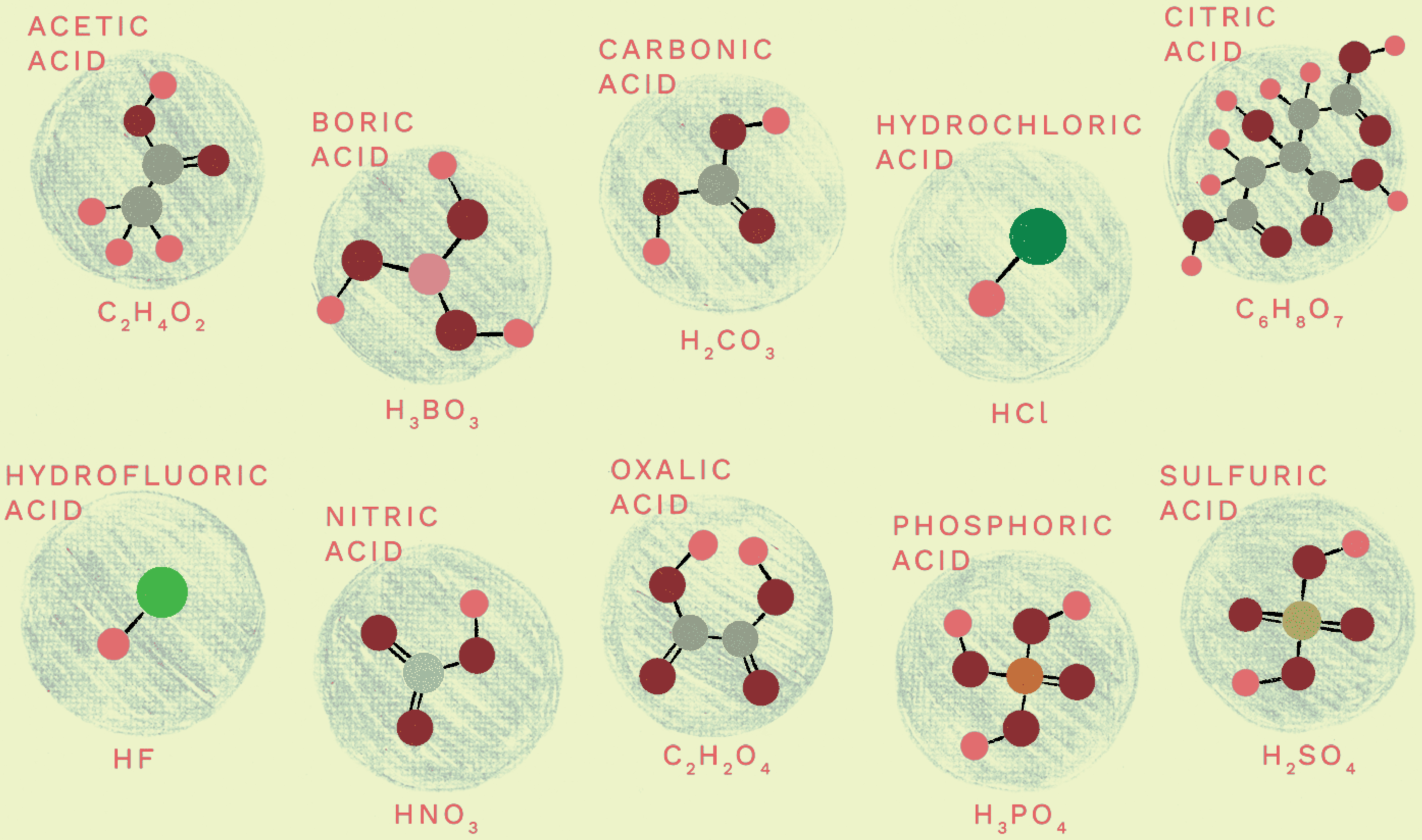
(Fig 1.2)

Certain features of water systems such as inappropriate well filter, plumbing design or material choice, poor construction, water treatment choices, and well usage patterns can aggravate biofouling symptoms. One solution is shock chlorination. If the build-up of iron or other bacteria is large, physical agitation and jetting can be used to clear the well and then disinfect it using chlorination.

Special acids and their solutions are used to get rid of biofouling, but for appropriate concentration and usage, an experienced contractor should be called.

A reference chart with strength, corrosiveness, concentrations, and pH values for different acids is provided.

10 Common Acids



Characteristics of common well cleaning acids

Characteristics	Sulfamic	Hydrochloric	Phosphoric	Hydroxyacetic	Citric	Oxalic
Appearance	White crystal	Slight yellow liquid	Clear liquid	Clear liquid	White crystal	White crystal
Type	Mineral	Mineral	Mineral	Organic	Organic	Organic
Hazardous Fumes	None	High	None	Some	None	None
Relative Strength	Strong	Strong	Strong	Weak	Weak	Moderately Strong
pH @ 1%	1.2	0.6	1.5	2.33	2.6	1.25
Relative Reaction Time 1=Fast 10=Slow	<2	1	4 - 5	4 - 5	4 - 5	2
Corrosivenes metals skin	Moderate Moderate	Very High Severe	Slight Moderate	Slight Slight	Slight Slight	High Severe
Reactivity vs: Carbonate Scale Sulfate Scale Fe/Mn Oxides Biofilms	Very good Good Fair Poor	Very good Good-poor Very good Poor	Very good Good-poor Good Poor	Poor-fair Very poor Good Moderate good	Poor Very poor Chelates Poor	Very good Good Good Moderate good
Pounds of Acid (100%) Required to Dissolve 1 lb of Calcium Carbonate	2.0	0.73	0.65	4.5	4.0	2.0

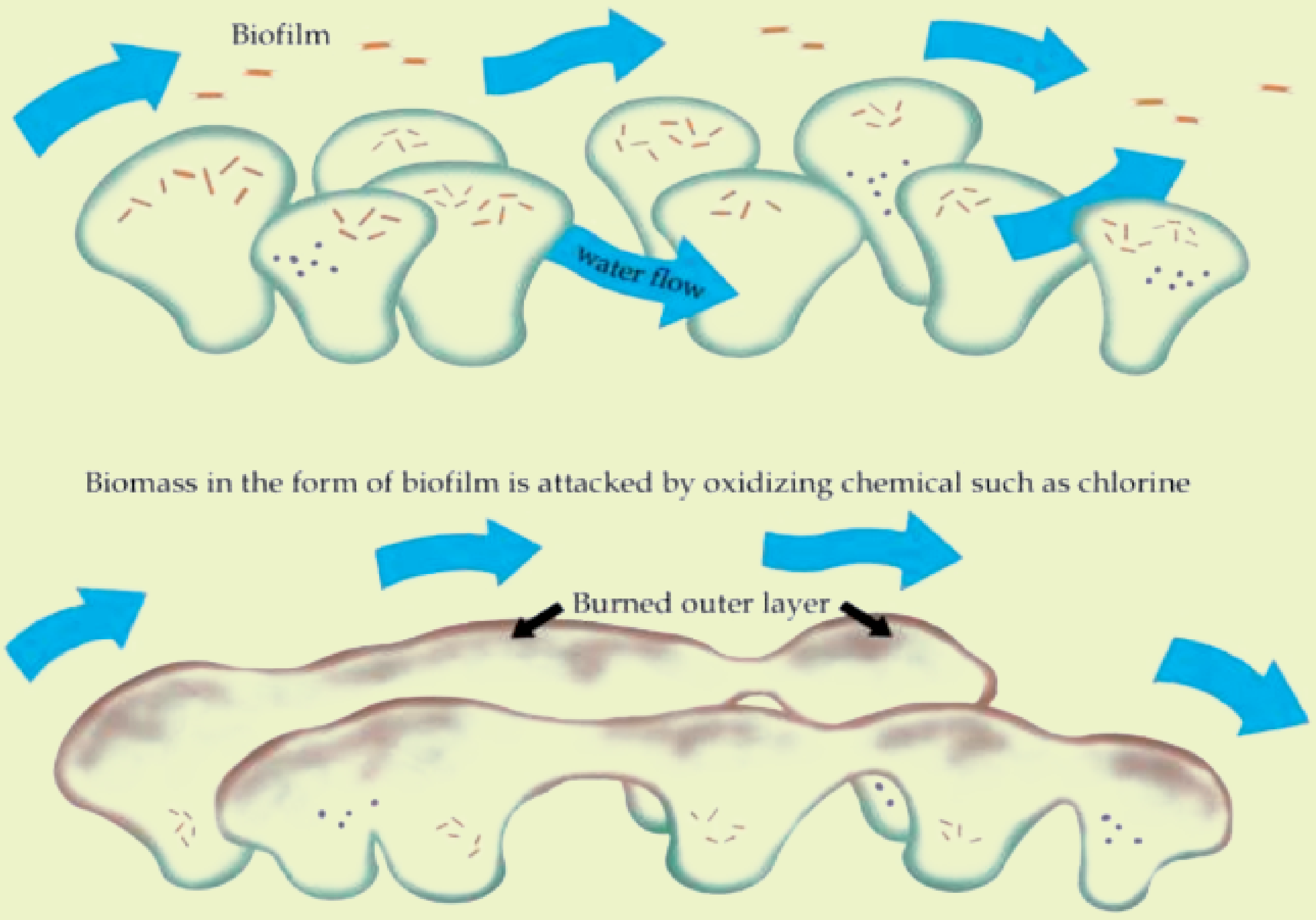
5. JETTING

Jetting is a process that uses high-pressure water and steam to forcefully remove and clear debris such as sand and rocks that clog a well, making it difficult to extract water. It can also be used to clean the screen of the well by using high-pressure water. A pipe is lowered down into the well and compressed air and foam are pumped in, which blows out any debris blocking the well.

6. CHLORINATION

When handling and storing chlorine, certain precautions and guidelines must be followed to ensure safety. The strength of chlorine decreases over time, so allowance should be made for its age. Chlorine should not be mixed in a metal container as it reacts with metal. It is a hazardous chemical and should be handled with care, as it can irritate skin and eyes and HTH powder (Dry chlorine) or strong solutions produce gases that are dangerous to breathing. It should be stored in a cool, dry, well-ventilated, and dark location, and not in the same room where people sleep.

Higher concentration of chlorine does not give better or faster results, and it is less effective than the ideal concentration(As shown in Fig 1.3). High concentrations are very oxidative and can have pH levels greater than 10 which promotes mineral precipitation. The ideal chlorine concentration should be decided by a professional based on the conditions.



Effect of Excessive Chlorine Use

(Fig 1.3)

Steps to carry out chlorination are given below.

- STEP 1

The well will often be shut off for 24 to 48 hours to see if the static level – the level of the water table in a well when the pump is not operating – returns to or gets near the original level. If so, rehabilitation will usually work, if other factors suggest success. The contractor will then run a short pumping test to check pump function, flow, water quality, presence of sand, etc.

Notify all users of the well not to drink the water during the rehabilitation procedures and to store sufficient water for use during the period of rehabilitation.

- STEP 2

Determine the characteristics of the well(diameter and depth). Take surveys and gather information from people using the well. Test for potability, hardness, salinity, ph value, microbiological growth in the water. Check the water table in the ground surrounding the well.

- STEP 3

Remove the pumping mechanism or lifting device and undertake any cleaning and repairs to the headwalls, drainage curtain, sanitary seal, cover and lifting device. For cleaning, use a chlorine solution. After removing the pump, Check for damages and wear and tear of the pump and the whole pumping mechanism.

- STEP 4

Remove all polluted water, sediments and debris from the well. For dug wells, you can use either buckets or pumps for removal. For drilled wells, there are several methods to do this, though the simplest method is jetting. Jetting can be used to clean the well and to remove the blockages in the well. After the removal of polluted water, sediments, and debris, operate the pump for about an hour to remove any suspended fines caused by the disaster or the jetting process.

- STEP 5

Repair the damage in the inside of the well. For dug wells, deepen the well, undertake localised repairs to the well lining, or consider re-lining of borewells as well as dugwells to reduce subsurface contamination. Walls of dugwells should also be cleaned either manually or by power washing to remove the biological buildup over the years. Contact engineers and install new equipment if needed. Check the condition of the screen, pump, casing, head and lining and the motor of the well. Check the condition of the well screen.

- STEP 6

Clean the well physically. For dug wells, clean the well lining manually using a brush and chlorinated water. For drilled wells, clean the well casing and screen by using a brush or by using jetting or surging techniques also applied for well development.

- STEP 7

Clean the well chemically (only if necessary). The chemicals are selected according to the present type of contamination. The selected chemicals are placed in the well and agitated frequently for 24 to 72 hours. The well is then dewatered to remove the chemicals.

For iron bacteria and slime, a liquid bacteria acid is effective. If the bacteria problem is persistent, some more aggressive chemicals are used, such as muriatic acid and hydroxyacetic acid.

For clogs with carbonate scale, sulphamic acids are used with inhibitors and modifiers.

Consult a hydrogeologist for the treatment and use of suitable chemicals.

- STEP 8

Disinfect the well. The most common method of disinfection is chlorination. The chlorine compound most commonly used is high strength calcium hypochlorite (HSCH) in powder or granular form, which contains 60 – 80% chlorine.

Alternatively, sodium hypochlorite in liquid bleach or bleaching powder form is used. 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.

- STEP 9

Dewater the well. Operate the manual or preferably mechanised pump until all the chlorinated water is removed. If you have a chlorine test kit you can check the residual chlorine concentration in the water. It should be reduced to 0.5 mg/l or below. Alternatively, pump the water until it no longer smells of chlorine. Use chlorine test paper at the water taps and faucets to check for chlorination in water.

- STEP 10

Seal the top of the well using a sanitary seal (e.g. made of layers of clay). Construct a drainage apron and head wall around the well to prevent surface water, insects and rodents from entering the well. Provide a cover for the well.

POST REJUVENATION MEASURES

After cleaning and rehabilitating a well, its water level should be allowed to return to normal and the turbidity and pH should be measured to ensure that the chlorination or other water treatment was effective. If the water is cloudy, no more chlorine should be added as the suspended particles protect microorganisms and reduce the effect of chlorination. If the turbidity of the well water is more than 5 NTU after cleaning and rejuvenation work, the well should be emptied and the internal liner cleaned with a strong solution of bleach, then refilled and re-checked for normal turbidity. Regular maintenance is necessary to ensure adequate water flow and continued safety of the drinking water. Identifying small problems through maintenance can prevent them from becoming costly and inconvenient situations.

ROUTINE MAINTENANCE

Water wells require regular maintenance to ensure adequate water flow and continued drinking water safety. Small problems can often be identified by performing maintenance before they become costly, inconvenient situations.

- Raising the walls of the well

It prevents animals and garbage from falling into the well and also prevents surface runoff water from entering the well. No garbage, human or animal waste in the 50m radius around the well.

- Detecting problems by monitoring

Water systems should be installed with sensors and other indicators which could be monitored on a daily or a weekly basis to ensure optimum water quality and performance from the well.

- Regular Evaluation

To ensure water quality, well water should be tested annually for total coliform bacteria and E. coli bacteria by a state accredited testing laboratory.

Every three years, additional testing is recommended for pH and total dissolved solids as well as tests related to land uses occurring or expected to occur within sight of the well. Additionally, if there are obvious stains, tastes, or odours in water, seek testing that will help identify the source of these symptoms.

Water wells should also be inspected annually for obvious signs of damage or contamination. Be sure the area within 100 feet around the well is clear of debris or items that might pollute the water supply.

Get the well professionally inspected by a water well contractor every ten years. Keep all records related to the water well including:

- Water well completion report or log (if you have it) which should include information such as water well depth, date drilled, construction (including casing specifications, grouting and screen), and water well yield or flow rate in gallons per minute (gpm).
- Water quality test reports
- Past inspection reports
- Invoices from work done by water well contractors (including pump replacement)
- Water treatment equipment warranties, invoices and manuals.

Necessary parameters and test during well evaluation are:

- A flow test
- Visual inspection
- A water quality test for coliform and anaerobic bacteria, nitrates, and anything else of local concern
- Inspection of Pump and Motor Housing
- Checking valves
- Electrical testing.

SUMMARY

The performance (flow rate and drawdown) of water wells and their water quality can deteriorate over time. This is a natural occurrence and common experience of mechanical structures. The situation is not always bleak when a household water well fails to produce the water it did when it was first installed. Instead of the expense of abandoning the well and installing a new one, a professional contractor can often "*rejuvenate*" the well and restore flows that provide enough water for household or farm needs.

Well rejuvenation(including disinfection) should be applied if the well's yield is decreasing and/or the quality fails to meet drinking water criteria, and if a prior analysis has shown that the construction of a new well wouldn't be more economical. As for well development, simple and basic rejuvenation procedures can be highly effective although they do not require costly equipment and very experienced labour.

The variety of different well types and constructions requires tailor-made well development and rejuvenation procedures for every single well. Many such procedures are basic and easy to apply, yet a certain level of care is important as ignoring basic rules can compromise the water quality and long-term functioning of the well.

Consulting an expert or a hydrogeologist is the best way to properly rejuvenate the well. An expert knows the nuances involved and can appropriately advise you with a rejuvenation plan. The eligible procedures range from very basic to quite sophisticated. Hence, applicability is given under most circumstances, including regions lacking financial or technical resources, or experienced contractors.

Any natural disaster has a great impact on groundwater of that region. Water quality and equipment of the well should be tested after it. Natural disasters could contaminate the aquifer, destroy the equipment such as pumps and screens and also dump garbage into open wells.

Authenticated by:

Dr. B.L. Ayare - Professor & Head of soil & water conservation, CAET, Dapoli, Maharashtra.

www.burhanifoundation.org

info@burhanifoundation.org

+919152105253 / 68075324 / 68075325

burhani.foundation

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