

ALABAMA DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

GROUND WATER BRANCH

GUIDELINES FOR WELL ABANDONMENT

GENERAL

According to the U.S. E.P.A., the objectives of an abandonment procedure are to: 1) eliminate physical hazards; 2) prevent groundwater contamination; 3) conserve aquifer yield and hydrostatic head; 4) prevent intermixing of subsurface water. The purpose of sealing an abandoned well is to prevent any further disturbance to the pre-existing hydrogeologic conditions that exist within the subsurface. The plug should prevent the vertical movement within the borehole and confine the water to the original zone of occurrence (U.S. EPA, 1991).

Selection of the appropriate method of well abandonment should be made after considering: 1) the casing material, 2) casing condition, 3) diameter of the casing, 4) quality of the original seal, 5) depth of the well, 6) well plumbness, 7) hydrogeologic setting and 8) the level of contamination and the zone or zones where contamination occurs. If no cross-contamination can occur between various zones and contamination cannot enter from the surface, grouting the well from bottom to top without removing the casing may be sufficient. However, since the primary purpose of monitoring well abandonment is to eliminate the vertical migration of fluids along the borehole, removal of the casing is the preferred method of well abandonment. When the casing is removed, the borehole can be sealed completely and there is less potential for channeling in the annular space or inadequate casing/grout seals (U.S. EPA, 1991).

Regulatory requirements and accepted procedures for the abandonment of monitoring wells, public water supply wells and domestic water wells vary depending upon the regulatory program which required the well to be installed and/or regulates its use, the geologic environment in which the well is located, the purpose and use of the well and the type of well installed. The appropriate subsection listed below should be consulted prior to planning a well abandonment program. *Some regulatory programs require a plan to be submitted prior to attempting well abandonment. In situations where a plan is not required before well abandonment is performed, consultation with the appropriate ADEM personnel is highly recommended.*

SOLID WASTE

The requirements for monitoring well abandonment at facilities permitted under the Solid Waste Regulations, 335-13, include:

335-13-4-.27

(a) The owner or operator must notify the Department that the design, installation, development, and/or abandonment of any monitoring wells, piezometers and other measurement, sampling, and analytical devices has been documented, and placed in the operating record; and:

(b) The monitoring wells, piezometers, and other measurement, sampling, and analytical devices must be operated and maintained so that they perform to design specifications throughout the life of the monitoring program.

(c) Abandoned wells and bore holes shall be abandoned in accordance with the following procedures in order to prevent contamination of groundwater resources. A plan of abandonment must be submitted and approved by the Department prior to implementing abandonment of any well.

1. A well shall be measured for depth prior to sealing to ensure that it is free from any obstructions that may interfere with sealing operation.
2. Where feasible, wells shall be completely filled with neat cement. If the well cannot be completely filled, the sealing material for the top 20 feet must be neat cement and no material that could impart taste, odor, or toxic components to water may be used in the sealing process.
3. Liner pipe shall be removed from each well in order to ensure placement of an effective seal. If the liner pipe cannot be readily removed, it shall be perforated to ensure that proper sealing is obtained.
4. Concrete, cement grout, or neat cement shall be used as primary sealing materials and shall be placed from the bottom upwards using methods that will avoid segregation or dilution of material.
5. Complete, accurate records of the abandonment procedure shall be kept for each well abandoned. The record of abandonment shall include, at a minimum, the depth of each layer of all sealing and backfill material, the quantity of sealing materials used, measurements of static water levels and depths, and any changes made in the well during the sealing. A copy of these records shall be submitted to the Department and a copy placed in the operating record.

UNDERGROUND STORAGE TANKS

The Department may require that all installed monitoring wells be properly plugged and abandoned upon completion of either the site investigative phase or remediation phase. In accordance with ADEM ADMIN. Code R. 335-6-15-.29(8) the wells may be required to be "properly closed". The purpose of sealing an abandoned boring or monitoring well is to prevent any further disturbance to the pre-existing hydrogeologic conditions that exist in the subsurface. In accordance with this purpose, no material that could impart taste, odor, or toxic components to water may be used in the sealing process.

Allowable procedures for abandonment of the various types of wells which may be installed at a UST site are as follows:

Abandonment of Borings:

A. Unconsolidated Formations

1. Borings extending into unconsolidated formations may be adequately sealed by filling with concrete, grout, neat cement or a grout/cement mixture.
2. The boring may be backfilled with cuttings if all of the following conditions are met:
 - a. The boring is in a well-drained area with no tendency to have standing surface water,
 - b. The boring is 25 feet or less in depth,
 - c. The boring does not penetrate an aquifer, and is not in an area of contamination.
3. If the boring is filled with concrete, grout, neat cement or a grout/cement mixture, the sealing material may be brought up to about two or three feet below grade and finished with clay or excavated cuttings. If the boring is located in a paved area, the finishing fill should include a final covering comparable to the original surface, for example, concrete or asphalt patching. Materials that could crack and provide a vertical conduit should be avoided.

B. Competent Rock

1. Borings that extend into competent bedrock should be filled from the bottom with concrete, grout, neat cement or a grout/cement mixture. If the bedrock is overlain by residual soils, the sealing material may be brought up to about two

or three feet below grade and finished with clay or cuttings as in unconsolidated formations site is paved.

Abandonment of Monitoring Wells

Wells can be abandoned either by removing the casing or by leaving all or part of the casing in place and cutting the casing off below ground level. Because the primary purpose of well abandonment is to eliminate vertical fluid migration along the borehole, the preferred method of abandonment involves casing removal. Abandonment methods for various types of wells are as follows:

A. Temporary Monitoring Wells

Temporary monitoring wells should have the casing pulled and the borehole sealed as with a boring.

B. Permanent Monitoring Wells

1. Permanent monitoring wells should have the casing pulled and the borehole sealed as with a boring.

2. Casing material, depth of the well, deviation of the well, or other reasons may make pulling the casing impossible. In this situation, the casing may be cut off two or three feet below grade and completely filled with concrete, grout, neat cement, and or a grout/cement mixture to prevent channeling. The hole should be finished up to the ground as with a soil boring.

3. The casing may be removed by over-drilling if necessary. The casing and debris should be removed and borehole sealed as with a boring.

C. Multiple Casing Monitoring Wells

Multiple cased monitoring wells are built to insure that vertical migration does not affect groundwater quality. Therefore, if the construction design is known to be satisfactory and the casing integrity has not been affected, it may be left in the ground and filled with concrete, grout, neat cement or a grout/cement mixture. The casing should be cut off two or three feet below grade and filled from the bottom up as with a permanent monitoring well. The hole should be finished up to the ground surface as with a boring.

PUBLIC WATER SUPPLY WELLS

Public water supply wells should be abandoned only after consultation with the ADEM Water Supply Branch (See note on next page).

ADEM Division 7 Water Supply Program

Admin. Code R. 335-7-5-.16, states:

Abandoned wells partially completed wells and bore holes shall be filled and sealed to prevent contamination of ground water formations. Where feasible, or when required by the Department, wells shall be completely filled with neat cement. Other wells shall be sealed in accordance with American Water Works Association (AWWA) Standard A100 Section 13. And Appendix G, latest edition except that the sealing material for the top 20 feet of fill must be neat cement and no material that could impart taste, odor, or toxic components to water may be used in the sealing process.

American Water Works Association Standards A100-(latest edition)

Sec.13.1 General

Abandoned test holes, including test wells, partially completed wells, and completed wells, shall be sealed.

13.1.1 *Need for sealing wells.* wells need to be sealed for the following reasons:

- To eliminate physical hazards,
- To prevent contamination of groundwater,
- To conserve yield and hydrostatic head of aquifer, and
- to prevent intermingling of desirable and undesirable waters.

13.1.2 *Restoration of geological conditions.* The guiding principle to be followed by the contractor in the sealing of abandoned wells is the restoration, as far as feasible, of the controlling geological conditions that existed before the well was drilled or constructed.

American Water Works Association Standards A100(latest edition)

Sec.13.2 Sealing requirements

A well shall be measured for depth before it is sealed to ensure freedom from obstructions that may interfere with effective sealing operations.

13.2.1 *Casing removal.* Removal of casing from some wells may be necessary to ensure placement of an effective seal.

13.2.2 *Exception to removing casing.* If the casing cannot be readily removed, it shall be perforated to ensure the proper sealing required.

13.2.3 *Sealing materials and placement.* Concrete, cement grout, sealing clay or neat cement shall be used as primary sealing materials and shall be placed from the bottom upward by methods that will avoid segregation or dilution of material.

American Water Works Association Standards A100-(latest edition)
Sec.13.3 Records of Abandonment Procedures

Complete, accurate records shall be kept of the entire abandonment procedure to provide detailed records for possible future reference and to demonstrate to the governing state or local agency that the hole was properly sealed.

13.3.1 *Depths sealed.* The depth of each layer of all sealing and backfilling materials shall be recorded.

13.3.2 *Quantity of sealing material used.* The quantity of sealing materials used shall be recorded. Measurements of static water levels and depths shall be recorded.

13.3.3 *Changes recorded.* Any changes in the well made during the plugging or sealing, such as perforating casing, shall be recorded in detail.

Appendix G is attached for reference and is noted in AWWA A100 that it is for information only and is not a part of AWWA A100.

WATER SUPPLY WELL ABANDONMENT PLAN

Name/Telephone # of well owner: _____

Name/Telephone # of person owning property on which the well is located (If different from the owner): _____

*Stage of construction: _____

Location of Well: Latitude: +Degrees__ Minutes __ Seconds __. __
Longitude: +Degrees__ Minutes __ Seconds __. __

Name/Telephone # of person who knows the location of the well:

Attach an 8 1/2 x 11 copy of a 7.5 Minute USGS Topographic Map and mark the location of the well. Give the name of the topographic map (usually located in the upper right hand corner of the original map). Attach an 8 1/2 x 11 cross sectional drawing showing the details of the well.

Type of geological formation: ___Consolidated ___Unconsolidated ___Other (Explain):_____

Screen: diameter _____Type _____ Length _____

Depth of the well: _____Diameter of the casings _____

Casing to be removed: ___Yes ___No If no explain why not:

Method proposed to remove casing:_____

Depth of casing grouting:_____**Type well:_____

Describe the proposed plan for abandoning the well: _____

Note: Add additional pages as needed to provide complete information
* 1= Test Hole; 2=Test Well; 3=Partially completed well; 4 Completed well
** A=Rock Wall; B=Gravel wall; C=Other Explain

HAZARDOUS WASTE MANAGEMENT SITES

The ADEM RCRA Program considers improperly abandoned monitoring wells to be a serious concern. Any boreholes or monitoring wells that are improperly constructed or unused should be properly abandoned ***after the proper approval has been received from ADEM***. Experienced geologists, geotechnical engineers and drillers should be consulted prior to abandonment. If the well to be abandoned is contaminated, the safe removal and proper disposal of the well materials should be ensured by the owner/operator. Appropriate measures should be taken to protect the health and safety of individuals when abandoning a well or borehole.

The monitoring well or borehole should be sealed so that it can not act as a conduit for the migration of contaminants from the ground surface to the water table or between aquifers. The preferred method shall be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing can then be removed from the hole with the drill rig or other appropriate equipment. The clean borehole can then be backfilled with the appropriate grout material. The backfill material shall be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). The top two feet of the borehole shall be poured with concrete to insure a secure surface seal (plug). If the area has very heavy traffic use, and/or the well locations need to be permanently marked, then a protective surface pad and/or steel bumper guards shall be installed. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists.

Because of its brittleness, PVC wells may be more difficult to remove than metal casing wells. If the PVC well casing breaks during removal, the borehole shall be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by the selected drilling fluid. Another method is to use a solid-stem auger with a carbide auger head to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole shall be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole shall be finished with a concrete surface plug and adequate surface protection, unless directed otherwise (EPA, 1991).

ABANDONED INDIVIDUAL WATER SUPPLY WELLS

Individual water supply wells are relatively shallow in depth and serve one to several households with enough water for domestic purposes. These wells are typically one of three types: shallow dug wells, driven or sand point wells or drilled or augered wells. As with other types of wells, the type and depth of well should be determined prior to plugging. Any obstructions in the well should be removed prior to initiating the plugging operation and under no circumstances should any part of the casing be allowed to remain above the surface of the ground after plugging.

Accurate records should be kept of the well location, depth, filling material, date of plugging, etc.

Shallow Dug Wells--Hand dug wells that extend down to the aquifer and are sometimes blasted or chipped into bedrock to reach the aquifer. Stone or concrete walls called curbing sometimes is necessary to keep the well from collapsing. These wells are rarely deeper than a few tens of feet and have diameters that are usually several feet across.

Pumps, piping or debris should be removed and the top 3 to 5 feet of curbing should be broken up prior to filling. Any portion of the well that extends into bedrock should be filled with a concrete-bentonite grout. The remainder of the well should be filled with clean native materials that approximate the permeability of the aquifer and overlying soils in the vicinity of the well. The soil should be compacted to prevent settling and ponding of water in the location of the former well.

Driven or Sand Point Wells--A well that is driven to the desired depth, either by hand or machine and may employ a wellpoint, or alternative equipment. These wells typically have a small diameter (2 inches or less) with a short screen near the pointed end and can only be used in soft sandy sediments or soils.

Driven or sand point wells should be removed if their diameter is 2 inches or less and their depth is 25 feet or less. The hole should be filled with a bentonite-cement grout. If greater than 25 in depth, larger than 2 inches in diameter, or cannot be removed, the well should be filled with a bentonite-cement grout from bottom to top using the pump-down method using a tremie pipe.

Drilled Wells--Diameters of 2 to 20 inches are typical for these wells which are installed with the use of a drilling rig and may be several tens to several thousand feet deep. In Alabama drilled domestic wells are generally less than 250 feet deep.

Drilled domestic wells are often unique in design and depth and should be abandoned only by a licensed well driller. If possible, the casing should be removed and the borehole filled with a cement-bentonite slurry. If the casing cannot be removed, the entire well should be filled with a cement-bentonite slurry using the pump-down method with a tremie pipe. In areas subject to subsidence and/or farming, the top of the casing shall be cut off a minimum of three (3) feet below the surface of the ground before plugging operations begins. After filling the well with the cement-bentonite slurry, the excavation above the top of the cement plug shall be filled with compacted soil to minimize future hazards to farming equipment etc. In other areas, the top of the casing shall be cut off at or below the ground surface.

REFERENCES

United States Protection Agency, 1991. Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells; United States Environmental Protection Agency, Office of Research and Development, EPA/600/4-89/034, 221pp.

ADEM Admin. Code R. 335-13.

ADEM Admin. Code R. 335-6-15.

American Water Works Association Standards A100-66-A1-13

EPA, 1991: Region IV Environmental Compliance Branch, Standard Operating Procedures; United States Environmental Protection Agency.