



**Oklahoma Water Resources Board's  
Standard Operating Procedures  
GMAP Continuous Recorder Program**

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# Oklahoma Water Resources Board GMAP Continuous Recorder

## 1.0 General Information & Background

The Oklahoma Water Resources Board (OWRB) exists to manage and improve the state's water resources; oversight of both water availability and quality within its boundaries is an integral commitment of the OWRB. The observation of water table changes across the state is a cost effective method of discerning effects of drought on water availability and implementing sustainable groundwater use allocation. Historically, the agency has maintained a statewide network used to collect annual measurements since the middle 1970s with measurement data for some aquifers that dates to the 1940s. This annual measurement program has varied in size but has continued uninterrupted since its inception. Most of the wells used are located within major bedrock and alluvium and terrace aquifers for the state.

With the initiation of the Groundwater Monitoring and Assessment Program (GMAP) in 2013, this annual monitoring network's density has been improved and expanded to include a trend network. GMAP's Trend Network collects data multiple times a year to recognize seasonal changes, changes due to climate, and/or changes due to usage over time. To facilitate this effort, many wells across the state have been equipped with water level data loggers. Water level measurements taken multiple times each day by the deployed data loggers maximize data resolution for the larger Water Level Network.

Data is collected continuously by the water level recorders, and sites are visited three times per year (Jan/Feb; May/June; Sept/Oct) in concurrence with the Trend Network visits. Field collection of these data include proper staff training for collection from the equipment and maintenance at the site.

## 2.0 Staff Training

Principle investigators for the OWRB are required to have degrees and/or experience with biological or other applicable sciences. Principle investigators are defined as crew leaders, and this designation may be made upon the leader of a multi- or a one person crew. Training is required for all SOPs dealing with water quality and quantity collections and measurements, as well as site assessments. Investigators must be familiar with the OWRB SOP document and all training will follow the methods outlined in that document; augmented training will be provided when new SOPs are developed. OWRB staff are trained on the job through mentoring by a senior field staff member and the continuous recorder managers. Training includes our multi-step site evaluation; measuring point determination; manual water level measurements; data downloads; and equipment maintenance.

## **3.0 Procedures**

### **3.1 Site Evaluation**

Wells selected for installation of data loggers must meet certain criteria to be considered for use. These steps are taken to promote employee safety and to ensure the quality of data. GMAP selects sites through a multi-step evaluation process.

First, well location and placement in the correct aquifer is verified using well drillers reports. Landowners are then contacted for permission to access their property and their well. Upon receiving permission, reconnaissance visits to each site are made to verify location, depth, and diameter of well casing. Staff also make notes of other construction details, if the well was functioning, and any potential sources of contamination nearby. A GPS point and picture of the site is taken. It is critical that the location of the proposed site corresponds to the description and location given in the associated well drillers report; this helps ensure that geological information used to describe a study site will be accurate. Wells that are being used or will be used by persons other than employees are not favorable candidates for installation.

If a site is currently unused, the owner has no plans for use in the near future, and the site is secure from the public but accessible by OWRB staff, then it is considered a candidate for continuous monitoring. Wells with a period of record prior to GMAP are also considered in order to keep long-term records active. Final selection is done by the Groundwater Quality Manager.

Some recorder sites in the GMAP program are inherited from the OWRB's Planning & Management (P&M) section. At the end of an intensive aquifer study, P&M staff will recommend sites that they have good data from as candidates for long-term continuous recorders through the GMAP program. Final selection is done through collaboration between the P&M and the Groundwater Quality managers.

### **3.2 Instrument Installation**

The OWRB uses data loggers manufactured specifically for use in water level recording; installation is performed by the data managers for the program. These instruments contain integrated pressure transducers that are used to output pressure values. Vented and non-vented models are utilized, depending on the location of the well. Typically, non-vented units are used in the far west reaches of the state where water tables are much lower, making such a long length of vented cable cost prohibitive. In these regions, a separate data logger is installed which collects barometric pressure readings that are used to correct for error.

#### **3.2.1 Measuring Point Determination**

A permanent measuring point needs to be established for consistent and accurate manual water level measurements. These measurements are used to scale and also periodically rescale an instrument. A measuring point is typically identified on the upper circumference face of a well casing. Measuring points can be marked with a hacksaw, file, or permanent marker in some way that is easily identifiable. After a permanent measuring point has been identified and marked, a measurement must be made

from the measuring point to ground level. This measurement is referred to as “measuring point correction length” or “measuring point height”. The measuring point height (MPH) must be subtracted from the measured static water level to obtain depth to water below ground surface.

### **3.2.2 Measuring Water Level**

Note: Chalked graduated steel tapes are the most accurate method of well measurement and is the preferred method for use in scaling water level recorders. OWRB well measurement follows the agency’s Water Well Measurement SOP 1.1. Specifically part 3, which is summarized below.

1. Prior to deploying a steel tape, use carpenters chalk to mark the first 10-20 feet before lowering the tape in to the well casing to the approximate water level tape (known from either historical water level records or from the driller’s log, or from practical experience). A typical rule of thumb is to “over shoot” the anticipated DTW by around 2 feet to insure part of the chalked and graduated portion of the tape do, in fact, enter the water.
2. For steel tape measurements, the tape “hold” position at the MP should correspond to a whole number (75, 125, 280, etc).
3. Retrieve or up-reel the tape until you see a clear “cut” on the tape (i.e. the highest, wetted portion of the tape). Read and record this cut position to the nearest one hundredth of a foot.
4. The difference between the “hold” of the tape and the “cut” is the water level referenced to the MP. Subtract the MPH from this reading to obtain the final DTW reading referenced to ground level.
5. Wipe off tape and re-chalk for next well.

### **3.2.3 Programming**

Cabling, along with the connected instrument, is secured a few inches from the top of the casing using an eye bolt. Using a laptop computer or handheld device, a data logger is then programmed using proprietary software. The programming of a data logger should be performed following the manufacturer’s manual and/or the OWRB’s “In-situ guide” graphic protocols. Certain best practices are specified for GMAP such as criteria and formatting for site name, log name, measurement type, constituency of water, measurement frequency, setting a reference level, and other factors important to collecting usable and accurate data. The OWRB’s “Water Level Recorder Quick Reference Sheet” is also a useful source when programming a data logger.

It is important to forecast future water level trends at a site to ensure a sensor is never overloaded or hanging out of water. Past water level measurements at the site, along with knowledge of aquifer composition and behavior during weather events help inform cabling and PSI needs. Careful observation and good judgment are needed to determine appropriate cable length; senior staff should be consulted.

### **3.3 Preparation**

Prior to the site visit, staff should collect field equipment and paperwork as needed. This may include but is not limited to:

1. Site Field Data Book with blank forms
2. Maps

3. Keys
4. Handheld device or Laptop with connection cable
5. Clean/dry desiccant
6. Steel tape with necessary supplies (See: "OWRB Water Well Measurement SOP 1.1")
7. Printed Maintenance Guides for each type of recorder that will be visited
8. Decontamination supplies

Once on-site, staff should verify that they are at the correct site (utilizing maps, site pictures, and GPS points) and note site conditions prior to accessing the well.

### **3.4 Data Collection & Equipment Maintenance**

Consulting the guides for either the handheld device or the laptop, field staff will establish a connection to the recorder and download the data from the instrument. Battery Life and PSI are noted on the field data forms, and a manual water level measurement is made. Best practices dictate that forms are filled out completely, leaving no space blank. If there is missing or incomplete information, record "unknown", "NA", or "NM" on the field data sheet.

Periodically an instrument's recorded pressure value will disagree with the true value. This can be checked by comparing the manual measurement to the instrument's displayed depth to water value. If the disagreement is more than  $\pm 0.03$  feet, take another measurement to check the value. If the disagreement is still apparent, rescale the instrument.

On vented instruments, confidence can be tested by pulling the instrument out of the water column and compare the pressure across both transducers. The values should cancel, resulting in a value of  $0.0 \pm 0.03$  PSI. If the result is out of range, continue to troubleshoot the instrument or collect it to be sent to the manufacturer for repair or calibration. Most repairs will need to be performed by the manufacturer. **NOTE:** Never touch or use a harsh chemical solvent to clean the sensor.

OWRB staff will follow the guide for each specific instrument to download the log and set the instrument for the next season of measurements. After disconnecting from the instrument, a new desiccant pack is attached to the end of the cable and carefully placed back into the well. The cap is replaced onto the well casing.

Cleaning the instrument in the field is not recommended practice. If an instrument needs significant maintenance, it should be pulled and brought back to the office. If an instrument needs to be re-scaled three consecutive times, it should be pulled and brought back to the office to determine maintenance & repairs needed.

## **4.0 Data Management**

### **4.1 Data Entry**

Continuous recorder water-level data is housed in Aquatic Informatics' Aquarius Time-Series software. Continuous recorder managers upload the collected data from field handheld devices or laptops into Aquarius. Site visits with any measurement activities are manually entered into Aquarius. QA for

completeness on this process is done three times per year by either the Groundwater Quality Manager or someone he designates, checking against the field data sheets.

#### **4.2 Verification & Validation**

Continuous recorder managers apply instrument drift corrections and grades to the data series as they upload data into Aquarius Time-Series software. Staff also looks for suspicious values or slopes in the data, investigating any irregularities. The Groundwater Quality Manager looks at the corrected and graded data to either approve it as Final Data, viewable to the public, or return it to staff for any irregularities.

Calibration corrections will be applied as needed for specific time periods. Datum corrections will be applied on periodic basis determined by the Groundwater Quality Manager and the OWRB Data Manager. Programmed QC checks by Aquarius Time-Series for suspicious values and slopes at each site are planned for the future of the program.

#### **4.3 Archiving**

All data is housed in Aquatic Informatics' Aquarius Time-Series software. This software preserves the original, raw data. When a site is taken offline, any recorder data is kept in the software.