Possible Revisions to FDEP Groundwater Sampling Procedures for Wells used for Saltwater Intrusion Monitoring

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Problem Statement

Monitoring the saltwater/freshwater interface in groundwater from wells which are completed close to, or within, the saltwater/freshwater interface causes special issues which are not addressed in the Florida Department of Environmental Protection (FDEP) Standard Operating Procedures (SOPs) (FDEP, 2008). Regarding these types of wells, Prinos (2013) states that if applied without modification, the sampling guidelines established by FDEP (2008) may include some samples that are not representative of the maximum salinity of the well open interval. The FDEP SOPs for groundwater sampling (FDEP, 2008) divide wells into two main categories: (1) wells without plumbing (typically monitoring wells sampled with portable pumps) and (2) wells with in-place plumbing, such as water-supply wells typically found in well fields, industrial facilities, and private residences that have fixed pumps.

Section FS 2213 of the SOPs describes purging of wells without plumbing. It specifies: "Do not lower pump or intake hose (tubing) to the bottom of the well. Pump or tubing placement procedures will be determined by the purging option selected". If the following conditions are met, the pump intake hose should be positioned in the screened or open borehole interval.".

- The sample pump is used for both purging and sampling
- The well screen or borehole interval must be less than or equal to 10 feet
- The well screen or borehole must be fully submerged.

This procedure cannot be used for many wells without in-place plumbing because they have open intervals greater than 10 feet (Prinos, 2013).

Sections FS 2213.1.2 of the FDEP SOPs, "Conventional Purging" specifies, "Position the pump or intake tubing in the top one foot of water column or no deeper than necessary for the type of pump." Section FS2214, Purging Large-Volume, High-Recharge Wells with Portable Pumps" specifies that the well is purged by "placing the pump at the top of the open borehole segment of the well." Prinos (2013) indicates that well sampling utilizing these procedures yields salinity samples that are not representative of the maximum salinity in the aquifer in the depth interval to which the well is open.

Data collected by the US Geological Survey (USGS) demonstrates that in many wells the salinity at the bottom of the open interval is greater than near the top of the interval (Prinos, 2013). Kohout and Hoy (1963) determined that samples taken from monitoring wells with long open intervals preferentially represent salinity of the most permeable strata, rather than the depth of maximum salinity in the borehole.

Proposed Methods of Sampling the Saltwater/Freshwater Interface

Micro-Purging (also referred to as "Low-Flow Purging"). It is proposed that when sampling for salinity indicators in long open-interval wells with the purpose of monitoring the saltwater/freshwater interface, the pump intake be positioned at the location of maximum specific conductance (determined using a conductivity profile), or near the bottom of the well's screened or open interval. It is also proposed, based on studies presented by Prinos (2013), to have a minimum amount of water removed from the well at a flow rate of approximately 0.1 gal/min. Pumping at these rates will theoretically withdraw water from along a single flow line that will not induce drawdown in the well. At least two organizations have developed and/or reviewed protocols for micro-purging (New Mexico Environment Department, 2001; USEPA, 1996; USEPA, 2002).

Kearl et. al. (1994) showed that water from the aquifer that flowed through the screened interval during micro-purging did not mix with water in the casing of the well. However, the New Mexico Environment Department (2001) pointed out that "Micro-purging does not have a mechanism to verify that the sample results are indicative of water quality in the formation surrounding the well. The water obtained has the potential to be stagnant…" In addition, samples may still be affected by ambient vertical flow within the borehole.

Discrete Depth Samplers. It is proposed that discrete-depth sampling using nonisokinetic thief samplers be used for sampling wells with long open intervals. A number of nonisokinetic thief samplers are commercially available (Lane et al., 2003), including double check-valve bailers and Kemmerer's. Currently the USGS uses Kemmerer to collect samples from long open-interval wells in south Florida (Prinos, 2013). Kemmerers are lowered on a line to the desired depth, and a weight called a messenger is sent down the line. The messenger triggers a mechanism on the top of the Kemmerer that causes the stoppers on both ends of the sampler to snap shut and trap a sample in the bottle. The Kemmerer can prematurely close. So care must be taken in lowering the sampler. It is also helpful to test a portion of the sample with a conductivity meter prior to departing from the site to ensure the sample is in reasonable agreement with the history of previous measurements.

A disadvantage of using discrete depth samplers is that they do not draw water from the aquifer into the well to clear out any stagnant water. This disadvantage could be overcome by purging the well using a suction pump with a shallow intake line prior to sampling with a discrete depth sampler. One potential problem with this method is that when purging is completed, the salinity may decrease if recharge rates are higher from less saline portions of the screened / open interval (Kohout and Hoy, 1963).

Proposed Modifications to DEP SOP FS 2200

FS 2213

1.1.4. For the purpose of saltwater/freshwater interface monitoring position the pump or intake hose when purging monitoring wells using procedure FS 22XX.

FS 22XX. *Purging and Sampling Wells Without Plumbing, for the Purpose of Saltwater/Freshwater Interface Monitoring*

Use these guidelines if a well is selected for the purpose of saltwater / freshwater interface monitoring, but does not meet the construction requirements stated in FS 2213 Section 1.1.1. These guidelines should not be used for purging or sampling wells with the intention to collect water quality samples for purposes other than that stated above.

1. Use a conductivity profile to determine the depth in the well at which maximum specific conductance occurs. This will be the target depth for salinity indicator monitoring. If a conductivity profile cannot be performed, the target depth for salinity indicator monitoring shall be five feet above the bottom of the screened interval, or five feet above the bottom of the well for wells with open boreholes.
    1.1. Use a downhole conductivity probe to measure specific conductance at depth within the well.
    1.2. Lower the conductivity probe through the water column slowly and carefully, to minimize mixing of water from different depths.
    1.3. Collect specific conductance measurements at a minimum frequency of every 10 feet within the screened interval or open borehole.
    1.4. Do not allow the conductivity probe to contact the bottom of the well. Doing so may disturb sediments that have settled on the bottom of the well. If the sediments are accidentally disturbed during collecting data, wait a minimum of 24 hours before resuming conductivity data collection or collecting water quality samples.
    1.5. Do not collect conductivity data, from within the section of casing extending below the screened interval, if present. The water in this portion of the well is stagnant and is not representative of water quality in the targeted zone of the aquifer.
    1.6. The conductivity profile data does not need to be collected each time that the well is sampled for salinity indicators, but it should be periodically collected to ensure that well conditions have not changed.
2. Purge and sample the well using the low-flow purging technique described below.
    2.1. Use of a dedicated pump (left in the well) is recommended for low-flow purging. If a dedicated pump cannot be used, slowly and carefully lower a portable pump to the target depth for salinity indicator monitoring within the screen interval or open borehole, as determined in FS 22XX Section 1. Exercise care when positioning the pump intake to minimize mixing of stagnant water in the casing with flowing water in the screened interval or open borehole, and to avoid disturbing sediments that may be settled on the bottom of the well. Use of smaller-diameter pumps will also help to minimize disturbance of water and solids in the well casing (U.S. EPA 1996).

2.2. Purge the well at a rate of < 500 mL / min. Monitor the water level (depth to water) at a minimum of every five minutes while purging. Adjust flow rate as needed to prevent drawdown (drawdown must be < 0.1m). (U.S. EPA 1996)
2.3. Purge a minimum of one equipment volume before beginning to measure stabilization parameters (USEPA 2002).
2.4. Wait five minutes between consecutive stabilization measurements (U.S. EPA 1996, New Mexico Environmental Department 2001)
2.5. Complete the purging of the well when the last three consecutive measurements of the purge stabilization parameters have met the applicable criteria specified in DEP SOP FS 2212, section 3.
2.6. Collect samples from the well using the procedures in DEP SOP FS 2221, section 1. When using the low-flow purging technique, the same pump must be used for well purging and sample collection.

3. Alternatively, collect water quality samples at depth without purging the well.
3.1. Select a nonisokinetic thief sampler device, such as a double check-valve bailer or Kemmerer, for water quality sampling. The device should be capable of capturing water from a specified depth within the well, and should seal such that water from non-target depths will not enter the device while it is being retrieved.
3.2. Follow all general considerations for device construction and use listed in DEP SOP FS 2221 Sections 2 and 2.1.
3.3. Slowly and carefully lower the sampling device, at a rate less of ≤ 2 cm / sec, to the target depth for salinity indicator monitoring within the screen interval or open borehole, as determined in FS 22XX Section 1. Exercise care when positioning the device to minimize mixing of stagnant water in the casing with flowing water in the screened interval or open borehole, and to avoid disturbing sediments that may be settled on the bottom of the well.
3.4. Do not position any part of the device in the section of casing extending below the screened interval, if present. The water in this portion of the well is stagnant and is not representative of water quality in the targeted zone of the aquifer.
3.5. Follow the device manufacturer's instructions to trigger the device and capture a sample of water from the target depth within the well.
3.6. Slowly and carefully retrieve the device, at the same rate used when lowering the device (≤ 2 cm / sec).
3.7. Collect the sample.
3.7.1. Install a mechanism to control the flow from the bottom of the sampling device and discard the first few inches of water.
3.7.2. Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container.
3.7.3. Measure specific conductance of the collected water in the field. Compare measured value with data from conductivity profiles, as a rough check that the device has been deployed in the targeted location.
3.7.4. Discard the last few inches of water in the sampling device.

References

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