Water Well Data Collection Recommendations and Techniques

General

Measuring and recording water levels and discharge volumes from municipal water wells on a regular schedule provides invaluable information regarding 1) potential well maintenance issues and 2) aquifer conditions and characteristics. Obtaining this information over a period of time allows the water system operator to determine any changes in the production capabilities of the water supply well and/or aquifer. A reduction in water levels or water quality over time may be indicative of several well maintenance issues that include: 1) chemical incrustation, 2) biological incrustation, 3) sand pumping, 4) well screen failure, 5) well construction/pump design and 6) progressive failure of the pump. Aquifer conditions that may reduce the capabilities of water supply wells include; 1) reduced recharge (drought) and 2) well interference.

If historical water levels and discharge volumes are measured and recorded then the water system operator can determine if a reduction in water well capabilities exist and the potential cause. Water supply wells generally require maintenance every 2 to 10 years depending on the well construction and aquifer characteristics for continued operation. Problems with water supply wells generally develop over time and will most likely become apparent by reviewing the historic water level and discharge information. Recognizing potential problems early will allow for development of a timely and cost effective remediation plan along with continued well operation. If problems are allowed to worsen with continued operation then catastrophic well failure may result.

There are three commonly used methods of measuring water levels: 1) air lines, 2) water level indicators and 3) data loggers/pressure transducers. The following is a general guidance document that discusses these techniques for measuring and recording water levels.

Water Level Measurement Techniques

Air Line

General: Air lines are commonly used to measure water levels in deep wells due to their low cost and lack of maintenance. The air line consists of a hollow tube that extends from the surface to a depth below the lowest pumped water level. The procedure to measure water levels with an air line can be seen in Figure 1. The water level in an unpressurized air line will be the same as the water level in the well (either pumped or unpumped). Air pressure is applied to the top of the air line and is measured with a pressure gage. The air pressure increases until all of the water is evacuated from the air line at which time the air pressure stabilizes. The maximum air pressure in the air line is a measure of the height of water above the end of the air line. An air line is the least precise method of water level measurement relative to the other techniques discussed in this paper. The air line water level measurements are accurate only to about plus or minus 3 feet.

Construction:

1. The air line should be constructed of continuous, airtight tubing from the surface of the well to a depth that will be below the lowest pumped water level, generally at or near the pump intakes.
2. The air line can be made from almost any material either 1) galvanized steel, 2) copper, 3) PVC, or 4) plastic tubing. It is important to measure the length of the air line below the wellhead. This measurement is necessary to calculate the depth of water. The accuracy of this measurement is directly related to the accuracy of all subsequent water level measurements. If using PVC or any other material that comes in lengths it is recommended to use threaded material as opposed to gluing material together. The glue may introduce organic compounds that can appear in subsequent chemical analytical testing.
3. If the air line is being placed after the installation of the pump, then the tubing can be placed between the casing wall and the pump column. If the air line is being placed during pump installation then the tubing can be attached to the pump column as it is being lowered into place.
4. It is recommended that at least two air lines be constructed and placed at the same time. If one air line fails then others are readily available for use, which is much more cost effective then constructing and placing new lines again.

5. The air line diameter does not have to be large. Diameters generally range from ⅛ to ½ inch in diameter.
6. If the well head is not located in a well house or fenced compound then the end of the air line should be secured so that unauthorized personnel do not have access and potentially damage or introduce hazardous material into the air line.
7. At the top of the air line should be an airtight fitting that the pressurizing device can be attached to. The pressurizing device can consist of a bicycle pump or pressure pump. The necessary air pressure (in psi) is equal to the height of the water over the bottom end of the air line divided by 2.31.
8. A pressure gage should be attached near the top of the air line in a location that can be easily read as the line is being pressurized. The accuracy of the water levels is a direct function of the accuracy of the pressure gage.

Operation:

1. Attach pressurizing device to top of air line.
2. Apply pressure to air line until pressure gage stabilizes.
3. Note stabilized pressure reading (psi).
4. Depth to water can be calculated as follows (see fig. 1);

$$d = k - (2.31)(p)$$

Where:

d = depth to water (ft)

k = length of air line measured from well head (ft)

p = stabilized pressure reading (psi)

5. Record the following
   a. water system
   b. well number/identification
   c. person recording water level
   d. date/time
   e. depth to water
   f. cumulative flow volume
   g. flow rate
   h. weather conditions

Problems: If a constant water level is measured regardless of pumping condition or discharge rate of water well, the air line is non-functional. This condition is most likely caused by a leak in the air line. The single most common cause is a hole that develops in the air line caused by corrosion of the air line with age. The result is a change in the effective length of the air line so as the air line is pressurized the depth of water will always equate to the area of the leak. The air line must be replaced or the water system operator can use additional air lines if installed.

Water Level Indicator

General: A water level indicator or electrical tape (e-tape) consists of a battery activated two-lead wire with a weighed end. The wire is lowered down the well until the end comes in contact with water. An electrical circuit is completed through the water and an indicator is activated. The depth is read from graduated markings on the wire. Water levels can be measured using a water level indicator (e-tape) to a precision of plus or minus 0.1 feet. The procedure to measure water levels with a water level indicator can be seen in Figure 2.

Manufactures: There are a number of manufactures that produce water level indicators. Below is a partial list, please contact manufacturer regarding costs, options and specifications.

1. Slope Indicator
   12123 Harbour Reach Dr
   Mukilteo, WA, USA 98275
   Phone (425) 493-6200
   Fax (425) 493-6250
   http://www.slopeindicator.com/

2. Solinst Canada Ltd.
   35 Todd Rd.
   Georgetown, Ontario Canada
   L7G 4R8
   Phone (905) 873-2255
   (800) 661-2023
   Fax (905) 873-1992
   (800) 516-9081
   http://www.solinst.com/

3. Heron Instruments
   25 King Street, Georgetown,
   Ontario, Canada L7G 2G9
   Phone (905) 877-0876
   (800)-331-2032
   Fax (905) 877-7297
   http://www.heroninstruments.com/

Piezometer Construction: Water-level measurement using an e-tape can be accomplished either by inserting the tape down the annular space between the well casing and the pump column or by inserting the tape down a tube (piezometer) specifically placed in a well for water level measurement. Use of the piezometer tube for a measurement is best because it insures that the e-tape will not get caught or tangled on the casing, pump column or wiring within the well.

1. The piezometer is constructed of continuous tubing from the surface of the well to a depth that will be below the lowest pumped water level, generally at or near the pump intakes.

2. The piezometer is almost always constructed from PVC. It is important when using PVC to use **ONLY** threaded lengths as opposed to gluing material together. The glue may introduce organic compounds that can appear in chemical analytical testing.

3.The end of the piezometer should have a threaded cap to prevent the end of the water level indicator tape from being extended below the bottom of the piezometer. The bottom 5- to 10-feet of the piezometer should be slotted to introduce water into the piezometer. The slotted length can be constructed by hand cutting with a saw or commercial machine cut screen (20-slot) can be purchased.

4. If the piezometer is being placed after installation of the pump, then the piezometer can be placed from the wellhead to depth between the casing wall and the pump column. If the piezometer is placed during pump installation, then it can be attached to the pump column as it being lowered into place. The piezometer should be attached with wire ties; tape should not be used as the adhesive on the back of the tape may introduce organic compounds that can appear with chemical analytical testing.

5.The piezometer diameter should be large enough so that the weighted end of the e-tape can easily slip down the length of the piezometer regardless of any potential bends or kinks in the tubing. Diameters generally range from ½-inch to 1-inch diameter.

6.If the well head is not located in a well house or fenced compound then the end of the piezometer should be secured so that unauthorized personnel do not have access and potentially damage or introduce hazardous material into the well.

7. A small mark should be placed at the top end of the piezometer usually with a black indelible marker. All measurements should be made in relation to that mark to insure consistency.

Operation:

1. Remove cap from piezometer
2. Turn on water level indicator
3. Switch indicator to light or buzzer or both
4. Set gain to a setting approximately half way between high and low.
5. Press test switch to ensure proper operation
6. Lower water level indicator tape until indicator is activated
7. Note depth to water as indicated on the graduated tape from the mark on the upper end of the casing
8. Record the following
   a. water system
   b. well number/identification
   c. person recording water level
   d. date/time
   e. depth to water
   f. cumulative flow volume
   g. flow rate
   h. weather conditions

Problems:

Cannot get stable Indicator. The water in the well may be turbulent depending on pumping conditions. If this occurs turn down the gain until a stable indicator can be achieved.

Electronic Recording

General: Water levels can be recorded automatically with a data logger and pressure transducer. The pressure transducer is a device that is lowered into a well on a cable that attaches to the data logger at the surface. The pressure transducer measures the pressure due to the overlying column of water and transmits this information to the data logger via the attached cable. The data logger can be programmed with a laptop computer and associated software to record the measurements on any schedule from seconds to days. The information collected includes pressure measurements and a time/date stamp that can be stored for periods of days to months depending on the frequency of sampling. Using a laptop computer and software the pressure measurements can be converted to water levels and viewed directly on the computer or downloaded from the data logger into a number of different spreadsheet or text formats. Data loggers/pressure transducers can be used to take frequent water level measurements to a precision of plus or minus 0.1 feet. Hand measurement of water levels, using a water level indicator, are needed to field check the data logger/pressure transducer readings. The setup for use of a data logger/pressure transducer to measure water levels can be seen in Figure 3.

Manufactures: There are a number of manufactures that produce pressure transducers and data loggers. Below is a partial list, please contact manufacturer regarding costs, options and specifications.

1. In-Situ, Inc.
   210 S. Third Street, P.O. Box I
   Laramie, Wyoming 82073
   United States
   Phone: (307) 742-8213
   (800) 446-7488
   Fax: (307) 721-7598
   http://www.in-situ.com/

2. Instrumentation Northwest Inc
   8902 122nd Avenue Northeast, Kirkland, WA 98033
   Phone: (425) 822-4434
   (800) 776-9355
   Fax (425) 822-8384
   http://www.inwusa.com/

3. Solinst Canada Ltd.
   35 Todd Rd.
   Georgetown, Ontario
   Canada
   L7G 4R8
   Phone (905) 873-2255
   (800) 661-2023
   Fax (905) 873-1992
   (800) 516-9081
   http://www.solinst.com/

Operation:

1.Each data logger and pressure transducer manufacturer will have different software and operating instructions. Please refer to operation manual for specifics regarding the data logger and pressure transducer that will be used.

2. Pressure transducers are constructed to operate in various pressure ranges. It is very important that the pressure transducer to be used is designed to operate within the range of anticipated water depths or damage may occur. Please consult with manufacturer before acquiring pressure transducers to ensure proper operation.

3. It is strongly recommended to construct a piezometer as described above for the pressure transducer for ease of to placement and to protect the instrumentation.

4. Remove cap from piezometer

5. Lower transducer into piezometer to desired depth. The depth generally is read directly from the laptop computer in real time using the associated software. It is very important not to lower the transducer below the designed water depth and associated pressure range or damage can occur.

6.Once the transducer is lowered to the proper depth firmly attach to the wellhead. A number of transducer cables have a small air line incorporated into the cable and is used equilibrate measurements with atmospheric pressure. If the cable is kinked or crushed then incorrect measurements may result.

7.Following manufacturers directions, program the data logger to record measurements on a regular schedule.

8. Periodically visit the site and download information. Repeat as necessary.

9. Record the following

   a. water system
   b. well number/identification
   c. person recording water level
   d. date/time
   e. depth to water
   f. cumulative flow volume
   g. flow rate
   h. weather conditions

Problems:

Problems are generally related to equipment failure and it is recommended to contact the manufacturer.

Recommended Water Level Measurement Frequency and Documentation

It is recommended that water level measurements be obtained weekly. The data should be complied and reviewed at least once per year. It is recommended that the information be compiled in a commercially available spreadsheet format. The spreadsheet will allow 1) the water system operator to view trends by graphing the information and 2) electronic storage of the information for ease of distribution and the creation of backup files.

For additional information please contact:

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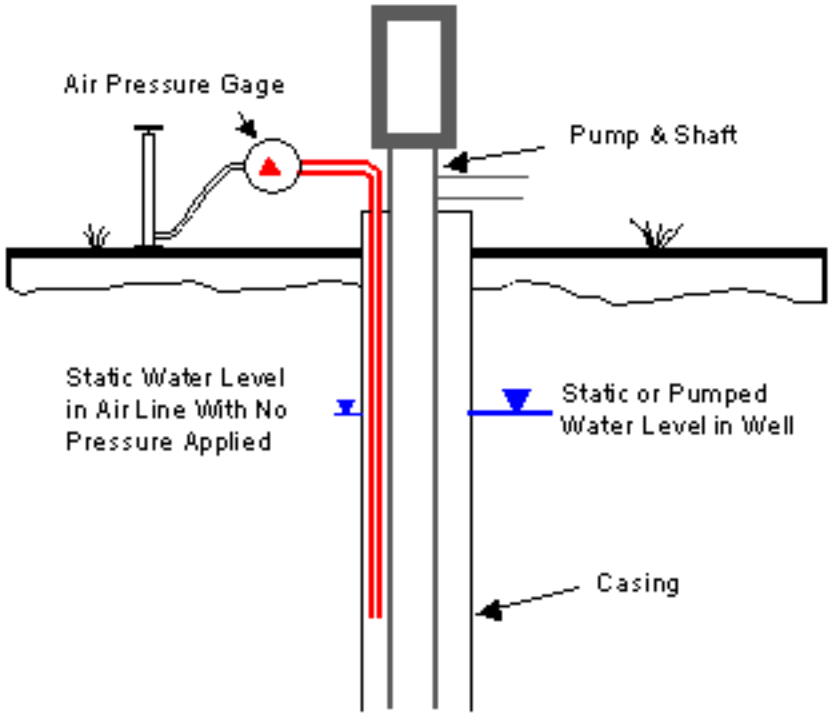
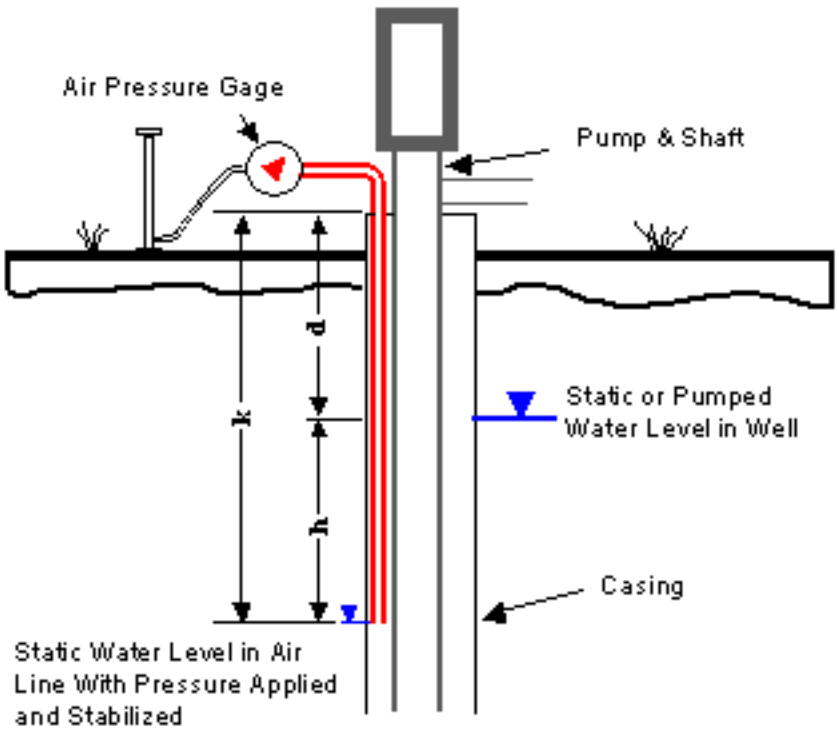
205 Morrill Hall
University of Idaho
Moscow, ID 83843
(208) 885-6429

Air Line Not Pumped



Air Line Pumped & Evacuated



Depth of water level in well
d = k- (p * 2.31)
d = Depth to water level in well (ft)
k = Length of air line (ft)

p = Pressure to evacuate water from air line - pressure will stabilize (psi)

Figure 1. Air Line Operation

Water Level Indicator

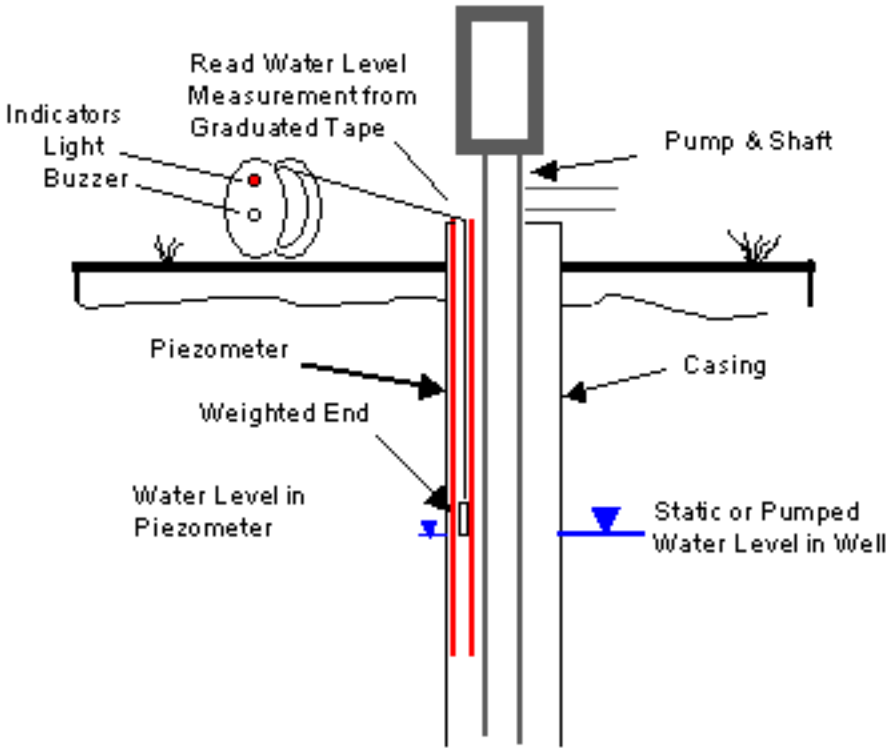


Figure 2. Water Level Indicator Operation

Data Logger/Pressure Transducer

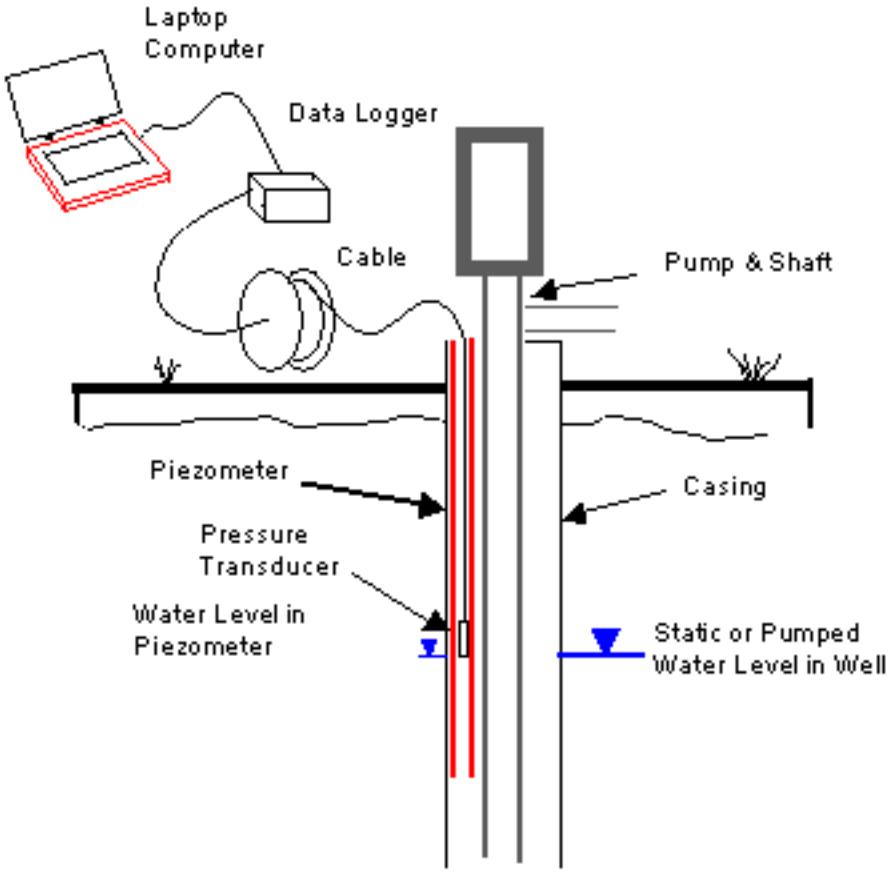


Figure 3. Data Logger/Transducerr Operation