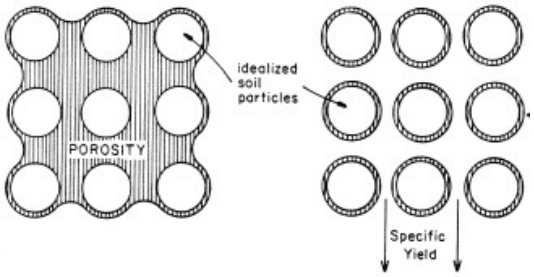
How Can I Measure My Well's Performance?

This paper provides technical information that should be of value to Nicasio well owners who are interested in learning whether their water wells and pumps are performing properly. As background, please refer to the previously published January 2023 Issue 2 paper that discusses water well construction, storage tanks and pressure tanks.

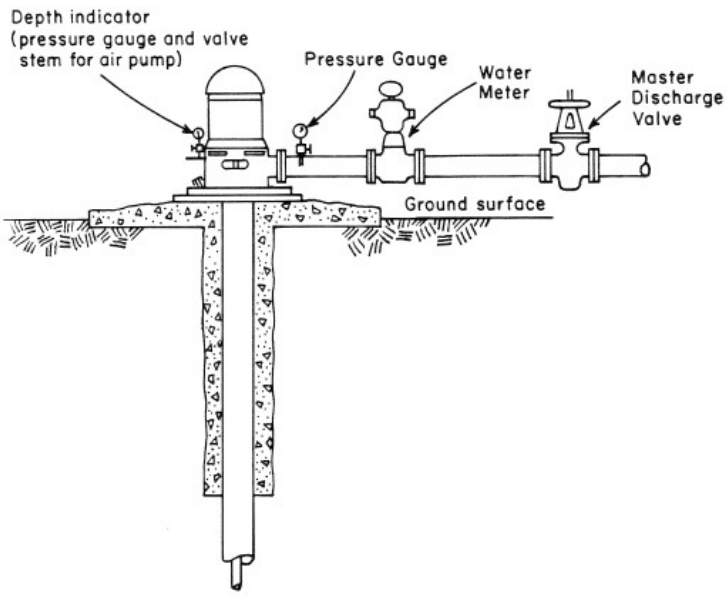


Groundwater conditions affect the performance of a water well. For a well to have satisfactory performance, it must be completed in saturated materials having a: (1) porosity, areal extent, and thickness sufficient to store an adequate water supply, (2) sufficient specific yield (aka drainable porosity) to allow the stored groundwater to drain into a well, and (3) hydraulic conductivity and transmissivity to permit a well to drain water from the saturated materials fast enough to meet the well flow requirements. The overall performance of a well is determined by these three properties of the saturated materials intersected by the screened interval of the well, as well as by the conditions of the well and pump themselves.

Three Required Measurements For Measuring Well Performance

To evaluate your well's performance, four measurements are required: (1) well flow rate, (2) elapsed time, (3) static water level, and (4) pumping water level.

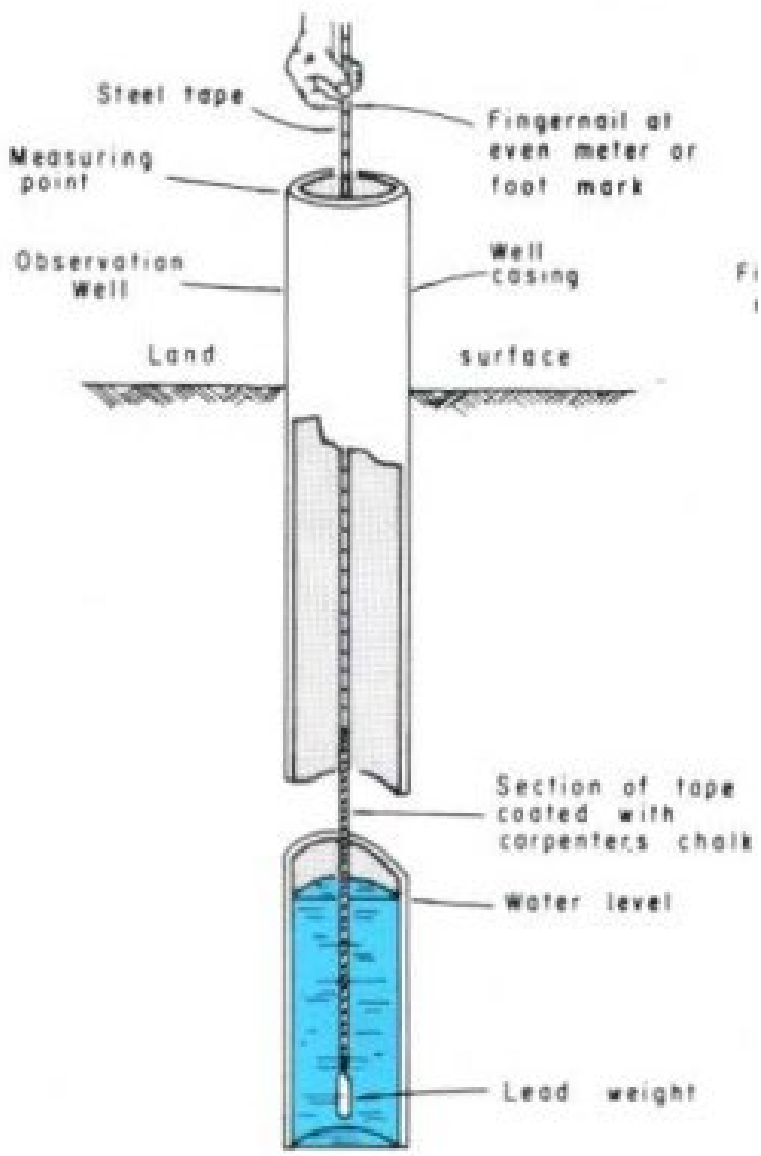
For measurement of small flow rates, the time it takes to fill a container of known volume from the well (i.e., elapsed time) can be used to



calculate the flow rate of the well[1]. For large flow rates, commercial water meters installed in the discharge line from the well can also be used. Recording net volume through the meter and elapsed time will give you a well flow rate.

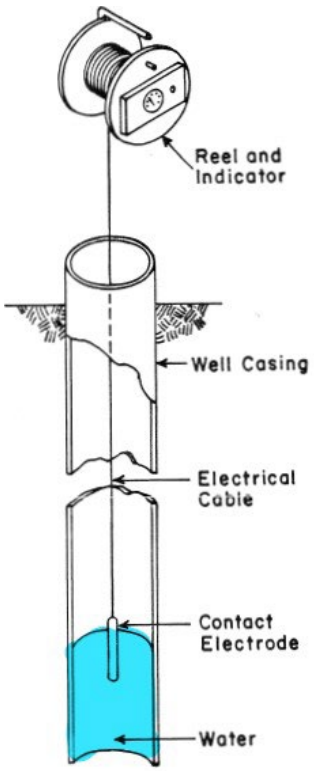
Among the many ways to measure static water level, drawdown, and recovery, the two following measurement methods are generally the easiest.

Steel Tape Method – Water levels in a well may be measured by chalking a graduated steel tape, lowering it a known distance into the well and determining the depth to groundwater by subtraction of the submerged part of the tape as indicated by the wetted chalk mark[2]. Carpenter's chalk or ordinary blackboard chalk that changes shade upon becoming wet can be used. The line of the color change denotes the length of tape immersed in water. Cascading water in a well may mask the mark of the true water level on the tape; however, this usually occurs only in a well that is being pumped. When this condition is encountered, another method of measuring may have to be used.



[1] For example, consider a 5-gallon bucket that fills in 1 minute. That indicates a flow rate of 5 gallons per minute [5 gallons/1 minute = 5 gallons per minute]. If this flow rate is sustainable over the course of one day, then the well yields 7,200 gallons per day [5 gallons/minute for 1440 minutes/day = 7,200 gallons/day].

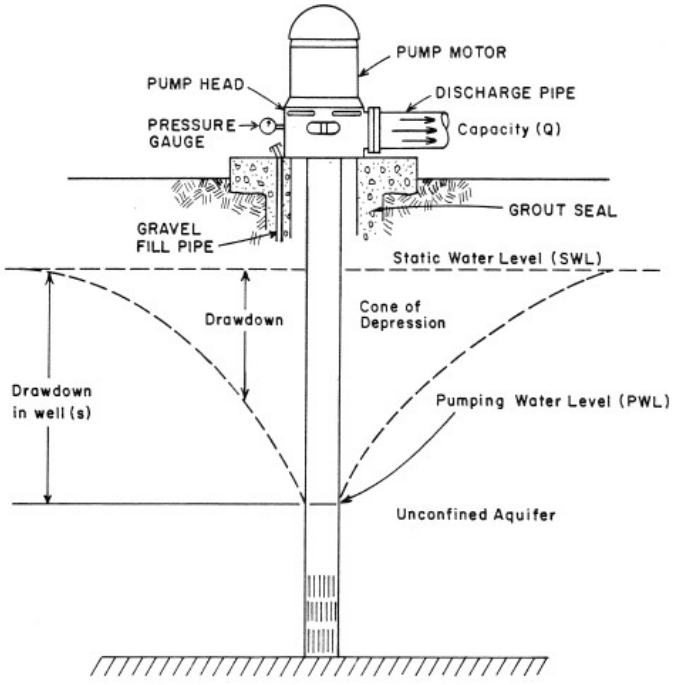
[2] For example, after chalking the bottom 5 feet of the steel tape, you lower the tape 100 feet below the top of the well casing. After withdrawing the steel tape from the well, you observe a line of color change in the chalk at 3 feet. That indicates that the depth to water in the well is 97 feet below the top of the casing [100 – 3 = 97].



Electronic Sounder Method – Water levels in a well can be measured by an electric sounder attached to a graduated measuring tape by slowly lowering it into the well and determining the depth to the groundwater by noting the depth when the sounder beeps. The electrical sounder consists of a pair of insulated wires powered by a battery. When the wires touch water, the electrical circuit is completed, an indicator receives a flow of current, and the device beeps.

A Simple Pumped-Well Test to Evaluate Well Performance

Among other pumped well tests, a specific capacity test can be performed during the normal operation of your well. The specific capacity of a well is defined as the ratio of the well flow rate to water level drawdown[3]. Put differently, your well's specific capacity is the flow rate of the pumped well divided by the change in the depth to water due to pumping the well[4].



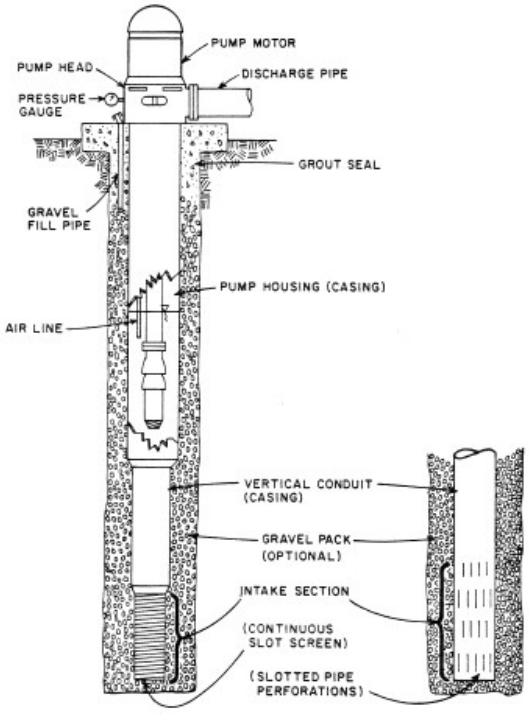
[3] Drawdown is the difference between the static and pumping water levels. The static water level is the water level in a well unaffected by pumping. When your well has been pumping, you may need to allow it to sit idle for 3-4 hours before you can accurately measure its static water level. The pumping water level is the water level in a well while it is pumping.

[4] For example, if your well pumps at 5 gallons per minute (gpm) and the water level in the well drops 5 feet from static to pumping conditions, then you could calculate the specific capacity of the well as 1 gpm per foot of drawdown [5 gpm/5 feet water level change = 1 gpm/ft].

You can perform a specific capacity test by measuring the static water level in the well after the pump is turned off and the depth to water has stabilized. Depending on the groundwater conditions, it may take several water level measurements over a period of several hours to determine the static water level. Once the static water level is identified, the pump is then started and the pumping water level is measured over a period of several hours to define the depth to water under pumping conditions.

Ideally, well and pump performance should be tested on a regular basis. You should try to run specific capacity tests on your well at about the same time each year to minimize the impact of seasonal changes on groundwater conditions. You can then compare these test results with previous test results to determine if your well's performance has changed. Decreases in well flow rate and/or increases in drawdown during specific capacity tests are an indication of impaired well performance. Improper or inadequate maintenance of a well and pump can lead to decreased well flow rate, increased energy requirements, higher well maintenance and repair costs, and even well failure.

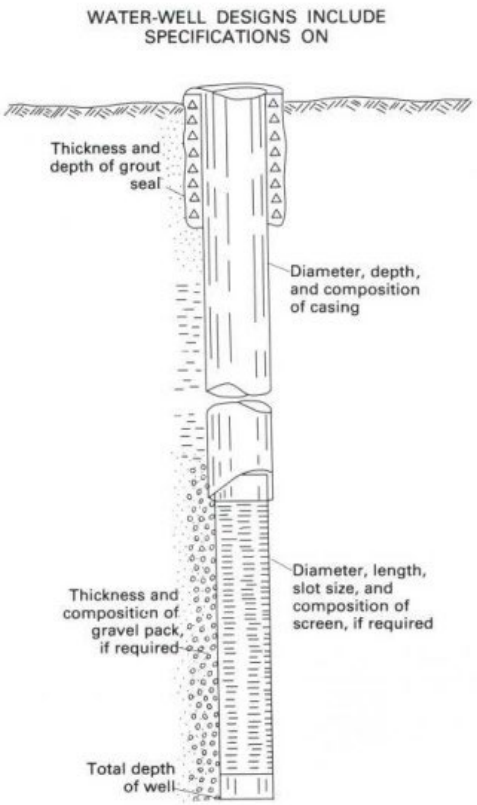
Conditions Affecting Well and Pump Performance



There are several factors that can negatively affect the performance of your well and pump. These include: incrustation, corrosion, mechanical wear, and declining groundwater levels. Incrustation includes calcium and magnesium carbonates (aka scale), iron and manganese hydroxide, iron bacteria, and deposition of silt and clays on a well screen. Corrosion in water wells usually consists of a chemical reaction in which metal is attacked by constituents in the groundwater, forming a chemical product (a metal compound) that dissolves in water and is carried off. This may result in general rusting of a metal well casing, localized pitting and possible penetration of a well casing, enlargement of well screen openings, or accelerated wear of pump parts. Mechanical wear of pump parts over time should be expected. Sand in the pumped groundwater significantly accelerates wear. It can also cause wear in the well screen, resulting in wider openings, and decrease sand control. Declining groundwater levels will reduce the available drawdown in your well and can reduce the well's flow rate.

Well Operation Records

The better the records you keep, the better able you will be to assess your well's performance. Complete records are the key to effective evaluation of well and pump performance. Without such records, it is difficult to make decisions about the condition of a well and pump. We recommend that you obtain and retain as much of the following information as possible:



- The driller's log showing the location of your well, date of construction and completion, identification of subsurface materials encountered, and method of well construction,
- Well completion information, including sizes and depths of casings, sizes and depths of screens or perforations, size and amount of sand/gravel pack used,
- Well and pump tests, including test dates, specific capacity, and pump performance tests,
- Records and dates of the static water level in the well, preferably in the spring and fall of each year,
- Production information, such as rates pumped, hours of operation, cumulative pumpage,
- Details and dates of maintenance and rehabilitation work performed on the well.

These records will provide an accurate history of your well's construction and performance and will make it possible for you or a well service professional to conduct an informed assessment of your well's performance.

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