USER MANUAL 52

A Field Manual for Groundwater-level Monitoring at the Texas Water Development Board

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Introduction

Purpose of the Texas Water Development Board (TWDB) Water-Level Program

The purpose of the TWDB's water-level program is to gain representative information about static water levels in aquifers (water levels unaffected by recent or nearby pumping) throughout the state in order to support water planning from the local to a more regional perspective. The TWDB and its cooperators, primarily groundwater conservation districts (districts) and the U.S. Geological Survey (USGS), have been measuring depth-to-water at least annually in over 7,000 wells for the last two decades. It is not uncommon for districts to provide measurements more frequently than once a year when they start measuring wells in their jurisdiction that were previously measured by the TWDB.

Texas does not have an official "dedicated" network of wells that were drilled specifically as monitor wells. Instead, TWDB relies on access to privately owned wells, preferably that are no longer in service and not equipped. Fortunately, nearly half of the wells that the TWDB and cooperators measure are in this category; however, other wells that are part of the current observation (water-level) network are still in use and provide water for domestic, stock, irrigation, industrial, and public-supply.

Monitoring Section employees normally measure water levels during cooler months when groundwater pumping is at a minimum to ensure that measurements are most indicative of static or ambient conditions, particularly in those wells that are still in use. They also communicate with well owners in advance to be certain that pumps are turned off for at least 24 hours. The TWDB and other entities measure the same wells each year, recognizing the value of many measurements over as long a period of time as possible in the same location. TWDB and district employees strive to find replacement sites when access to a well is no longer granted (rarely) or when a well is destroyed or other conditions in the well bore preclude obtaining accurate measurements.

Whereas levels collected for the water-level program typically provide an understanding of water-level changes (or lack of) over a long period of time, water levels collected and posted online in the TWDB's Recorder Program (unused wells equipped with automatic water-level recording equipment) provide current information and more frequent measurements (hourly) that allow cities and groundwater conservation districts to react quickly in mandating pumping limits during drought. The recorders measure water levels in (near) real time and transmit the data by satellite to the TWDB where daily readings of hourly measurements are published on the Water Data for Texas website. The equipment at each recorder well site typically consists of data loggers attached to water-level recording devices, such as transducers or floats and pulleys; satellite transmitters; power sources, including solar panels; antennae; and equipment shelters. The number of groundwater conservation districts that work with the TWDB, typically through

purchase of equipment, to install more recorders that also provide data for publication on the TWDB Web site has continued to increase in the last decade. More than 10 groundwater conservation districts cooperate with the TWDB. While this cooperation is beneficial to both the TWDB and the local districts, staff limitations at the TWDB currently limit the number of recorders that can be maintained adequately at no more than 200 sites.

Although the two water-level data-collection programs are distinct, Monitoring Section employees working in the water-level program also visit recorders. They measure depth-to-water in all recorders at least once a year to check the accuracy of the data provided by the recorder equipment.

All data collected by the TWDB Groundwater Monitoring Section and from cooperators that send in data on their monitored wells are available from the Groundwater Database (GWDB) Reports website.

History of the TWDB Water-level Program

Beginning in the 1960s, TWDB team leaders in four different regions across the state determined which wells would be routinely monitored. Each of these regions conducted water-level and water-quality data collection according to regional priorities and prioritized annual collection of water levels. After 1988, TWDB management centralized decisions about groundwater data collection and more formally initiated programs requiring annual measurement in a network of wells in nearly all counties and periodic, cyclic sampling of wells and spring water. Management recognized that the information collected was essential in characterizing current conditions and the changes occurring in water levels and water quality over time.

Legislative Budget Board Influence

The State Legislature in 1991 mandated that all state agencies determine performance measures to reflect the results of their work in quantifiable, time-based metrics. Agencies were required to compile and report their measures quarterly and yearly to the Legislative Budget Board. The Monitoring Section continues to plan data-collection assignments considering these metrics.

In having to respond to the Legislative Budget Board, TWDB groundwater and surface water staff created two basic measures. Their “output” measure is designed to reflect the majority of all ground- and surface-water related data collected or received and processed by TWDB staff in support of monitoring, investigating, and defining the state's surface water and groundwater resources. This output measure number includes the total number of groundwater levels (and groundwater samples analyzed by an accredited lab) collected by TWDB and its cooperators along with different sets of water data collected by the Surface Water Division such as reservoir levels and stream gage data. Another significant type of groundwater data, or volumes pumped, is collected by a different division in the agency, primarily through well owner surveys.

The Sections' "outcome" measure, or the "percent of information available to adequately monitor the state's water supplies," was crafted to reflect the relevancy of the total amount of data collected in an "adequate" network. The challenge of formulating an adequate network of wells capable of providing water-level and water-quality data for any purpose at any location is obvious—the future is difficult to predict, and almost all data become more valuable with time. As a response to this legislation, the TWDB realized the need for choosing network wells based on criteria that would ensure a representative number of groundwater levels or samples per aquifer per county. These networks would also have to accommodate, to some extent, wells with long-term histories of measurement (and sampling), no matter their location and aquifer completion.

To distribute wells in the observation network throughout the state in an equitable and reasonable manner, TWDB geologists used formulas to apply to each county-aquifer combination that mainly relied on production, but also considered other variables. Although these criteria determine the number of wells needed per county-aquifer combination, spacing requirements are qualitative. We strive to choose wells that are relatively evenly distributed, but the heterogeneity within aquifers often results in variable production throughout, and even distribution of monitor wells may not be possible or desirable. TWDB must also rely on the existence and availability of wells best suited for measuring. In the water-level program, ideally TWDB would measure wells that are not equipped, whereas wells best suited for sampling must contain pumps. By necessity, however, TWDB measures some equipped wells, taking extra care to be aware of and document recent pumping. Above all, well owner cooperation is essential.

Criteria determining number of adequate current water-level observation wells per county-aquifer combination:

- **1 well/25 square miles** (> 100,000 acre-feet of groundwater pumped annually)
- **1 well/50 square mi**les (> 10,000 & < 100,000 acre-feet of groundwater pumped annually)
- **1 well/75 square miles** (> 10,000 & < 100,000 acre-feet of groundwater pumped annually, coupled with little water-level fluctuation, or < 50 feet of decrease per decade in artesian aquifers or < 20 feet per decade in water-table aquifers as determined from the latest water-level change maps; or where few wells available as in extreme downdip limits)
- **1 well/100 square miles** (> 2,500 acre-feet & < 10,000 acre-feet of groundwater pumped annually)
- **1 well/125 square miles** (> 2,500 acre-feet & < 10,000 acre-feet of groundwater pumped annually and little water-level fluctuation or few wells available)
- **1 well/150 square miles** (> 1,000 & < 2,500 acre-feet groundwater pumped annually)
- **1 well** for entire aquifer-county combination (<1,000 acre-feet groundwater pumped annually)

The adequacy achieved by TWDB staff in measuring the ideally "adequate" or "required" number of wells in each county every year, even with cooperator help, does not reach 100 percent. This is mainly due to the discrepancy between where the aquifer is mapped compared to where wells are actually completed in the aquifer. For example, many of the aquifer-county combinations include the downdip extent of an aquifer that was determined by older studies that used geophysical log interpretations from oil and gas reports rather than the actual presence of wells. The number of sites prescribed as adequate by the formula for a county-aquifer combination may not exist.

Not surprisingly, county-aquifer combinations with large production—defined as over 100,000 acre-feet a year—are commonly found in areas where districts have long engaged in monitoring activities such as in the High Plains. These districts measure and share data with the TWDB, and such partnerships have allowed TWDB to focus their efforts on other geographical areas. District help has also allowed TWDB staff to spend more time training newer districts in water-level measuring procedures and in helping them to obtain data, maps, and reports that will facilitate their new data-collection programs.

National Ground Water Monitoring Network Influence

To improve collection of and access to groundwater information throughout the United States, the Subcommittee on Ground Water to the federal Advisory Committee on Water Information, whose purpose is "to improve water information for decision making about natural resources management and environmental protection", proposed a National Ground Water Monitoring Network (NGWMN) in the late 2000s. The Subcommittee chose TWDB and four other states/entities in 2010 to participate in a pilot project to explore the feasibility and necessary resources for implementation of this network. The U.S. Geological Survey (USGS) has participated as the lead agency since the inception of the Network, and has created and continues to maintain and operate a data portal for the transmission of water level, water quality, and associated well data from an increasing number of states, once their proposals have been evaluated by the NGWMN's Program Board.

During the pilot project, the TWDB evaluated field practices, data elements stored in databases, data management procedures and documentation, and the ability to transmit data to the data portal. Instrumental in this last endeavor was the work performed by the agency's Information Technology group in creating web services. The Monitoring Section initially provided 425 wells with long measurement histories in eight of the nine major aquifers, including 57 recorder well sites, for inclusion in the NGWMN. With the passage of specific bills in Congress in 2015, the NGWMN received more funds to enhance its program through the participation of more states and/or maintenance and additional activities conducted by existing members. TWDB, as a recipient of funds after response to the 2015 and 2016 program announcements, selected more than 600 sites as part of its water-quality subnetwork and more than 400 sites as replacement and additional wells for the original water-level subnetwork, completing the selection of wells in the

one remaining aquifer, the Ogallala (or High Plains) Aquifer, that was not included in the original water-level subnetwork.

The NGWMN wells have, in general, longer water-level and water-quality histories and more associated meta data, such as driller's logs. The Monitoring Section will strive to ensure that these wells are visited and measured regularly, with meta-data gaps filled to the extent possible. Also, when these NGWMN wells must be deleted from the current observation well network, staff will select appropriate replacements from within the observation well network. Similar to the benefit inherent in the TWDB's Water Data for Texas groundwater page, on which the near real-time recorders appear, the NGWMN portal allows viewers a similar benefit. It is an interactive map that highlights only these selected water-level (and water-quality) network wells. Further, as more states contribute to the NGWMN, comparisons in water-level histories in wells in several of Texas' shared aquifers will also be available.

The remainder of this manual is devoted to the details, described chronologically, involved in measuring water levels in wells. In addition, the manual includes certain administrative tasks that TWDB employees must undertake that won't be applicable to non-agency personnel. The manual revision is in part an outcome of the TWDB's involvement with the NGWMN and the specific protocols promoted by other Network contributors.

Preparing for a Water-level Trip

In-office preparation before a water-level trip ensures efficient use of time while working in the field.

Water-level Trip Assignments

The TWDB water-level monitoring program strives to obtain static (non-pumping) water-level measurements to better understand the natural properties of the aquifers of Texas. Therefore, staff typically measure wells between October and February each year. The Water-level Program Specialist within the Groundwater Monitoring Section prepares water-level trip assignments for staff. Assignments are created with the intention of staff spending approximately 10 days per month in the field. Past trips are also taken into consideration so employees visit different areas of the state each year, although some trips require the same personnel to measure annually. The Water-level Program Specialist attempts to keep the same county/month combinations when possible. In general, they are as follows: Central Texas in October, North and East Texas in November, Panhandle in December, South Texas and Gulf Coast in January and West Texas in February.

Travel Authorization

Before traveling, staff must prepare a Travel Authorization (TA) Form. Once the TA is submitted, it is best to secure hotel accommodations. Since travel procedures are updated frequently, check in the "Travel" section of the IWEB (internal TWDB website) to get a list of current state contract hotels and per diem instructions.

Vehicle/Phone Request

Due to the severe terrain and remote locations of TWDB observation wells, the water-level program requires full size pickup trucks (4x4 is recommended). While most field staff use the same vehicle throughout the year, a Vehicle Request Form is required before travel. It is very important to have a mobile phone available for field work, and there are a limited number of state issued mobile phones available. If one is needed, fill out the Cell Phone Request Form and turn it in along with the Vehicle Request Form to Support Services. These forms are located under the "Forms" drop down list on the main page of the IWEB (internal TWDB website).

Field Books

A water-level field book is created for each county and, along with a county map and index page, includes the following for each well:

- Water-level field sheet
- Well schedule
- Location sketch
- Photos
- Contact notes (if necessary)

Go through the field books and make any necessary notes about each well. It is a good idea to create a separate page with contact information and required equipment for easy reference.

Contacting Well Owners and Groundwater Conservation Districts

Communication with our volunteer observation well owners and the groundwater conservation districts are vital to the success of the water-level program.

Well Owners

For some wells, the well owner has requested TWDB personnel contact them before measuring. Check the index sheet and/or contact notes in the field book to identify those wells.

If the well is located near a residence or business, regardless if the well owner requested prior contact, knock on door or attempt to find well owner before measuring. Well owners in the TWDB Water-level Observation Well Program graciously allow staff to enter their property for data collection. Courtesy and respect are required when interacting with well owners.

Groundwater Conservation Districts (GCDs)

Check the most recent GCD map to determine if a GCD is in the county being measured. If one exists, make any necessary steps to notify the GCD of the upcoming water-level trip. Usually an email will suffice, but sometimes a phone call is necessary.

Equipment

The following is a list of standard equipment for water-level trips:

- 2 – 500 ft. steel tapes
- 2 – 300 ft. steel tapes
- 1 – 200 ft. steel tape
- Electric Tape/Line (E-line)
- Gloves
- Water-level stickers
- Carpenters chalk

- Engineer's measuring tape
- Shop towels
- Disinfectant/bleach
- Handheld GPS
- Truck GPS w/base & charger
- Camera
- Calculator
- Field books
- Laptop/Tablet
- Notepad/paper/clipboard/pencils/pens
- Business cards
- Cell phone w/charger
- Batteries
- Air compressor
- Snake leggings
- Flashlight/head lamp
- Work boots
- Wasp/hornet spray
- First aid kit
- Water
- WD-40
- Shovel
- Ladder
- Tools
    - Hammer
    - Pry bar
    - Screwdrivers (flat & philips)
    - Wrenches
    - Pipe wrench
    - Post stepper
    - Duct tape
    - Electric tape
    - Wire

Equipment needed for special trips (see notes in field books):

- 1500 ft. powered electric tape/line (E-line)
- 1000 ft. electric tape/line (E-line)
- Nitrogen tank
- Regulator
- Pressure gauges
- Airline fittings
- Flow gauge

Vehicle Preparation

Most staff should have a dedicated full size 4x4 truck and are responsible for maintaining the vehicle with guidance from Support Services. Make sure the vehicle is in good working order before leaving headquarters.

- Check tire pressure and oil level
- Make sure all equipment loaded securely in truck
    - Nitrogen tank securely stored upright
    - Never operate vehicle with regulator attached to nitrogen tank

Measuring Water Levels

While each well site is unique, the following are basic standard procedures for measuring wells in the TWDB Water-level Observation Well Program.

Survey the Well Site

Upon arrival at the well site, and before exiting the truck, ensure conditions are safe (no vicious animals or dangerous conditions). If the well is near a residence or business, knock on the door. Make sure the field book contains the current well owner and that owner still gives TWDB permission to measure.

If the well is in an enclosure or well house, open the entry and step back. Let the well house "air out" a bit. Enter cautiously, paying particular attention to the ceiling and corners for stinging insects, spiders and snakes. If the well pump is on, check the field book as we may have permission to turn off the well pump for measurements. Remember to turn the well pump back on after measuring.

After locating the well, take a minute to observe. If the well owner is present, ask if there have been any recent changes to the well. Check the photo in the field book and make note of any changes. If there are significant changes to the well site, take new photos. Make note of any pertinent information: Is the well pump on? Are nearby wells pumping? Are crops growing nearby? Are there signs of recent construction or well work?

Locate the Measuring Point

The measuring point (MP) is the measurement in feet between the access point for measuring equipment to enter the well and the land surface. The water-level field sheet and/or well schedule should have the MP identified. The MP is subtracted from the measurement reading to ascertain the depth to water from land surface. It is very important to maintain the same MP for each well. The MP is changed only if the access point to enter the well has changed.

The examples below are for non-flowing well measurements. For flowing well measurements, wells in which the groundwater is under pressure and flows above land surface, the MP is added to the measurement.

If the MP is above ground, it is a positive number. For example, the MP is the top of the casing 1.5 feet *above* ground level. The distance from MP to water is 165.2 feet. To get the depth to water from land surface: 165.2 – 1.5 = 163.7

If the MP is below ground, it is a negative number. For example, a well is located in a basement and the MP is the top of the casing which is 7.7 feet *below* ground level. The distance from MP to water is 165.2 feet. To get the depth to water from land surface: 165.2 – (–7.7) = 172.9

If the MP is level with the ground, it is zero. For example, the MP is a screw plug of a capped well at ground level. The distance from MP to water is 165.2 feet. To get the depth to water from land surface: 165.2 – 0 = 165.2

(See the section Enter Measurements into the Groundwater Database (GWDB) in this manual for an explanation of how to report non-flowing and flowing well measurements.)

Methods of Measurement

The method of measurement used depends on the configuration of the well head and access to the measuring point. While there has been an increase in the popularity of non-contact sonic/laser devices to measure groundwater levels, these devices are not considered an approved method of measurement by TWDB or USGS. Several tests have proven the devices too unreliable for scientific data collection. However, TWDB does accept measurements obtained using sonic/laser devices as long as the cooperator calibrates each well by using an approved method of measurement to get the initial water level measurement. The following are TWDB approved methods for measuring water levels in groundwater wells:

Graduated Steel Tape

The graduated steel surveyor's tape has been used to measure water levels in groundwater wells for over one hundred years. It is still the preferred method of measurement for TWDB. They offer the greatest flexibility when measuring water levels. Almost any well is accessible with a steel tape as long as there is enough of a gap in the casing to thread the tape through. One of the drawbacks to the steel tape includes the uncertainty of how far to insert the tape down hole, which could cause the measurer to enter the hole several times before hitting water. Another downside is the possibility of the tape coming into contact with electric wires, or breaking and falling into the well. These last two factors are mitigated by 1) using a "spacer" or electrical tape to create a barrier between the electric wires and the steel tape at the entry point, and 2) making sure the steel tape is free of crimps or rust.

Steel tapes are typically available in lengths of 100, 200, 300 and 500 feet. The steel tapes currently in use at TWDB are Lufkin Super Hi-Way Nubian tapes 5/16 inch wide with an extra foot of graduations in tenths of feet before zero and graduated every foot after. The accompanying reel is purchased separately; the tape is then manually loaded onto the reel.

How to measure:

1) Reference the most recent measurement. Depending on aquifer characteristics, insert the graduated steel tape approximately 3 – 5 feet deeper than most recent measurement.
2) Put on protective gloves then completely chalk at least the first five feet of the graduated steel tape.
3) Insert the graduated steel tape at the measuring point (MP) referenced in the field book.
4) Slowly feed the tape down hole.
5) The tape will begin to feel a little heavy or "weighted". If the "weighted" feel is lost while feeding tape, reel tape up hole and try to feed past the obstruction. The most common reason for losing weight is the tape hanging on a casing joint.
6) Once the desired depth is reached (the HOLD mark), place the graduated line at the MP and hold for 3 to 5 seconds. Make sure the tape does not go in the well past the HOLD mark.
7) Begin reeling the tape up the well at a rapid pace so the wetted mark does not dry before reaching the surface. If an obstruction is encountered, lower tape below obstruction and carefully work the tape past the obstruction.
8) Watch for the wetted mark (the CUT) on the chalked end of the tape.
9) Read the graduation to the nearest hundredth of a foot of the CUT mark on the tape. If the mark is not at a graduated line, an engineer's measuring tape is used to obtain the measurement to the hundredths of a foot.
10) Subtract the depth of the inserted tape (HOLD) from the wetted mark on the tape (CUT). For example (see Figure 1), if the tape was lowered to 150 feet and the wetted mark was at 3.25 feet the calculation is: 150 – 3.25 = 146.75.
11) The result (in the above example 146.75) is the depth to water from MP
12) In order to get the depth from land surface, the measurement is adjusted for the MP which is reported in feet to the hundredths. If the MP is above land surface it is referenced as a positive number (+) in the field book; if it is below land surface it is referenced as a negative number (–) in the field book. It is important to keep the MP constant for the well. DO NOT adjust the MP if the land subsides around the well or is built up. Only change the MP if the actual entry point to the well is changed.
13) If the MP in the above example is +1.5, the calculation is 146.75 – (+1.5) = 145.25. The result, 145.25 feet, is the depth to water from land surface.
14) Check the measurement by repeating steps 2 through 13.
15) Dry the graduated steel tape and apply disinfectant to prevent cross contamination of wells.

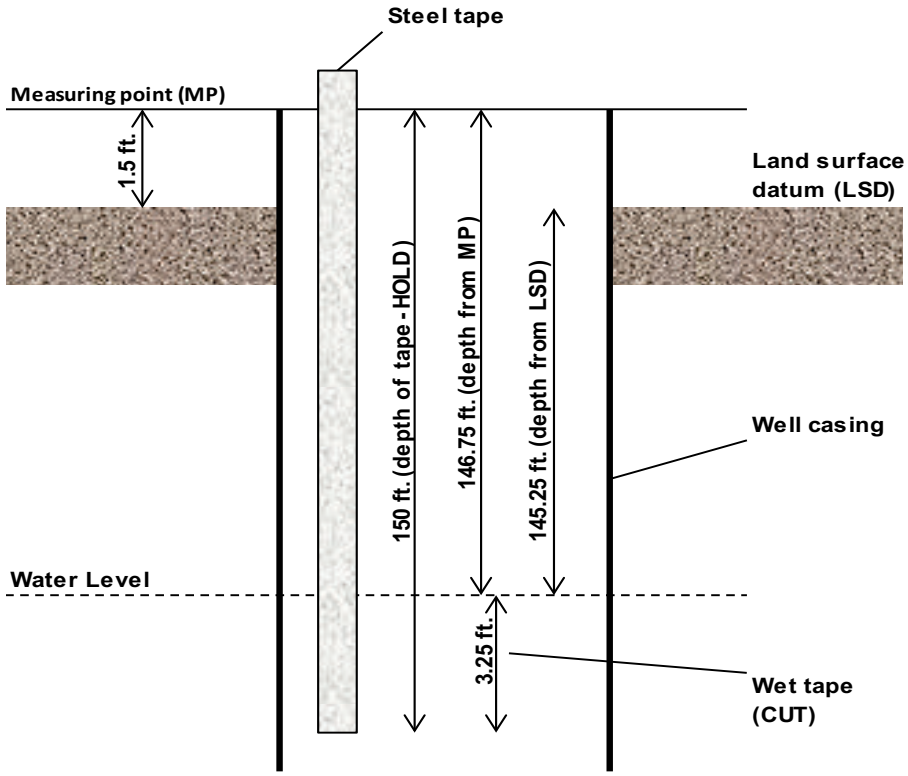

Figure 1. Graduated Steel Tape method of measurement for groundwater levels (not to scale).

Electric Tape/Line (E-line)

The electric tape/line (E-line) is used in wells with unknown water levels or leaky casings with cascading water.

TWDB currently uses Solinst Water Level Meter Model 101 (500 ft., 650 ft. and 1500 ft. powered reel) and Waterline Model 1000 ET.

<u>How to measure:</u>

1) Put on protective gloves, turn the unit's sounder on.
2) Press the battery test button, should hear a beep.
3) If no beep is heard, replace 9V battery in unit.
4) Approach the measuring point (MP) and unlock the reel.
5) Slowly feed the tape down hole.
6) The tape will begin to feel a little heavy or "weighted". If the "weighted" feel is lost while feeding tape, reel tape up hole and try to feed past the obstruction. The most common reason for losing weight is the tape hanging on a casing joint.
7) Once the water level is reached, the unit will beep.
8) Reel tape up until unit is no longer beeping.
9) Slowly lower back down until beep is heard.
10) Note the measurement reading at the MP to the hundredth foot.

11) Begin reeling the tape up the well at a slow and steady pace. If an obstruction is encountered, lower tape below obstruction and carefully work the tape past the obstruction.
12) The measurement reading obtained is the depth to water from MP
13) In order to get the depth from land surface, the measurement is adjusted for the MP which is reported in feet to the hundredths. If the MP is above land surface it is referenced as a positive number (+) in the field book; if it is below land surface it is referenced as a negative number (–) in the field book. It is important to keep the MP constant for the well. DO NOT adjust the MP if the land subsides around the well or is built up. Only change the MP if the actual entry point to the well is changed.
14) For example (see Figure 2), if the depth to water from MP is 147.58 and the MP is +1.5, the calculation is 147.58 – (+1.5) = 146.08. The result, 146.08 feet, is the depth to water from land surface.
15) Check the measurement by repeating steps 2 through 14.
16) Dry the e-line probe and tape and apply disinfectant to prevent cross contamination of wells.

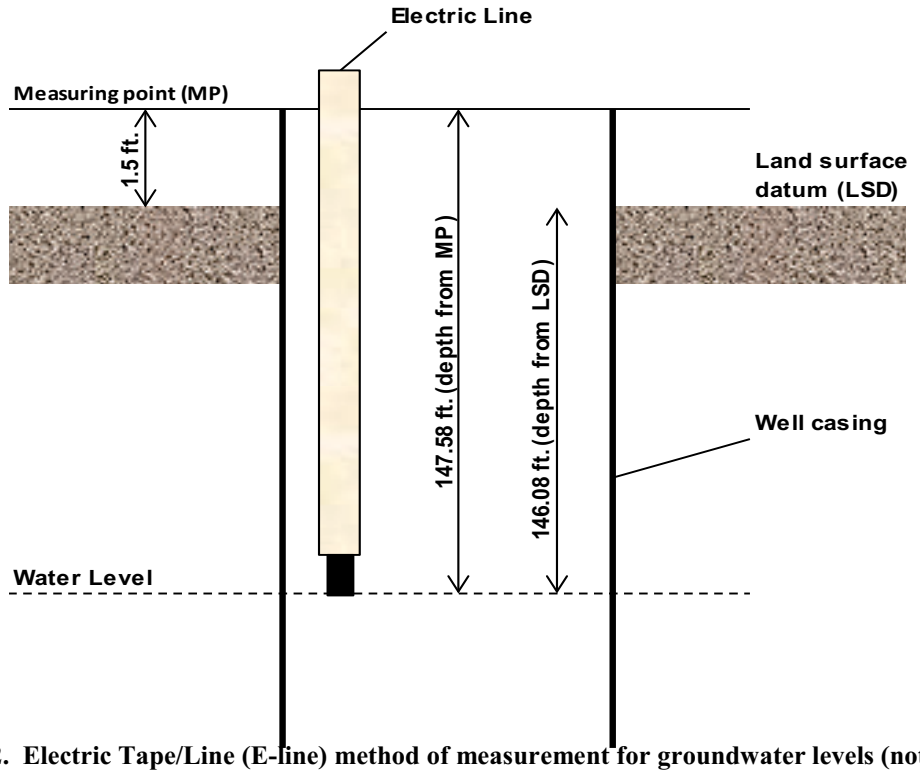

Figure 2. Electric Tape/Line (E-line) method of measurement for groundwater levels (not to scale).

Air Line

Air lines are commonly installed in wells equipped with large power pumps, such as public supply wells, to determine the drawdown during pumping as well as fluctuations in the static water level. Generally, the well is sealed so that a tape is not accessible for a measurement. An

air line well has small diameter flexible plastic tubing installed extending from the surface to a known depth below water level. The bottom tubing is usually fastened to the base of the pump and the top tubing fitted with a valve and suitable connections so that a pump and pressure gauge can be attached.

Compressed gas, either from an air compressor or nitrogen tank, is pumped into the tubing until all the water is displaced. Some gauges indicate the amount of air pressure as air escapes into the well, and others indicate the feet of water above the end of the tubing. The pressure is gradually built up until the air begins to escape; thereafter, the pressure remains fairly constant. The maximum pressure that can be obtained is therefore a measure of the length of submerged air line, or depth to the lower opening in the air line (which might not be hanging exactly vertical).

Measurements by the air line method are usually not very accurate and are better for representing trends in water levels. Error in reporting the length of the line or holes that develops by corrosion below the water level cause even greater measurement errors. Ideally, wells measured by air line should also have a measurement taken by either graduated steel tape or e-line to confirm the air line reading. However, because of the great depth to water and inaccessibility for other measuring devices, the added check is rarely performed.

Wells measured by air line are reported to the nearest foot.

<u>How to measure:</u>

1) Determine if the well has a working pressure gauge.
2) If a working pressure gauge does not exist, install a gauge and valve stem on the end of the air line.
3) Add compressed gas (nitrogen tank or air compressor) into the air line through the valve stem.
4) Watch the gauge and make sure the pressure increases. If the gauge does not move, there is a leak in the air line, check connections.
5) Remove the compressed gas and watch the gauge readings. The readings should slowly decrease and then stop. If the reading falls back to zero, there is a leak in the air line and the readings will be in error. If the reading does not move, the air line is plugged or crushed and the readings will be in error.
6) Repeat steps 3 – 5 a couple of times to make sure the gauge readings are consistent.
7) Make note of the pressure (psi) reading, or feet of water, where the gauge stops.
8) Multiply the pressure reading by 2.31 to get the feet of water above the end of air line.
9) Subtract the feet of water above the end of air line from the total length of air line (usually the pump depth from land surface) to get the depth to water.
10) For example (see Figure 3), if the pressure reading is 45 psi and the length of the air line from land surface is 600 feet, the calculation is 45 x 2.31 = 103.95 (feet of water above

end of air line) then 600 – 103.95 = 496.05, then round the result to get 496 feet as depth to water from land surface.

11) If using a nitrogen tank be sure to close valve and remove regulator before operating vehicle.

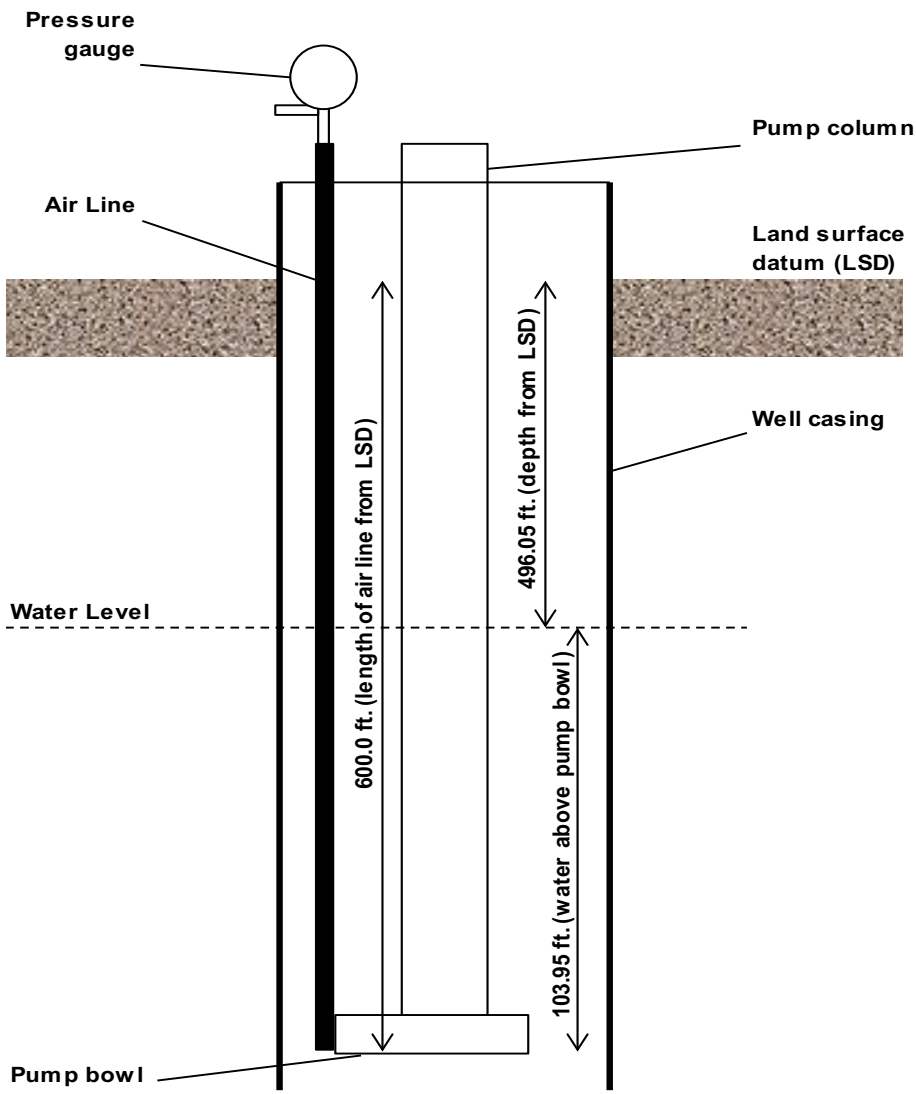

Figure 3. Air Line method of measurement for groundwater levels (not to scale).

Flowing Wells (Tubing, Pressure Gauge)

For flowing wells, or wells in which the groundwater is under pressure and rises above land surface, there are two methods of measurement. For low pressure head, transparent tubing is attached to the well discharge point and raised until the water no longer flows from the tubing. For high pressure head, a pressure gauge is attached to the well discharge point. No matter which method is used to measure flowing wells, the flow of water must first be cut off so that the shut-in pressure can be observed.

When using a pressure gauge, make sure any booster pumps are turned off before attaching the gauge. It is very important to make sure the pressure gauge maximum range is sufficient for the head pressure of the well. If the head pressure of the well exceeds the maximum range of the gauge, the gauge can be damaged.

How to measure (Tubing – low pressure head):

1) Cut off flow from the discharge point.
2) Attach a length of transparent tubing to the discharge point.
3) Close any other discharge points.
4) Open water flow and raise tubing until water does not flow from tubing.
5) Measure the distance from land surface to the water level in tubing (see Figure 4).
6) Lower and then raise tubing, measuring again to ensure consistency.
7) The result is the feet of water above land surface.

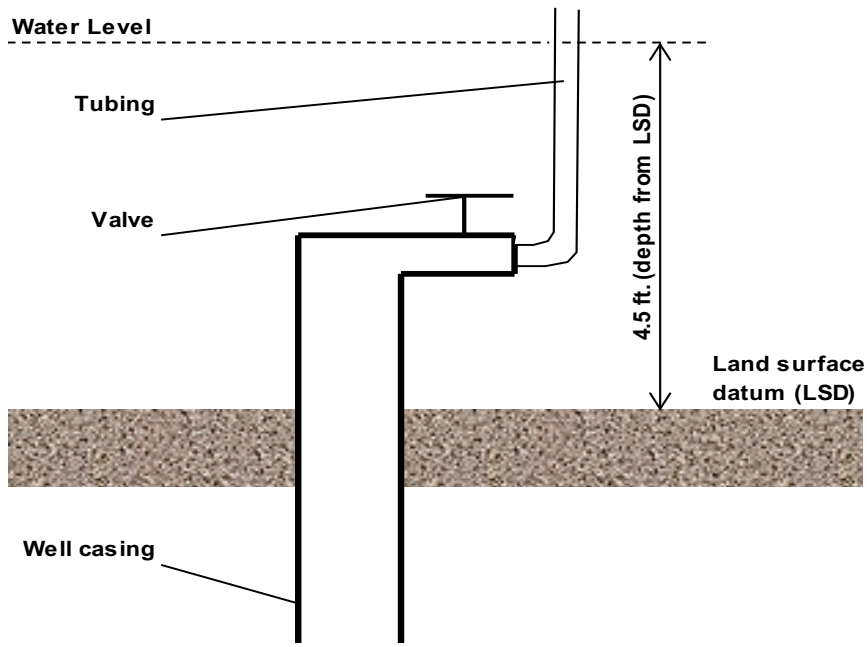

Figure 4. Flowing well – Tubing method of measurement for groundwater levels (not to scale).

How to measure (Pressure Gauge – high pressure head):

1) Cut off flow from the discharge point.
2) Install a pressure gauge with hose bib to the discharge point, this is the measuring point (MP).
3) Close any other discharge points.
4) Slowly open water flow to pressure gauge.
5) Make note of the pressure (psi) reading. Multiply the pressure reading by 2.31 to get feet of water above MP.

6) For flowing wells, the MP is *added* to the feet of water above the MP. For example (see Figure 5), if the feet of water above MP is 35.2 and the MP is +1.5, the calculation is 35.2 + (+1.5) = 36.7 feet.

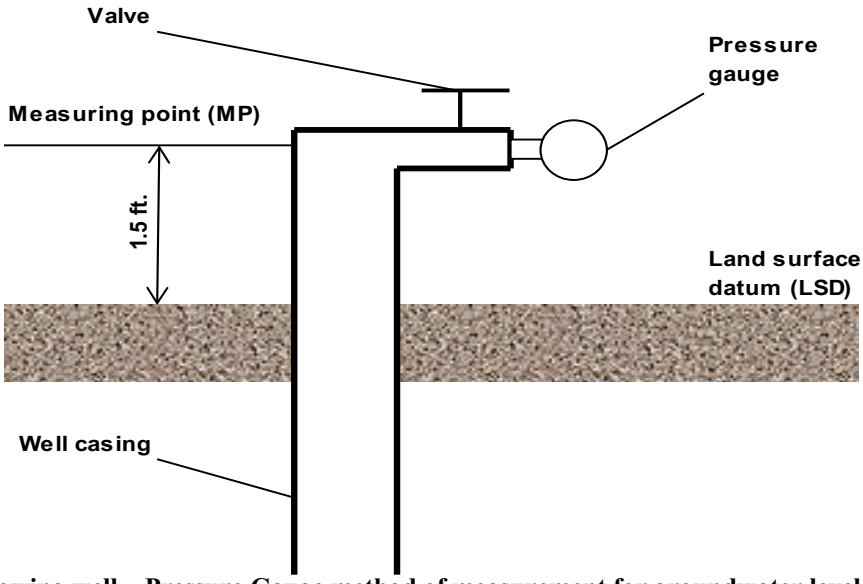

Figure 5. Flowing well – Pressure Gauge method of measurement for groundwater levels (not to scale).

Recorders (Float & Weight, Transducer)

The TWDB installs and maintains a vast network of recorder wells that record hourly water levels. While the program is transitioning to the use of pressure transducers to obtain the level, many recorder wells are still equipped with a float & weight system.

During annual water-level measurements, TWDB staff obtains a "tape down" measurement of recorder wells to ensure accuracy of the recorder instrumentation. In general, graduated steel tape is used for wells with a float & weight system, and e-line is used for wells with a transducer.

For more detailed information on the TWDB Recorder Well Program, see User Manual 54: A Field Manual for Automated Water Level Recorders.

Record Measurement in the Field Book

After measuring the well, record the following information in the field book. See appendix for Water-level Field Sheet.

- Date of measurement
- Time of measurement (24h)
- Staff initials
- Depth to water from MP (feet)
- MP used (feet)

- Depth to water from land surface (feet)
- Measuring agency
- Method of measurement
- Well use
- Remarks/field observations

Leaving the Well Site

Always leave the well site the way it was upon arrival. Collect all tools, equipment, trash, etc. If the well pump was turned off for measuring, be sure to turn the well pump back on. Identify the location around the well for the water-level stickers (check field book for notes on where to leave the sticker). Fill out the water-level sticker, adding your initials in the upper corner and any remarks about the measurement, and place the sticker at the prescribed location near the well.

Returning From a Water-level Trip

After completion of a water-level trip, it is very important to document any well updates along with the water-level measurements.

Travel Voucher

In order to obtain monetary reimbursement in a timely fashion, it is best to fill out a Travel Voucher (TV) immediately after returning to headquarters. Since requirements for submitting a TV can change over time, check in the "Travel" section of the IWEB (internal TWDB website) for the most up to date requirements. In general, a copy of the hotel(s) receipt showing a zero balance due, along with a print out of the contract hotel list for the city and any exemptions used, are required with submittal of the TV.

Update Field Books

Go through the field books and make any updates to the well sheets. If a new water-level field sheet is needed, insert it into the field book. Insert any new photos or map updates. If a well was made historical (unable to get a measurement for four consecutive years), remove all well pages from the field book and prepare documents for archive.

Enter Measurements into the Groundwater Database (GWDB)

Open the Texas Groundwater Information System (TGWIS) website (only available to TWDB staff). In the Wells List, select the county measured and select "True" for Water Level Trip to get the list of wells. Click each well to enter the water level measurements. After the measurements are processed for publication, they are available on the Groundwater Database (GWDB) Reports website.

Return Vehicle/Phone

Upon completion of a water-level trip, it is the driver's responsibility to ensure the vehicle is in good working order before turning in the vehicle packet. Check with Support Services personnel to see if the vehicle packet and cell phone must be returned or if you may keep the vehicle packet and just turn in the monthly use reports.

Cooperator Submission of Water Level Measurements

One of the benefits of uploading measurements from cooperators into the TWDB Groundwater Database (GWDB) is to get groundwater data from across Texas in a standardized format. This enables analyses of groundwater-related data statewide. While the Groundwater Monitoring Section requires all cooperators to follow the procedures outlined in this user manual for water-level collection, not all cooperators have the same procedures for disseminating those data. However, there are some minimum requirements for sharing water-level measurements with TWDB. Please contact the Groundwater Data Team (GroundwaterData@twdb.texas.gov) with any questions about sharing data.

State Well Numbers

The state well number is a unique identifier assigned to all wells in the TWDB Groundwater Database (GWDB). ***Only TWDB staff can assign state well numbers.*** The GWDB contains only those wells where information exists to help determine the properties of aquifers in Texas, for example geophysical logs, water levels and water quality data. There is no need to assign state well numbers to all water wells in Texas; only wells where data are shared with the TWDB need state well numbers. In order to obtain a state well number from the TWDB, please send all known information about the well, including a driller's log or State of Texas Water Well Report (with or without a tracking number) if available. The following parameters are the minimum required for TWDB staff to assign a state well number:

- Coordinates - latitude and longitude
- Method for obtaining coordinates (GPS, map, Google Earth, etc.)
- Second form of location identification (location sketch, cross streets, narrative, etc.)
- Well use (domestic, irrigation, stock, unused, etc.)
- County
- Cooperator/district well number or identification* - only required if one exists

Water Level Measurements

All cooperators that share groundwater-level measurements with the TWDB must provide the following minimum parameters:

- TWDB assigned state well number
- Depth to water from land surface in feet
- Date of measurement (month, day, year)
- Instrument used for measurement (steel tape, eline, etc.)
- Any comments about the measurement* - only required if they exist (pumping, recently pumping, spotty tape, changed well use, etc.)

Well Updates

It is inevitable that over time something about the water level observation wells may change; a new well owner, new pump or a change in well use, for example. If any changes to the well are observed or reported, please send the updated information about the well with the water levels. Remember that state well numbers are unique to the well, so if a well is removed from observation and a new one is added, it must get a different state well number even if it is right next to the old one.

Selected References

Cunningham, William L. and Schalk, Charles W., 2011, Groundwater Technical Procedures of the U.S. Geological Survey, Techniques and Methods 1-A1, U.S. Geological Survey.

Hopkins, Janie, 1994, Explanation of the Texas Water Development Board Ground-Water Level Monitoring Program and Water-Level Measuring Manual, Texas Water Development Board.

Finnell, Andy, (revised) 2009, User Manual 54 – A Field Manual for Automated Water-level Recorders, Texas Water Development Board.

Rein, Heather and Hopkins, Janie, (revised) 2008, User Manual 50 – Explanation of the Groundwater Database and Data Entry, Texas Water Development Board.

Appendix – Water Level Field Sheets

1. Well Schedule Sheet
2. Water-Level Field Sheet
3. Location Sketch Sheet

Texas Water Development Board
Well Schedule

State Well Number ____ Prev. Well No. ____ County ____ County Code ____

Basin ____ GMA ____ RWPA ____ GCD ____ Aquifer ____

Latitude ____ Longitude ____ Coord Accuracy ____ Aquifer ID1 ____ Aquifer ID2 ____ Aquifer ID3 ____

Owner/ Well No. ____ Driller ____

Address ____ Tenant/Oper. ____

Well Depth ____ Source of Depth ____ Altitude ____ Source of Alt. Datum ____

Date Drilled ____ Well Type ____ User Code ____

Lift Data Pump Mfr. ____ Type of Lift ____ Pump Depth Setting (ft) ____ ft.

Motor Mfg ____ Type of Power ____ Horsepower ____

Water Use Primary ____ Secondary ____ Tertiary ____

Other Data Available Water Level ____ Water Quality ____ Well Logs ____ Other Data ____

Well Construction Const Method ____ Casing Material ____

Completion Method ____ Screen Material ____

Water Levels

Date ____ Meas. ____ Remarks ____ M.P. + - ____

Date ____ Meas. ____ Remarks ____

Date ____ Meas. ____ Remarks ____

Water Quality (Remarks: ____

Yield Flow Rate ____ Pump Rate ____ GPM Circle how rate was determined Meas Rept Est Date of Test ____

Performance Test Length of test ____ hr Production Rate ____ GPM Circle how rate was determined Meas Rept Est Date of Test ____

Static Level ____ ft. Pumping Level ____ ft. Amount of Drawdown ____ ft. Specific Capacity ____ GPM ft.

Casing Records:

Casing or Blank Pipe (C)

Well Screen or Slotted Zone (S)

Open Hole (O)

Cemented from ____ to ____

	Diam. (in.)	Interval of C,S, or O. From	To
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			

Date Record Collected or Information Updated ____ Reporting Agency ____ Recorded by ____

Other Remarks

1 ____
2 ____
3 ____
4 ____
5 ____
6 ____

Aquifer ____

Well Number - -

Excel format by Gary Franklin 06/2001

TEXAS WATER DEVELOPMENT BOARD - WATER LEVEL MEASUREMENTS

SWN - -

DEPTH feet

Lat. ° ' . "

Long. ° ' . "

DATE OF MEASUREMENT MO. DAY YR.	TIME OF MEASUREMENT CST/CDT (24HR)	DEPTH TO WATER FROM LAND SURFACE (FEET)	Field Tech	DEPTH TO WATER FROM M.P. (FEET)	MEASURING POINT M.P. (FEET)	Meas Agency	Meth Meas	Remarks	WELL USE	FIELD OBSERVATIONS

AQUIFER

STATE WELL NUMBER (SWN)

COUNTY

MEASURING POINT (M.P.)

Texas Water Development Board - Well Location Sketch

By: _____ Date: _____ G.P.S Coordinates: ___˚___'___.___" ___˚___'___.___"

County _____ M.P. = _____ State Well Number: _____

State Well Number _____