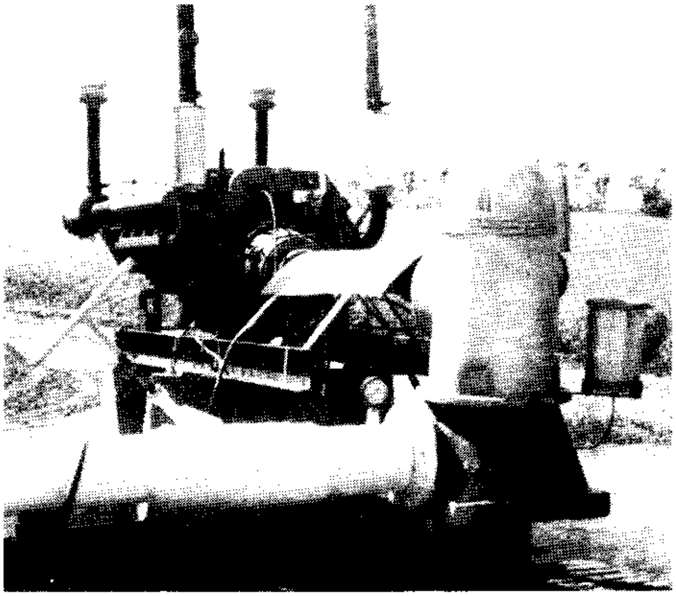

Operation and Maintenance of Irrigation Wells

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The irrigation well is the heart of any irrigation system when the water source is ground water. After the well is constructed, there are certain recommended procedures for operation and maintenance which are necessary to retain maximum production.

I. WELL TESTING

The first and most important step is to maintain accurate records. **Each year** measurements must be made of the static water level (when pump is shut off), pumping rate (gallons per minute, gpm), and the water level when the pump is operating. The difference between the pumping level and the static level is the drawdown. From these measurements, calculate the specific capacity of the well (gpm/ft. of drawdown) as shown under Sample Calculations and compare it with the value calculated from the pumping test completed by the well driller when the well was new.

II. WELL PROBLEMS

Be aware of potential well problems which can cause a reduction in well yield. The two main problems, iron bacteria and mineral incrustation, are different in origin and require different treatments for removal. In either case, however, the result is a plugged well screen and less water from the well.

Iron Bacteria

Waters containing even small quantities of iron (most North Dakota waters)

Sample calculations for specific capacity of irrigation wells.

	(New Well) Year No. 1	Year No. 2	Year No. 3
Static Level	10'	8'	10'
Discharge (gpm)	1000	1050	900
Pumping Level	60'	57'	65'
Drawdown	60 - 10 = 50'	57 - 8 = 49'	65 - 10 = 55'
Specific Capacity = $\frac{\text{Discharge}}{\text{Drawdown}}$	$\frac{1000}{50'}$ = 20 gpm/ft dd	$\frac{1050}{49'}$ = 21.5 gpm/ft dd	$\frac{900}{55'}$ = 16 gpm/ft dd
Comparison to new Well —		107%	80%

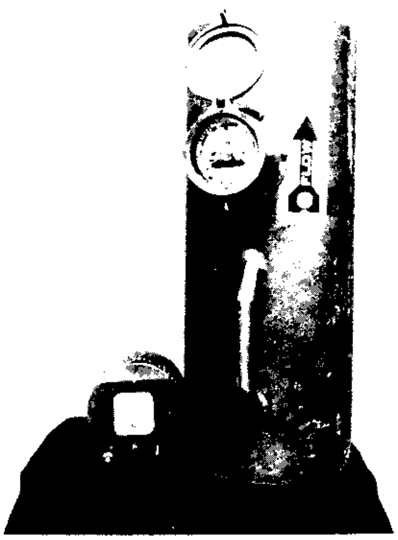

Figure 1. Drawdown meter and flow meter for irrigation well testing.

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provide a source of energy for the growth and development of iron bacteria. These bacteria accumulate in the form of a slimy organic substance on the well screen, casing, pump, and out into the water bearing formation. As the bacteria builds up, they reduce the open area of the screen and the open spaces in the formation, thus reducing well yield. If exposed to air, this buildup hardens. Procedures for preventative maintenance for this problem are described in Section IV of this publication, "Chlorination Procedures."

Mineral Incrustation

Mineral incrustation is a buildup primarily of calcium and magnesium carbonates that have precipitated out of the water and have bonded the aquifer materials into a hard mass over the screen openings and out into the water bearing formation. This settling out of these inorganic substances is probably caused by a reduction in the ability of the water to hold them in solution because of a change in pressure within the formation during pumping. Water entering the well screen at a rate greater than 0.1 feet per second can also contribute to rapid incrustation. A properly designed well screen will have entrance velocities of less than 0.1 foot per second. The rate of buildup in incrustation accelerates with time because as some of the slots become plugged, the water must enter the remaining slots at a higher velocity which in turn causes more incrustation and the problem is quickly out of hand.

Figure 2. Mineral incrustation removed from an irrigation well screen. (Photo courtesy South Dakota State University)

Figure 3. Iron bacteria buildup which has hardened on pump column after exposure to air. (Photo courtesy South Dakota State University)

The procedure for removal of incrustation is described in Section V, "Acidizing the Well."

III. ANNUAL MAINTENANCE

The following procedures and practices are recommended for increasing the useful life of the irrigation well and to prevent iron bacteria and mineral incrustation.

1. Keep continuous records of well operation as described in Section I.

2. Never allow the pumping level to drop below the top of the screen because this will accelerate the buildup of incrustation and the hardening of iron bacteria.

3. Chlorinate the well in both the spring and fall. Follow the procedures outlined in Section IV, "Chlorination Procedures."

4. Acidize the well when the specific capacity has declined to 80 percent of the original value. If you look at Year No. 3 under Sample Calculations, you can see the specific capacity of the well has declined to 80 percent of what it was when the well was new (.80 x 20 = 16 gpm/ft. drawdown) and the well should be acidized. Waiting until the well deteriorates beyond the 80 percent level may mean several acid treatments might be necessary and the well may never return to its original condition.

5. Check water for quality every three years by sending a sample to the NDSU Soil Testing Laboratory, Waldron Hall, Fargo, North Dakota 58105.

IV. CHLORINATION PROCEDURES

Either of the following materials may be used in a chlorine maintenance program for iron bacteria control: (a) high-test dry calcium hypochlorite (H-T-H) approximately 70 percent available chlorine and available through swimming pool companies, well drillers, and some irrigation sales firms, and (b) common household bleach usually 5 percent chlorine and available in supermarkets. Purchasing H-T-H in 100-pound lots is much cheaper than smaller quantities, so several irrigators may wish to jointly purchase a 100-pound drum.

Chlorinate in the spring and in the fall.

The following chlorination procedure is recommended:

1. Determine the depth of water standing in the well. (This is equal to total well depth minus the static water level.)

2. From Table 1 determine the amount of material required for your casing diameter. Note that the quantities given are for each 10 feet of water in the well. This gives a minimum concentration of 500 PPM chlorine.

3. Introduce the chlorine into the well using one of the following methods. Use protective gloves, goggles, and overalls as chlorine solutions can cause skin burns.

   a. Drop H-T-H **pellets** to the bottom of the well. (This is the easiest form of chlorine to use.)

   or b. Dissolve the H-T-H **granules** by slowing adding 10 gallons of water and stirring until smooth. Pour the solution to the bottom of the well through a rubber or plastic hose.

   or c. Pour liquid bleach to the bottom of the well using a rubber or plastic hose.

4. Allow to stand for four hours.

5. Surge or rawhide the well for one hour (surging is starting and stopping the pump intermittently, but not allowing water to discharge from the well). With electric motors, allow at least 5 minutes between starts with no more than six starts per hour.

6. Force the chlorine solution into the aquifer by introducing a volume of water into the top of the well equal to the volume of water standing in the well (see Column 2, Table 1).

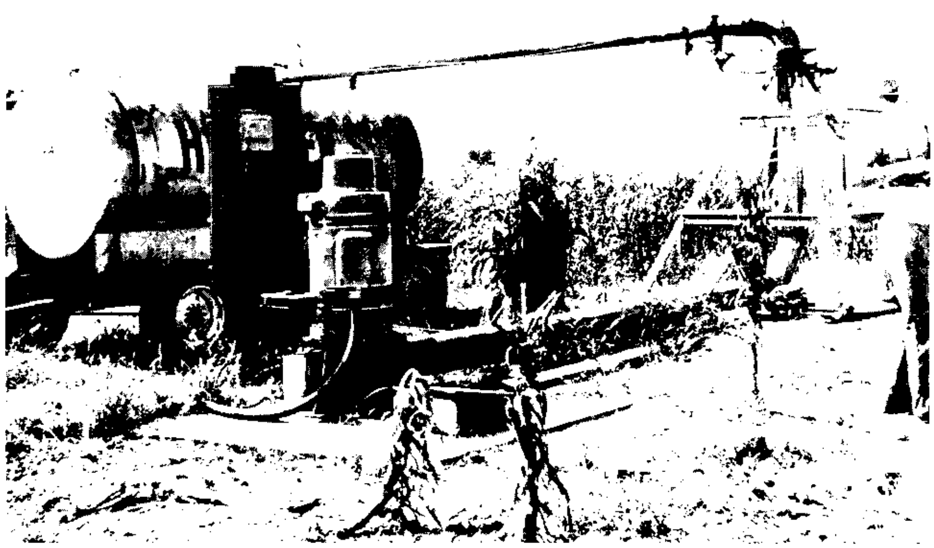
Table 1. Quantities of chlorine material to use for each 10 feet of water in irrigation well.

Well Diameter (Inches)	Gallons of Water for Each 10 Feet of Depth (Gallons)	H-T-H 70% Chlorine (Pounds per 10 Feet of Water)	Bleach 5% Chlorine (Quarts per 10 Feet of Water)
8	26	.2	1
10	41	.3	2
12	59	.4	3
14	80	.5	4
16	104	.6	4
18	132	.8	5

7. Allow to stand for 24 hours.

8. Surge (rawhide) the well for one hour (see Number 5).

9. Pump to waste until water is clear and odor of chlorine is gone.



V. ACIDIZING THE WELL

The chemicals available for removal of mineral incrustation include sulfamic acid (**not** sulfuric), a commercially prepared 100 percent acid in either granular or crystalline form available from such sources as McKesson Robbins Chemical Company in Minneapolis, Minnesota, and Nu-Well*, a commercially prepared compound in tablet form available from Johnson Division, St. Paul, or through an irrigation well driller. Sulfamic acid must be mixed with water and requires the addition of a cold water detergent as a wetting agent. Johnson's Nu-Well and similar prepared products are in a tablet form and contain all necessary ingredients.

Wear productive gloves, goggles and overalls and provide good ventilation when handling acids.

Use the following procedures for acidizing irrigation wells whose specific capacity has decreased to 80 percent:

1. Test the well for discharge and drawdown.

2. Chlorinate the well by following Steps 1 through 9 described earlier in Section IV.

3. Determine the amounts of material needed from Table 2. In this case the screen size and length are the determining factors. Weigh the acid into a container.

4. Introduce the acid into the well by one of the following methods:

   a. For sulfamic acid, a barrel, a sprayer pump, and a hose long enough to reach the bottom of the well are required. Put about 30 gallons of water in the barrel and while continuously stirring, add acid and detergent until a weak slurry is formed. Do not make it too thick. Stir continuously while injecting the slurry into the screen area of the well with the sprayer pump and hose. Repeat the process until the required amount of acid is used and then flush the pump with clear water.

   <u>or</u> b. Pour the required amount of Johnson's Nu-Well tablets into the top of the well.

5. Pour the proper amount of common salt or rock salt (extra coarse crystals or water softener pellets) into the top of the well to ionize the acid and make it more effective. See Table 2 for correct amounts depending on the type of acid used.

6. Allow to stand for four to six hours.

* *Mention of commercial names does not constitute an endorsement of company or product by North Dakota State University.*

Table 2. Quantities of acid for irrigation well treatment.

Screen Diameter (inches)	Sulfamic Acid Treatment				Nu-Well Treatment	
	Sulfamic* Acid	Cold Water Detergent	Rock Salt	Corrosive Inhibitor**	Nu-Well	Rock Salt
	Pounds of materials for each 10 feet of screen					
8	25	4	5	4	33	5
10	40	5	8	5	50	8
12	55	8	11	8	75	11
14	75	10	15	10	100	15
16	100	13	20	13	130	20
18	125	17	25	17	165	25

* Pounds of active ingredient per 10 foot of screen

** Recommended when acidizing galvanized screens or very old wells. May be purchased from firm supplying the acid product.

Note: These rates give a 10 to 15 percent sulfamic acid solution. This solution is approximately one-half the rate suggested by some references. The one-half rate is more economical for use in larger diameter wells with long screens. If a satisfactory cleaning is not accomplished a second treatment may be necessary.

7. Surge or rawhide the well for one hour (surging is starting and stopping the pump intermittently, but not allowing water to discharge from the well). With electric motors, allow at least 5 minutes between starts with no more than six starts per hour.

8. Add an amount of water to the top of the well equal to the total volume of water in the well (see Column 2, Table 1) to force the acid into the aquifer.

9. Allow to stand overnight.

10. Surge or rawhide for one hour (see Number 7).

11. Pump to waste until the water is clear.

12. Test the well for discharge and drawdown to evaluate the effectiveness of the treatment.

13. Chlorinate a second time as described in Section IV.

Badly deteriorated wells (those with a specific capacity which has dropped by more than 20 percent) should be treated by an irrigation well driller who knows acidizing procedures and will redevelop the well by **jetting** for about four hours instead of the surge treatment in Step 10.

Continue a chlorination program with treatments before and after the irrigation season.

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