STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

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TO: Auger-Drilling Machine Contractors
Local Health Departments
Attn: Environmental Health Directors

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SUBJECT: GROUTING AUGER-DRILLED WATER WELLS GUIDANCE

Background

The use of auger-drilling methods for water well construction is concentrated in western lower Michigan and central-northern lower Michigan where highly-permeable sand aquifers are predominant. Some contractors have expressed concern that grouting to comply with Michigan's Water Well Construction and Pump Installation Code cannot be easily accomplished on augered-drilled wells due to collapse of the formation in the saturated zone when augers are extracted. Local health departments (LHDs) have questioned the ability of well drilling contractors to properly install and grout auger-drilled wells.

The goal of this guidance document is to proactively eliminate threats to drinking water aquifers resulting from installing improperly grouted auger-drilled water wells. This is accomplished by: clarifying regulatory intent, promoting uniform statewide interpretation of administrative rules, and providing further information on grouting of wells constructed with auger well drilling machines.

The procedures contained in this document for installing and grouting auger-drilled wells are approved methods and meet the intent of the grouting provisions pursuant to Part 127, 1978 PA 368, as amended, and the Groundwater Quality Control Rules (Michigan Water Well Construction and Pump Installation Code). Specifically, Rules 133a, 134a, and Rule 135 which pertain to well grouting.

Type of Auger-Drilling

There are different types of auger-drilling rigs and a variety of ways that augers are used during well drilling operations. Some contractors use augers for the entire well construction process. Others use them only to construct the upper borehole, and then switch to cable tool to complete the well. The common types of augers used for water well drilling in Michigan are solid stem and hollow stem augers. Both auger systems typically employ a top head drive rotary mechanism to rotate the auger string. As the augers turn, they act as a screw conveyor, carrying cuttings to the ground surface.

Solid Stem Augers
The diameter of the borehole created by a solid stem continuous flight auger is determined by the radius of the outer edge of the helical auger. As solid stem augers wear, the outer helical edges decrease, resulting in a smaller radius borehole. Excessive auger wear can render the auger unusable for installation of some well casing sizes.

When solid stem augers are used, the permanent well casing is installed after the drilling is completed, and the augers are removed from the borehole. Depending upon the type of geology being penetrated, the borehole may or may not collapse in either the upper unsaturated zone or in the saturated zone (below the water table), when the auger flights are withdrawn.

Oversize Solid Stem Augers/Steel Well Casing
After auger-drilling a borehole that is at least 2 7/8 inches larger than the nominal size of the permanent well casing, to the full depth of the finished well, a steel well casing is placed (with the screen attached) into the borehole by manually lowering it or pushing it (with or without the aid of the well rig) to the bottom of the borehole. Field evaluations have demonstrated that augers can be extracted in a manner that allows the driller to retain borehole integrity without inducing excessive collapse, thereby allowing for placement of the well casing and screen. An example of one such method involves introduction of drilling fluid or gel into the borehole, by reverse rotating the augers as they are slowly removed from the borehole, leaving the gel in the open borehole. The gel keeps the borehole from collapsing before the casing can be installed.

A grout pipe is then placed into the annulus, and the gel is flushed from the borehole. Field demonstrations have shown that the loosened material around the casing that may be present in the annulus has a significantly lower density than undisturbed formation material. This allows for the insertion of the grout pipe into the annulus and down to the top of the screen. The grout pipe must be installed to a depth not less than ten feet above the top of the well screen. When pumping a bentonite grout (high solids content – greater than 20 percent recommended) through the grout pipe up to the surface, any loose material slurry in the annulus is displaced. The grout pipe shall be removed as the slurry is pumped. This grouting procedure will effectively prevent the annulus from acting as a conduit for contaminant movement. Please note that jetting of the grout pipe to the appropriate depth is not considered a standard practice for this installation method. Jetting may create an avenue for the grout to channel around the exterior of the grout pipe and not effectively seal the entire borehole.

Where a deeper well is being installed and incidental caving or bridging occurs above the saturated zone, the contractor shall place a rigid pipe into the annulus and either knock or jet out the bridge before commencing grouting operations. If the bridge cannot be removed, the casing shall be withdrawn and the bridge shall be drilled out before proceeding with completion of the well.

Undersize Solid Stem Augers
Where undersize solid stem augers (augers that are smaller than the nominal size of the permanent well casing) are used, steel casing is driven into the borehole. The casing may also be spun by the top head drive mechanism or pushed into the borehole using hydraulic down pressure. This well construction process is considered to be a "driven" method, rather than augered. Plastic well casing may not be installed using this method.

Because this is a driven casing method, the well shall be grouted by maintaining dry granular bentonite around the permanent casing as it is driven, pursuant to Rule 135.

Both solid stem auger well installation techniques are not recommended where flowing well conditions are present because there is no drilling fluid used. The ability to effectively control potential flows or flow breakouts is limited at best. However, some drillers have successfully developed special grouting techniques to manage difficult flowing well conditions.

Hollow Stem Augers
The diameter of the borehole created by a hollow stem auger is determined by the radial extent from center, of the outside helical edge of the auger flight, and not the outside extent of the cutters that are located on the leading edge of the first auger section.

When installing a well with a hollow stem auger, the casing and screen are put in place before removal of the auger string. Where a plug or cap is used on the end of the hollow stem auger-drilling string, water must be introduced or maintained inside the hollow stem auger at the time that the plug or cap is removed to prevent formation materials from heaving up into the hollow stem. An annulus is present between the well casing and the inside surface of the hollow stem auger.

If the driller is going to grout with a grout pipe that is placed inside the hollow stem auger adjoining the permanent well casing, the inside diameter of the hollow stem auger shall be a minimum of 2 7/8 inches larger than the nominal size of the permanent well casing, pursuant to Rule 133a.

The inside wall of the hollow stem auger allows for placement of filter pack materials and grout without the risk of borehole collapse. After placement of the filter pack material to a point not more than ten feet above the top of the well screen, the annular space that is present between the permanent well casing and the hollow stem auger shall be grouted by pumping neat cement or bentonite grout (high solids content recommended) using a grout pipe placed within the annulus, up to the surface. This grouting process shall proceed incrementally, as the sections of auger flight are extracted. To prevent or limit potential upper borehole collapse, not more than two 5-foot sections of augers should be extracted at any one time.

If the inside diameter of the hollow stem auger is less than the minimum 2 7/8 larger than the nominal size of the permanent casing, the driller may employ the grouting methods described in the **Oversize Solid Stem Augers/Steel Well Casing** section. Another method would involve the pumping of bentonite drilling fluid into the hollow stem drills between the inside diameter of the auger and the well casing before and during removal. The drilling fluid will maintain the borehole much like installations involving rotary drilling methods. The grout pipe is then put into place and the hole is flushed before grouting commences.

Displacement grouting methods may be utilized for hollow stem auger-drilled wells provided that the hollow stem auger inside diameter is at least two inches greater than the nominal size of the permanent well casing, pursuant to Rule 133a.

Some hollow stem auger well installation methods may be problematic in areas where flowing well conditions are anticipated. The ability for well drilling contractors to control potential flows or flow breakouts on the outside of the hollow stem auger flights is negligible. An alternate drilling and casing installation method should be employed in those areas.

Auger/Cable Tool Combination/Steel Well Casing
Sometimes a combination method is used whereby the upper borehole is completed with an auger machine and the lower portion is completed with a cable tool rig. The augers used must be at least 2 7/8 inches larger in diameter than the nominal size of the permanent (driven) well casing.

The size of the augers being used in the upper portion of the well is going to be dependent upon the type of grouting procedure that is going to be used. If dry granular bentonite is going to be used to grout as the permanent casing is being driven, then the outside diameter of the augers must be smaller than the outside diameter of the couplings on the steel well casing that is going to be driven. In cases where the auger-drilled portion of the well is going to be grouted using a grout pipe, then the auger size must be at least 2 7/8 inches larger than the nominal size of the permanent well casing.

If the auger-drilled portion of the borehole is less than 25 feet deep and the auger-drilled borehole is dry, granular bentonite shall be placed into the bottom of the auger-drilled borehole and it shall be maintained around the permanent well casing as it is being driven. After the permanent casing has been driven, the annulus in the upper portion of the well may be grouted by either pumping bentonite slurry grout or neat cement grout from the bottom of the auger-drilled borehole up to the surface, or by pouring granular or chip bentonite into the annulus, from the surface.

In cases where the auger-drilled portion of the borehole penetrates into the saturated zone, the annulus created by the 2 7/8 inch oversize auger shall be grouted using the procedure approved for use with oversize solid stem augers. Where this installation

method is used it is not necessary to maintain granular bentonite around the permanent casing as it is being driven. The auger-drilled portion of the borehole must extend not less than 25 feet below the ground surface.

Communication
Auger-drilling contractors are encouraged to communicate with the LHD regarding the type of auger-drilling performed, and LHDs are encouraged to communicate with the contractor and arrange to observe auger-drilling in the field. By seeing the drilling and grouting first hand, this will help to clear up any confusion about the procedures used and if they meet the grouting provisions in Part 127.

Water Well Record Review
LHDs are required to review all water well records for completeness, accuracy, and compliance with Michigan's Water Well Construction and Pump Installation Code. When the drilling method is listed as auger-drilling, the LHD must first determine which type of auger-drilling method was used. This can be determined by reviewing the borehole size, grouting method, and grout material.

Auger contractors are encouraged to use the general remarks on the well record to provide drilling method (solid stem, hollow stem, etc.) and installation techniques. If anything on the water well record is unclear, the LHD should contact the driller for clarification.