ABANDONED WELLS

Introduction
Michigan has approximately 2 million abandoned wells. Abandoned wells, which are often safety or health hazards, can be a tremendous liability for a well owner. There are reports every year of children and pets falling into abandoned wells and of groundwater contamination due to abandoned wells. For this reason, when a well is abandoned for any reason, it should be “plugged” rather than “capped.” This would include "dry holes," wells that are being replaced by a new well, wells that no longer produce water, wells producing water of unsuitable quality, or any other case where a well is no longer being used. The term "plugged" means to be filled up with an impervious material. The reason for doing so is to prevent contamination of the fresh water aquifer by foreign material from the surface or by water from other strata which may be of lower quality.

Responsibility for Plugging
The well owner is ultimately responsible to assure that any abandoned well on his/her property is properly plugged. Local health departments issuing replacement well permits should include a stipulation on the permit indicating the requirement to plug the existing well. When conducting the final inspection for the replacement well, a field inspection shall also be conducted to assure that the old well has been either properly plugged or repaired and made operational. The well driller is responsible for plugging "dry holes" and other drill holes where a permanent well is not installed.

Locating Abandoned Wells
The following recommendations should be used when trying to locate abandoned wells:

- Look for physical evidence such as casing, well pits, cement slabs, windmills.
- Talk to previous owners, neighbors, contractors, inspectors.
- Search for records such as permits, well logs, bills, receipts, photographs.
- Use equipment and tools such as a metal detector, a detectable tape, or a magnetometer.

For more detailed information on locating abandoned wells, refer to the DNRE Factsheet, “How to Locate Abandoned Wells”.

Permit Requirements
Local Health Departments routinely make plugging the old well a requirement on the replacement well permits they issue. Contractors and well owners must understand that since it is a permit requirement, any changes to the permit must be discussed with the LHD prior to well construction. For this reason, drillers need to make plugging the old well a part of their bid to drill the new well.

Plugging Materials
The common materials that are now available for plugging abandoned wells are: bentonite grouts/slurries (either powdered or granular), coarse grade bentonite, neat cement, and concrete grout. The most effective abandoned well plugging material is neat cement grout.

At this time, coated bentonite pellets are not recommended for plugging abandoned wells due to the detection of acetone in some pellet coatings.
**Bentonite Grouts/Slurries:**
This category of well plugging materials includes powdered and granular bentonite slurries. They all consist of bentonite solids placed in water, a mixture that remains pumpable for a short period of time. The plugging of a well is generally done in one continuous operation with placement from the bottom of the well upward by pumping the material through a tremie pipe. Upon placement, the bentonite particles in the slurry absorb water and swell in place to form a pliable seal of low permeability. Their use in plugging wells in Michigan is restricted generally to drift wells. Mixing directions and yield of product will vary greatly between the different bentonite types and manufacturers. Some products may require considerable caution and/or experience in their use to consistently achieve acceptable results.

**Coarse Grade/Pelletized Bentonite:**
These plugging materials consist of bentonite in crushed, chipped, granular, or compressed states to achieve particle sizes of 1/4 to 3/4 inch. They are intended for use and placement by pouring through the water column and cannot be pumped. Placement should be performed slowly and accompanied by tamping or measurement to check the level of accumulated bentonite and insure that "bridging" has not occurred. The bentonite must be prescreened before placement to remove all fine powder that accumulates in the shipping containers (bags). Screening is intended to eliminate the fines that will immediately hydrate upon coming in contact with water and cause "bridging" of the bentonite inside the casing. Bentonite chips shall be poured slowly, with rates not to exceed 50 lbs in 3 - 5 minutes. Slower rates of placement are required in smaller diameter wells. Once in place, the bentonite chips swell to form a high solids, low permeability plug.

**Neat Cement/Concrete Grouts:**
Neat Cement consists of 1 bag (94 lbs.) of Portland cement mixed with not more than 6 gallons of water. Neat cement grout is placed from the bottom of the well upward in one continuous operation until the well is filled. This is generally done by pumping the grout through a tremie pipe extended to the bottom of the well. Concrete grout consists of 1 bag of cement, an equal volume of sand, and not more than 6 gallons of water. Concrete grout is difficult to pump using conventional grout pumping equipment. Placement is largely restricted to the dry portion of an abandoned well or dry hole.

**Obstruction Removal**
Abandoned wells need to be checked for obstructions before they are plugged in order to verify that anything that may interfere with the plugging operations has been removed. Drop pipes, check valves, pumps, drawdown seals, and any accumulated debris, must be removed from the well to enable the well drilling contractor to properly plug the well. In cases where the drilling contractor cannot eliminate an obstruction from an abandoned well, the driller should notify the local health department and indicate the obstruction removal efforts he/she performed under "comments" on the Abandoned Well Plugging Record. Obstruction removal tools are termed "fishing tools" by the well drilling industry. They are specialized in design, require drilling rigs or pump hoist trucks to use, and take experienced workmen to operate. Obstruction removal activities should be conducted under the supervision of a registered well drilling contractor. Homeowners are ill equipped to attempt obstruction removal activities.

The depth of the abandoned well should be measured to allow the well drilling contractor to estimate the total volume of plugging material necessary to completely fill the abandoned well casing and/or borehole. Casing size and depth are used to calculate the required volume of plugging material. The tables at the end of this document are useful in estimating volumes of plugging material necessary for typical well plugging jobs.
Wells Terminated in Unconsolidated Formations (Drift wells):
Screens in small diameter “point” or driven wells and in typical 2 inch to 6 inch drift wells are generally not removed when the well is abandoned. In situations where the casing and screen are to be removed, the screen should be removed first, then as the casing is being removed, the hole should be kept full of the grouting material, adding more grout from time to time during the process. A few days after the casing is removed, a visit should be made to the site to determine if settling has occurred. If settling of less than 20 feet has occurred, the unfilled portion of the borehole may be refilled with an approved grout by pouring from the surface.

Wells Terminated in Bedrock Formations:
Where an abandoned well is determined to be terminated in bedrock, the well must be plugged with neat cement or concrete grout. Geologic information documenting the presence of bedrock or drift formations are typically identified on the original well drilling record for the well being abandoned. Alternatively, where no record exists for the abandoned well, records of other nearby wells may be used to establish typical geologic conditions for the area, including the presence and depth of bedrock.

When calculating the amount of plugging material necessary to plug a rock well, the normal procedure is to determine the casing and borehole volume, then add 20 percent for material loss into the rock formation.

In some rock formations, fractures or porous conditions may occur. These conditions are termed “lost circulation zones” and must be addressed in order for the abandoned well to be effectively plugged. Fractured intervals within a rock bore hole may be filled with aggregate (peastone) mixed with neat cement or a commercial plugging additive. The remainder of the well shall be plugged using standard neat cement placement procedures. Where porous conditions are encountered, a commercial plugging additive like cellophane flakes, ground walnut shells, or medium ground bentonite granules, etc. added to the neat cement or concrete grout typically will be employed to reduce loss to the formation and accomplish plugging the well.

When using a neat cement or concrete grout slurry for plugging rock wells, the plugging material shall be pumped from the bottom of the well to the surface using a tremie pipe. If simultaneously placing aggregate to fill fractures, the tremie pipe must be raised as the plugging material is pumped to keep it from becoming stuck in the well by the aggregate.

Flowing Wells:
In most cases, neat cement grout pumped directly into the well will stop the flow. However, the plugging of a flowing well can present unusual difficulties and hidden problems which must be handled properly. An inaccurate assessment of the situation can result in water breaking out around the casing or channeling of the water through porous drift formations with subsequent discharge to the surface either at the well or in the vicinity of the well.

It is important to know the depth of the strata from which the flow originated, the discharge rate of the well, and the hydrostatic head characteristics of the well. It is also important to know how (or if) the well was grouted when it was installed. The majority of problems associated with plugging flowing wells result from improper flow control, not stopping the flow before starting the plugging operation, or the grout column weight being inadequate to “hold down” the flow.
Due to their upward, continuously discharging flow, flowing wells often erode void spaces in the formation just below and along the well casing. Because the voids must be filled before the well casing can be plugged effectively, such circumstances frequently require many more times the calculated grout volume than you would expect when calculations are based upon the well casing diameter and casing length alone.

Situations are encountered where the artesian pressure of the formation exceeds the weight of the grout slurry columns. These circumstances require a means of increasing the weight of the grout slurry or provisions for additional flow control. A reliable approach involves (1) stopping or controlling the discharge, and (2) determining the hydrostatic pressure head.

When the head pressure is less than 10 psi, the first option is usually to install a casing seal with a discharge valve on the well head. Once this piping is in place, neat cement is pumped into the well against the pressure head. After delivering the calculated volume of plugging material, the valve is closed and the slurry is allowed to set. The casing seal and closed valve prevent the grout from washing back out of the abandoned “flowing” well.

Where higher head pressures exist (greater than 10 psi), stopping the flow by installing a casing riser may be more effective. Casing risers may extend 20-25 feet above grade but become less practical at greater lengths. When using a casing riser, the concept is to have the discharge water from the well retained inside a vertical well casing extension that is attached to the existing well casing. The water will rise up inside the casing extension to the point of the well’s natural static level, which may be many feet above grade. Once this occurs, the “flow” naturally stops. A tremie pipe can be placed down the casing riser to the bottom of the well. The neat cement grout can be pumped into the well without risking it being expelled because there is no longer any “flowing” discharge.

In some instances, artesian pressures are so great that containing the flow by extending the casing or drive pipe is not possible. The drive pipe can be fitted with valves and connections to allow pumping of neat cement directly into the well and annular space. In these extreme cases, large volumes of plugging material may have to be placed under high pressure. The most reliable means of completing a plugging job of this nature is by the well drilling contractor subcontracting with an oil field cementing firm.

The Michigan Department of Environmental Quality, Groundwater Section may be contacted for more information concerning this alternative. More detailed information on plugging flowing wells can be found in the DEQ’s Flowing Well Handbook at www.michigan.gov/deqwaterwellconstruction.

Some older well casings may be deteriorated to the point that placing grout through them under pressure is impractical. There may also be washouts along the outside of the casing where holes in the casing are present and the flow has been discharging. In these cases, an outer drive pipe and the use of a plugging design utilizing a tremie pipe will usually be necessary.

**Plugging Records**

An Abandoned Well Plugging Record must be filed with the DNRE and local health department. The report must include the type and amount of plugging material used and the method of placement of the plugging material. A Water Well and Pump Record form may also be used for this purpose. Abandoned well plugging records may also be filed electronically.
using the DNRE Wellogic program. For more information on using Wellogic, please email the Wellogic Staff at wellogic@michigan.gov.

**Abandoned Well Rules**
The following rules from the well code apply to abandoned wells.

**Rule 101 & 105:**
- Definitions of an Abandoned water well and a temporarily abandoned well.

**Rule 106**
- Only well drillers can plug wells, not pump installers.

**Rule 162**
- Abandoned wells shall be plugged by a well drilling contractor or by the well owner.
- Public water supplies shall be plugged by a registered well drilling contractor only.
- Obstructions shall be removed, if possible, before plugging.
- Abandoned wells shall be plugged when public water is installed.

**Rule 163**
- Wells that terminate in drift materials (sand, gravel, clay, etc.) shall be plugged with neat cement, concrete, or bentonite.
- Wells that terminate in bedrock (shale, sandstone, limestone, etc.) shall be plugged with neat cement or concrete from the bottom up to at least 20’ above the bedrock.
- Other materials are approved to plug gravel or cavernous, creviced, or fractured bedrock.
- Flowing wells shall be plugged with neat cement or concrete.
- Methane wells shall be plugged with neat cement or concrete.

**Rule 164**
- Bentonite chips or bentonite pellets shall be poured slowly to prevent bridging and fine particles shall not be used.
- Water shall be put into well to promote expansion of the bentonite chips.
- Plugging slurries shall be placed through a tremie pipe from the bottom of the well to the top.
- Other materials and methods may be used if approved by the local health department.

**Rule 165**
- Large diameter well shall be plugged by layering bentonite chips and clean soil.
- Granular bentonite may be used in place of bentonite chips.
- Neat cement or concrete may be poured if the well has been dewatered before plugging.
- Remove upper 3 feet of concrete crock or tile.

**Rule 167**
Illegally drilled wells shall be plugged.

**Rule 168**
The local health department can order a well plugged.
Rule 169
Well owner is responsible for plugging their well. Improperly constructed or located wells shall be plugged by the well drilling contractor.

Rule 170
- A temporarily abandoned well shall meet current code.
- A temporarily abandoned well shall be disconnected from any water distribution piping and shall have the top of the casing securely capped.

Rule 175
An abandoned well plugging record shall be submitted within 60 days of plugging an abandoned well or dry hole.