Care and considerations for your public water well

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Rules? What "rules"?

§103. General Requirements for a Potable Water Supply [formerly paragraph 12:002-1]

A. Every potable water supply which is hereafter constructed, or reconstructed, or every existing water supply which the state health officer determines is unsafe, shall be made to comply with the requirements of the Code.

AUTHORITY NOTE: Promulgated in accordance with R.S. 40:4 (A)(8) and R.S. 40:5 (2)(3)(5)(6)(17)(20).

HISTORICAL NOTE: Promulgated by the Department of Health and Hospitals, Office of Public Health, LR 28:1320 (June 2002).

More “rules”?

§105. Permit Requirements for a Potable Water Supply [formerly paragraph 12:002-2]

A. **No public water supply shall be hereafter constructed, operated or modified** to the extent that the capacity, hydraulic conditions, functioning of treatment processes, or the quality of finished water is affected, **without**, and except in accordance with, **a permit from the state health officer**.

B. **No public water supply shall be constructed or modified** to the extent mentioned above **except in accordance with the plans and specifications** for the installation **which have been approved, in advance**, as a part of a permit issued by the state health officer prior to the start of construction or modification.

C. **Detailed plans and specifications for the installation** for which a permit is requested **shall be submitted** by the person having responsible charge of a municipally owned public water supply or by the owner of a privately owned public water supply.

D. The review and approval of plans and specifications submitted for issuance of a permit, will be made in accordance with the "Ten-State Standards" and the Louisiana Water Well Rules, Regulations, and Standards, plus any additional requirements of the state health officer as set forth in this Part.

Who is really responsible?

§307. Responsibility of Owner [formerly paragraph 12:003-1]

A. It shall be the duty of the mayor, or the person having responsible charge of a municipally owned water supply, or the legal or natural person owning a public water supply, to take all measures and precautions which are necessary to secure and ensure compliance with this Part of the Code, and such persons shall be held primarily responsible for the execution and compliance with regulations of this Code. A printed copy of this Part of the code shall be kept permanently posted in the office used by the authority owning or having charge of a public water supply.

AUTHORITY NOTE: Promulgated in accordance with R.S. 40:4 (A)(8) and R.S. 40:5 (5)(6).

HISTORICAL NOTE: Promulgated by the Department of Health and Hospitals, Office of Public Health, LR 28:1321 (June 2002).

Why preventive maintenance?

- Wells are mechanical devices: Timely maintenance designed to overcome specific problems can sustain well performance and prolong well life. Compare to your service fleet vehicles.
- Early warning allows time to address problem prior to critical stage. “Pay me now or pay me a lot more later”.
- Preventive maintenance costs are historically 10-20% of well rehabilitation costs over time.
- Well rehabilitation means restoring a well to its most efficient condition by various treatments (chemical/physical) or reconstruction methods (screen or casing replacement).
- Well rehabilitation costs may be 10-33% of new well construction costs.
- Quick math: 10% of 10% is 1% (best case scenario). You are paying now, but over time it will likely save substantial amounts of money.
- Maintenance costs can be included in annual budget, reducing need for emergency funding.

How preventive maintenance?

- Pay attention to any changes in the operating characteristics of *both* the well *and* the pump. Either or both may have problems.
- If you notice a problem, it is critical to correctly identify source of the problem. Is it above ground or below ground?
- A good well may appear bad due to a pump with worn parts. Avoid rehabilitating the well when all you need are some (relatively) inexpensive pump repairs.
- On the other hand, the worn parts may be the result of pumping sand due to a corroded well screen. Screen replacement may be expensive.
- AVOID: Overpumping; clogging or collapse of screen, corrosion, encrustation, even permanent damage to the aquifer.
- CRITICAL: Maintain a written log of all repairs and performance tests! Without this you have no reliable way to compare past and current well performance .

Why do wells fail?

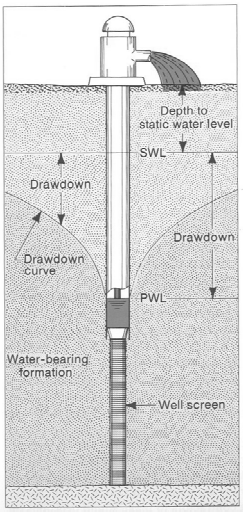
1. Reduction in well yield due to chemical incrustation or biofouling of the well screen and formation materials.
2. Plugging of the formation (aquifer) material around the well screen by fine particles dislodged during pump cycling.
3. Onset of sand pumping, often as a result of corrosion of the screen. This is a self-perpetuating problem (it will only get worse).
4. Structural collapse of the well casing or screen, typically associated with acidic environment with high TDS and CO_2 causing electrolytic corrosion along the casing below the static water level.
5. Poor pump condition: Damage to impellers, impeller housing, and pump shaft due to sand pumping or corrosion in acidic environments.

Aquifer types and associated well problems

Aquifer type	Common well problems	Major maintenance frequency (years)
Alluvial	Silt, clay, sand intrusion; iron precipitation; incrustation of screens; biofouling; limited recharge; casing failure	2-5
Sandstone	Fissure plugging; casing failure; sand production; corrosion	6-10
Limestone	Fissure plugging by clay, silt, and carbonate scale	6-12
Basaltic lavas	Fissure and vesicle plugging by clay and silt; some scale deposition	6-12
Interbedded sandstone and shale	Low initial yields; plugging of aquifer by clay and silt; fissure plugging; limited recharge; casing failure	4-7
Metamorphic or igneous	Low initial yield; fissure plugging by silt and clay; mineralization of fissures	12-15
Consolidated sedimentary	Fissure plugging by iron and other minerals; low to medium initial yield	6-8
Semi-consolidated sedimentary	Clay, silt, sand intrusion; incrustation of screens in sand and gravel wells; fissure plugging of limestone aquifers in the interbedded sand, gravel, marl, clay, silt formations; biofouling; iron precipitation	5-8

Well performance evaluation checklist

1. What is the static water level in the production well?
2. What is the pumping rate after a specified period of continuous pumping?
3. What is the pumping water level after a specified period of continuous pumping?
4. What is the specific capacity after a specified period of continuous pumping?
   - **Specific capacity** of a well is its yield per unit of drawdown.
   - **Drawdown** = pumping level minus static level (feet)
   - **Yield** = flowrate (gallons per minute)
   - **Specific capacity = yield/drawdown (gpm/ft)**
   - Specific capacity is the primary indicator of a well screen problem. If it begins to decrease, it may signal early onset of screen trouble.
   - Specific capacity should be monitored monthly for the first year to develop a baseline.
   - After initial monitoring period, specific capacity should be monitored at least twice a year.



Well performance evaluation checklist continued

1. What is the sand content in a water sample after a specified period of continuous pumping?
2. What is the total depth of the well?
3. What is the efficiency of the well (actual vs. theoretical drawdown)?
4. What is the normal pumping rate and how many hours per day does it operate?
5. What has been the general trend in water levels in wells in the area?
6. How much drawdown is created in the production well because of pumping of nearby wells (composite cones of depression)?

These are all baseline parameters, some that should be recorded regularly.

Record keeping?

- **Water-level** measurements before and during pumping and flow rates allows us to calculate **Specific Capacity** (indicator of well screen impairment).
- **Pump run times** can be manipulated to reduce entrance velocities and minimize sand pumping (<0.1 ft/s).
- **Pump repair records** indicate the life expectancy of the pump and when routine work will need to be done.
- **Logs of waterline repairs** may help identify areas of distribution system that are more prone to failure due to age, vibration, or other causes. Use additional resources to predict where breaks are more likely to occur.
- **Chemical sampling** may help us figure out potential sources of well screen impairment, necessary adjustments to the treatment processes, potential problems with storage tanks.
- Keep records consistent, simple, organized, and accessible. *Anyone* on your crew should be able to decipher your notes.

Chemical sampling parameters

Remember those records you were supposed to keep?

- **pH**
  - If plugging is due to encrustation, the pH “may” be increasing.
  - If plugging is from biofouling, the pH “may” be decreasing.
- **Total Conductance (Total Dissolved Solids)**
  - Decrease in TDS may indicate encrustation.
- **Hardness**
  - Decrease in hardness may indicate encrustation.
- **Iron**
  - Decrease in iron concentration may indicate encrustation or biofouling.
- **Sulfide**
  - Increase in sulfide concentration may indicate biofouling.

pH scale in terms we can understand!

Hydrogen ions compared to neutral	Acid		Neutral		Alkaline or basic	Hydrogen ions compared to neutral
10,000,000	0	Battery acid		Sea water	8	0.1
1,000,000	1	Hydrochloric acid secreted by stomach lining		Baking soda, "hard" drinking-water	9	0.01
100,000	2	Lemon juice, gastric acid, vinegar, mine drainage		Great Salt Lake, Milk of Magnesia	10	0.001
10,000	3	Grapefruit juice, orange juice, soft drinks	7	Ammonia solution	11	0.0001
1,000	4	Tomato juice, acid rain		Soapy water	12	0.00001
100	5	"Soft" drinking-water, black coffee		Bleach, oven cleaner	13	0.000001
10	6	Urine, saliva		Liquid drain cleaner	14	0.0000001

Physical sampling parameters

More record-keeping? Yes!

- **Turbidity (qualitative measure)**
  - Increase in turbidity may indicate biofouling or screen plugging.
- **Suspended Solids (quantitative measure)**
  - Increase in suspended solids is a good indicator of potential screen plugging.
- **Odor**
  - Most often associated with biofouling
- **Color**
  - Most often associated with biofouling
- **Taste**
  - Associated with all three: encrustation, biofouling, and screen plugging.

Encrustation is what?

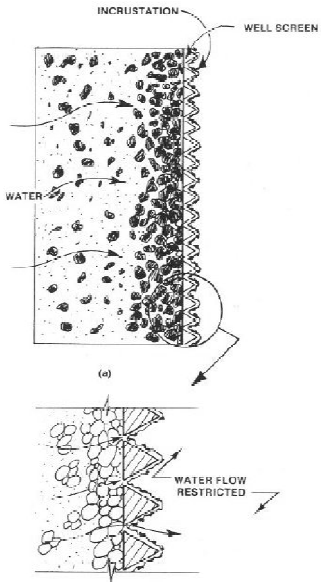
Narrowing of the screen openings by inorganic and organic deposits.

Common deposits:

1. Calcium- and magnesium carbonates and phosphates (hard and cement-like)
2. Iron- and manganese oxyhydroxides (soft and sludge-like)
3. Iron (ferric) oxides (reddish brown)
4. Biomass (slimy, iron+cellular matter)

Water Quality Characteristics:

1. Commonly alkaline (high pH).
2. Elevated carbonate hardness.
3. Iron- and manganese-rich.

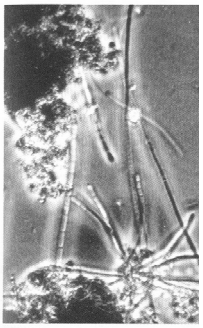


Biofouling is what?

Caused by the accumulation of slimy films of iron-oxidizing and/or sulfur-reducing bacteria.

Iron-oxidizing bacteria: Derive the energy they need to live by catalyzing the oxidation of dissolved ferrous iron in the presence of dissolved organic matter under oxic conditions. This frequently occurs abiotically.
Possible indicators: increase in turbidity, increase in alkalinity, taste/odor/color, pH rise, drop in dissolved oxygen.

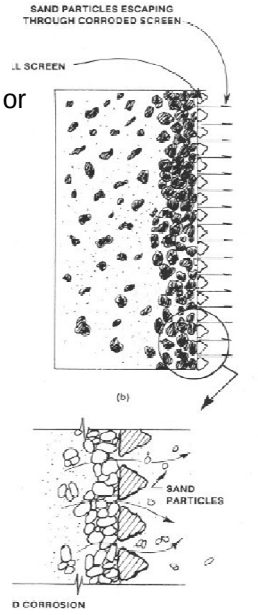
Sulfur-reducing bacteria: Derive the energy they need to live by reducing sulfate to hydrogen sulfide in the presence of dissolved organic matter under anoxic conditions.
Possible indicators: Increase in turbidity, increase in alkalinity, increase of sulfides (not if sedimentary iron-oxide is present), pH changes, taste/odor/color (rotten eggs).



Iron Bacteria

If you are experiencing any of these symptoms, it may be too late to economically rehabilitate the well.

Corrosion is what?



Process which results in the gradual decomposition or destruction of metals by changes in their oxidation states. "Rust".

Chemically:

$Fe \rightarrow Fe^{2+} + 2e^- + 2H_2O \rightleftharpoons Fe(OH)_2 + 2H^+ \rightleftharpoons FeO + H_2O$

$2Fe^{2+} + 0.5O_2 \rightarrow 2Fe^{3+} + O^{2-}$

$Fe^{3+} + 3H_2O \rightleftharpoons 2Fe(OH)_3 + 3H^+$

$Fe(OH)_3 \rightleftharpoons FeO(OH) + H_2O$

$2FeO(OH) \rightleftharpoons Fe_2O_3 + H_2O$

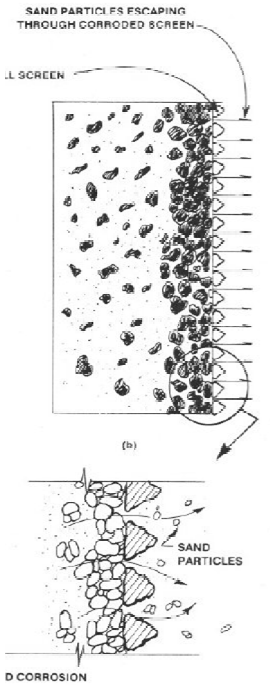
Water Quality Characteristics:

- Commonly acidic (low pH).
- High dissolved oxygen concentration
- High $CO_{2(aq)}$, TDS, Cl^-, HS^-

Other Characteristics:

- Changes in flow velocity

Screen infilling (plugging)



- Caused by damage to the screen by corrosion, improper installation, geological movements
- Sediment infiltrating the well screen through enlarged openings in the screen or casing.
- Reduces overall slotted area of the screen, reducing specific capacity and can either initiate screen encrustation or accelerate current encrustation.
- Translation: The screen fills up with sand and can "hold" less water.
- Not as common as encrustation or biofouling.

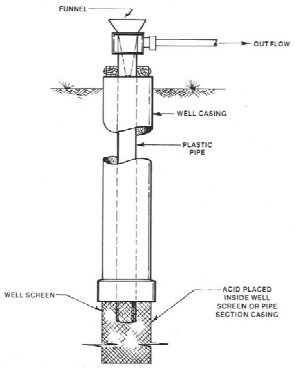
Response

- Determine true source of problem!
  - Above ground or below ground?
- Reduce production rate to reduce entrance velocity
  - As a rule of thumb, to minimize screen encrustation and corrosion the entrance velocity of water moving through the screen should not exceed 0.1 ft/sec.
  - Pumping rate may be reduced and the pumping period increased, thereby decreasing entrance velocities.
  - The pumping load may be divided among wells (you have more than one, right?).
  - A more frequent maintenance or cleaning procedure for wells in areas with greater risk of encrustation (acidic waters, high TDS, high CO_2, high HS^-).

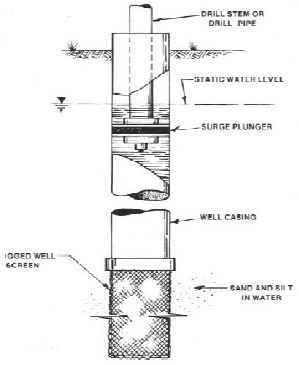
Response

- Plan on rehabilitation, if feasible
  - Investigate chemical and physical removal options
- Obtain pricing information from drilling contractors
  - Cost of well rehabilitation, as compared to
  - Cost of new well installation
- Compare costs to determine strategy
- Plan ahead for alternative source while rehabilitating old well or installing new well
- Get funding underway to finance either option
  - DHH Drinking Water Revolving Loan Fund Program
  - USDA-RUS (Rural Utility Service)
  - Community Resource Group (RCAP nationally)

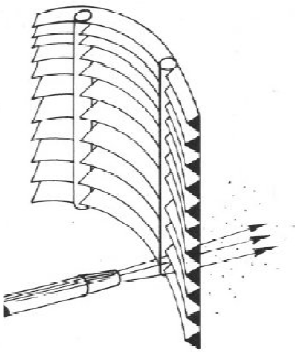
Screen trouble!
Solutions? Rehabilitation? New construction?



Sulfamic acid, chlorine, and polyphosphate treatment



Surging coupled with sulfamic acid treatment



High-velocity jetting coupled with sulfamic acid treatment

Did you know?

- Who issues permits for drilling/reworking water wells?
- Depends on intended use!
  - LDOTD? No, they only *register* the well after it has already been completed. This is a common misconception. LDOTD *does* issue the licenses required to drill wells in Louisiana, ensure your driller has a current license. Related: You do have a copy of the *completed* well registration for each well you own, right?
  - LDEQ? Typically not involved unless your driller intends to create an environmental hazard, but among many other things they can help you with your SWAP report and develop a wellhead protection program.
  - LDHH? Perhaps. If, and only if, the water well is intended for potable use you must obtain a permit from LDHH *before* construction begins.
  - LDNR? Yes! Well, sort of. A water well notification form must be submitted to LDNR 60 days prior to installation. After installation and registration LDNR reviews all available data and may a) issue an order placing restrictions on the well; or b) request further reasonable information; or c) take no action. DNR intends to absorb the water-well registration program from DOTD in near future.

Did you know?

- That the rules, as published by LDOTD, governing the construction of water wells intended for use as “public” supply of potable water are incomplete?
- That obeying the LDOTD rules for the construction of the water well may result in a well that cannot be used for potable purposes?
- What is different? Compare the following excerpts:

LAC56:I.329.C (DOTD)	LAC51:XII.327.A (DHH)
1. Community public supply wells shall be cemented to their full depth from the top of the producing aquifer to the ground surface. 2. Noncommunity public supply wells shall be cemented from a minimum depth of 50 feet to the ground surface.	6. The minimum depth of casings shall not be less than 50 feet in the case of public water supplies. 8. Community public supply wells shall be cemented to their full depth from the top of the producing aquifer to the ground surface; noncommunity public supply wells shall be cemented from a minimum depth of 50 feet to the ground surface.

- That this scenario can easily be avoided by following the rules and submit plans and specifications to LDHH prior to construction?

Why should I care to know the rules on well construction?

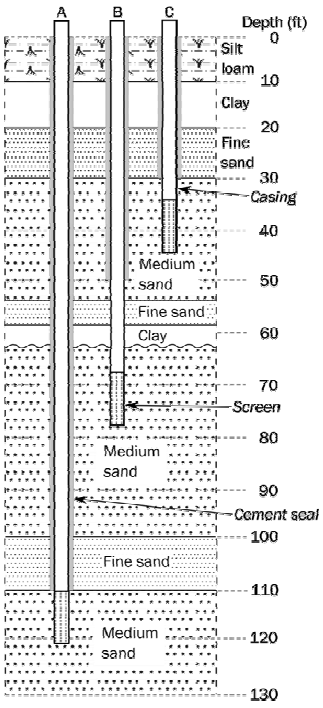
If nothing else, cost.

Who pays the driller?

Is there a money-back guarantee?

On sketch to the right, which wells are allowed under what circumstances?

If you do not know the answer, you may waste some money.



Things to keep in mind

- Don't put off maintenance.
- Keep accurate, timely, comprehensive, and comprehensible records.
- Responsible well operation includes preserving the quality and capacity of your wells, *including the ground-water source*.
- Neglect and excessive use may permanently damage the aquifer. Avoid overpumping like the plague!
- Be observant of potential sources of contamination around your facility.
- Keep your wells properly sealed to prevent direct aquifer contamination.
- Strive to maintain entire well facility clean, neat, and operating at optimum capacity.

Recommended Preventive Maintenance - Daily

- Check water meter readings and record water production – unaccounted-for loss <15%
- Check chemical solution tanks and record amounts used
- Record daily chlorine residuals
- Inspect chemical feed pumps for proper operation – manufacturer's recommended operating range?
- Check and record water levels in ground and elevated storage tanks
- Check and record water levels in hydropneumatic pressure tanks
- Inspect well heads
- Record well pump run times and pump cycle starts
- Inspect booster pump stations
- Check and record fluoride concentration in the distribution system
- Verify security measures are intact

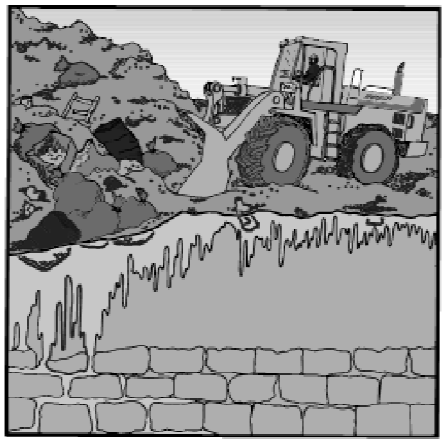
Sanitary code says:

§109. Requirements for Sources of a Potable Water Supply [formerly paragraph 12-002-4]

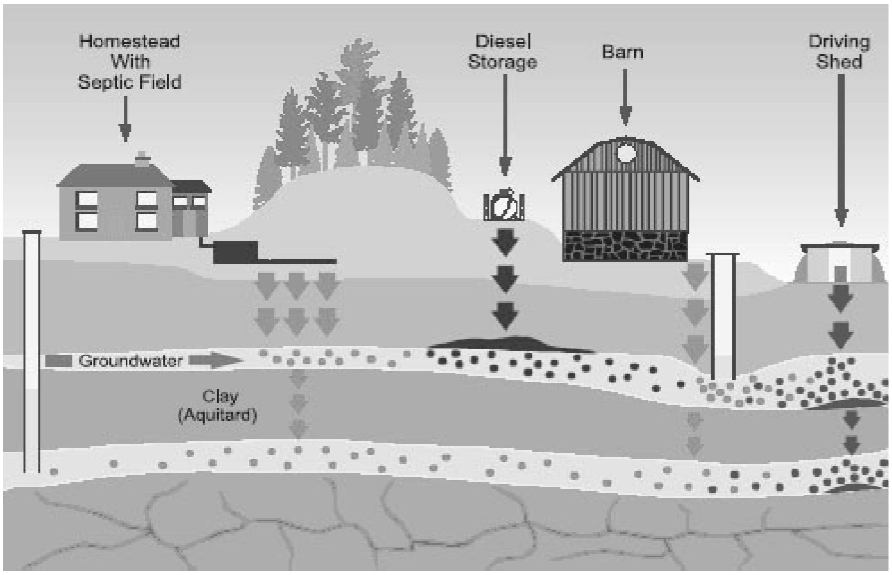
A. Water supplied for potable purposes shall be:

1. obtained from a source **free from pollution**; or
2. obtained from a source adequately **protected** by natural agencies **from** the effects of **pollution**; or
3. adequately protected by **artificial treatment**.

Sources of "pollution"



More sources of “pollution”



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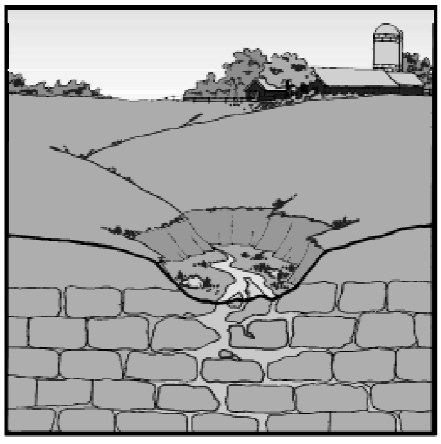
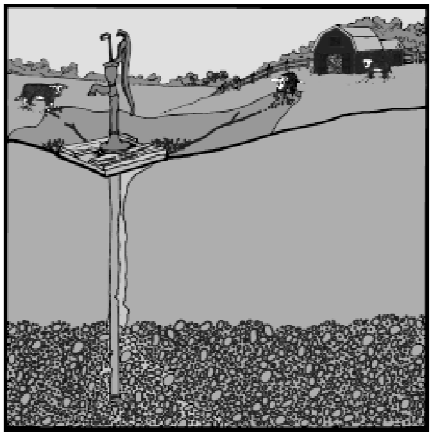
Sources you may not think of





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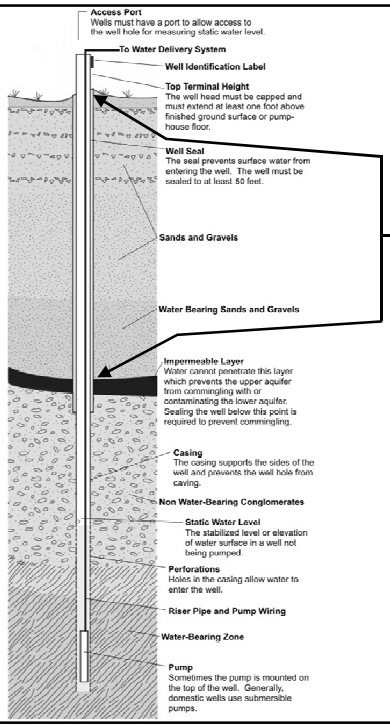


Why are these areas so important?

Horizontal separation?

§327. Ground Water Supplies [formerly paragraph 12:008-1]

A. All potable ground water supplies shall comply with the following requirements.

1. [Formerly paragraph 12:008-2 Exclusion of Surface Water from Site] The ground surface within a safe horizontal distance of the source in all directions shall not be subject to flooding (as defined in Footnote 4 of §327.A.2 below) and shall be so graded and drained as to facilitate the rapid removal of surface water. This horizontal distance shall in no case be less than 50 feet for potable water supplies.
2. [Formerly paragraph 12:008-3 Distances to Sources of Contamination] Every potable water well, and the immediate appurtenances thereto that comprise the well, shall be located at a safe distance from all possible sources of contamination, including but not limited to, privies, cesspools, septic tanks, subsurface tile systems, sewers, drains, barnyards and pits below the ground surface. The horizontal distance from any such possible source of pollution shall be as great as possible, but in no case less than the following minimum distances, except as otherwise approved by the state health officer.

How far from the lake?

Source	Distance in Feet
Septic tanks	50
Storm or sanitary sewer	50[1]
Cesspools, outdoor privies, oxidation ponds, subsurface absorption fields, pits, mechanical sewage treatment plants, etc.	100[2]
Another water-well	25[3]
Sanitary landfills, feed lots, manure piles, solid waste dumps and similar installations	100
Drainage canal, ditch or stream	50[4]

Ownership radius 50 ft.

Security?

§315. Security
[formerly paragraph 12:003-5]

A. All public water supply wells, treatment units, tanks, etc., shall be located inside a fenced area that is capable of being locked; said areas shall be locked when unattended. The fence shall be resistant to climbing and at least 6 feet high.

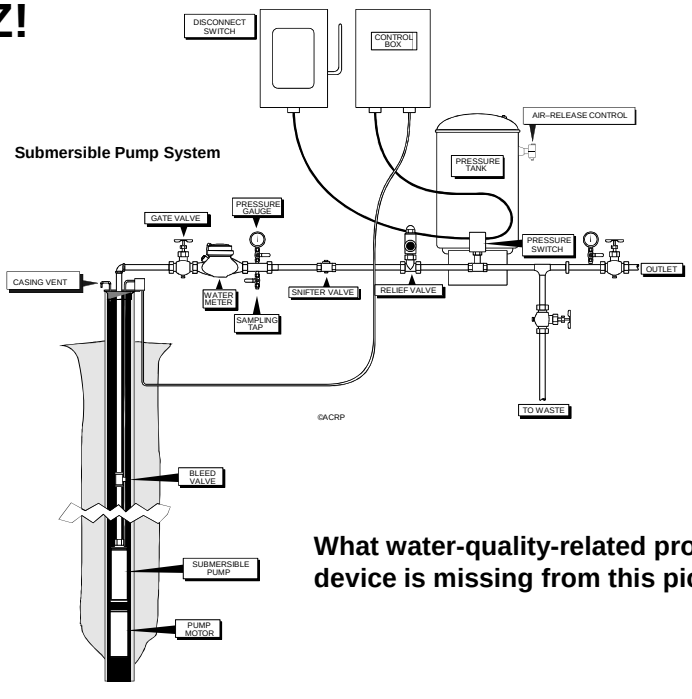
AUTHORITY NOTE: Promulgated in accordance with R.S. 40:4 (A)(8) and R.S. 40:5 (5)(6).

HISTORICAL NOTE: Promulgated by the Department of Health and Hospitals, Office of Public Health, LR 28:1322 (June 2002).

QUIZ!

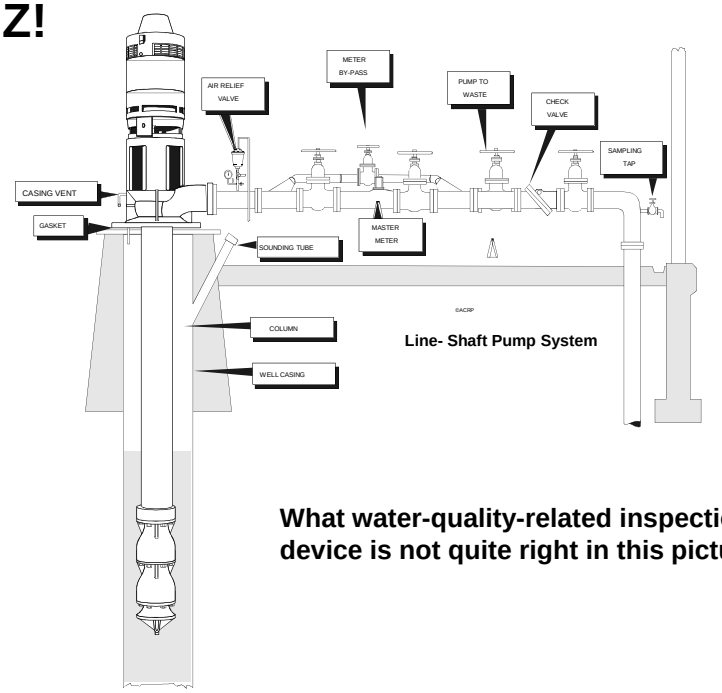
1. Which is more acidic, your favorite soft drink or acid rain? How much more acidic is it? _____
2. What is the minimum depth for a community-supply well? _____
3. What is “specific capacity”? _____
4. How can a written record of specific capacity be of benefit to you? _____
   _____
5. If the specific capacity drops, must it mean the screen is bad? _____
6. What types of aquifers might you find in Louisiana? _____
7. How often should you inspect your well sites? _____
8. Who issues the permit for your public-supply well? _____
9. Can you install a well anywhere you want? Please describe. _____
   _____

QUIZ!



What water-quality-related protection device is missing from this picture?

QUIZ!

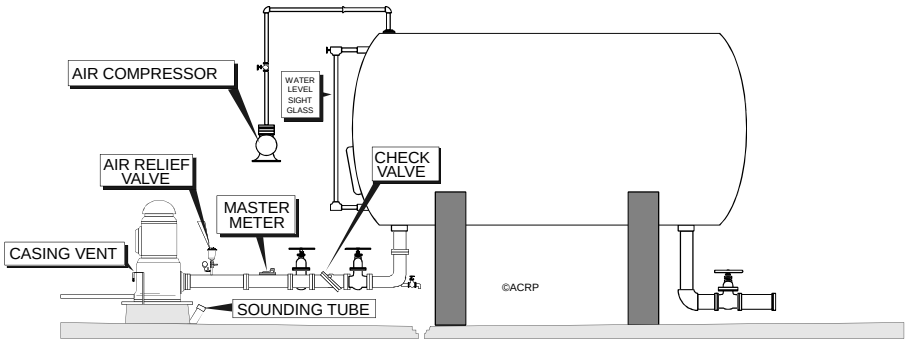


Line- Shaft Pump System

What water-quality-related inspection device is not quite right in this picture?

QUIZ!

Hydropneumatic tank with air compressor



What safety device is missing from this picture?

Anything else not quite right?