
**Maine Department of Environmental Protection**

**Bureau of Remediation and Waste Management**

**Division of Technical Services**

# Guidance for Well and Boring Abandonment

**January 7, 2009**

Below is guidance for the abandonment of wells and borings associated with environmental or geotechnical investigations.

**1.0** APPLICABILITY
These guidelines are applicable for the abandonment of geotechnical borings, environmental monitoring wells and soil borings installed in the State of Maine. These guidelines pertain to any vertical or high angle boring completed by rotary or direct push methods.

**2.0** PURPOSE
The purpose of these procedures are to: 1) prevent the possibility of abandoned wells and/or borings providing a means for contaminants to enter the groundwater; 2) prevent the possibility of personal injury; and 3) prevent the intermixing of separate water bearing zones.

Below are the types of wells/borings these procedures pertain to:

a) soil and rock borings that need to be properly abandoned so that they do not serve as a preferential conduit for contaminants;

b) monitoring wells that need to be abandoned after the site rehabilitation activities are completed or after the well is determined to be no longer useful so that the well can not be used in the future for unauthorized access; and

c) drinking water wells that need to be abandoned if they become unusable due to the presence of contaminants.

**3.0** RESPONSIBILITES
The onsite inspector is responsible for verifying that well/borehole abandonment has been conducted in a manner that is consistent with the methods described below and meets the purpose of these guidelines as state in Section 2.0 above.

Specifically, the onsite inspector must:

- verify and document the depth and diameter of the boring/well to be abandoned;
- review available boring logs and well construction diagrams and determine and document the appropriate abandonment method;
- verify and document the type and volume of sealing material that is to used by the well/boring abandonment subcontractor;
- verify and document that the bentonite/grout slurry has been mixed to manufactures specifications;
- document the abandonment procedures, including volume of material used, incidences of bridging, corrective actions taken and end result;

- provide a signed copy of the well abandonment record to the appropriate DEP project manager.

## **4.0** GUIDELINES AND PROCEDURES

Whenever there is doubt as to whether the well/boring will serve as a preferential pathway for the migration of contaminants, the boring must be hydraulically sealed.

The method used for abandonment of the well/boring must be indicated in field notes or on the boring log. A well abandonment record is included with this guidance and it is recommended that the form be completed at the time of abandonment and submitted to the site-specific project manager at the Maine Department of Environmental Protection for inclusion into the permanent site file.

Abandoned wells or boreholes should be sealed in a manner appropriate to prevent the entry of contaminants and from the mixing of waters from separate water bearing zones. Also, the abandoned well/boring should not be a physical hazard to any person walking, driving or operating equipment nearby. Below are procedures specific to each well/boring scenario.

**Soil borings**: Abandoning soil borings with a hydraulic seal is not always necessary. For sites that have a very shallow water table (i.e.,<10'), or where soils are contaminated down to the water table, or where the lithology consists of homogeneous sand, less rigorous abandonment methods may be used. In these instances, it is acceptable to backfill the boring with soil that has permeability equal to or lower than the soil in which the boring was completed.

Conversely, a soil boring needs to be abandoned with a hydraulic seal if there is a chance, by leaving it unsealed, that mixing of waters of separate water bearing zones and/or creation of a contaminant migration pathway will result. Specifically, the soil boring needs to be sealed if:

1. the soil boring is suspected to have penetrated a perched zone or a confining or semi-confining layer;
2. more than one geologic unit is encountered (e.g., glacial marine/esker);
3. the site has a deep water table and the lithology consists of heterogeneous sands and clay;
4. soil contamination is identified, but the groundwater is not suspected of being impacted by the contamination;
5. the soil boring goes into the water table and has the potential to short circuit the hydraulic head from deeper zones; and
6. the soil boring is drilled blind (i.e., no samples collected).

Soil borings can be completed via direct push, hollow stem auger, solid stem auger and drive and wash methods. Direct push and solid stem augers require

similar abandonment methods, as do hollow stem auger and drive and wash borings.

*Type A borings* - For Geoprobe® type drilling that uses only the Macro-Core® to advance the hole, or when solid stem augers are used to complete the borehole, the boring will be backfilled with hydraulic sealing material after the drilling tools are removed. Sealing is completed by slowly pouring bentonite chips/pellets or other plugging material in the borehole from the top. The seal should be brought up to one foot below grade. The last foot of the boring should be backfilled with soil to avoid the mess associated with bentonite on the ground surface. It is not acceptable to use alternating layers of sand and bentonite to seal the borehole. Tremie method of grouting is acceptable, although not required for soil boring completed with non-dual wall direct push or solid stem methods.

*Type B borings* - For borings completed using hollow stem auger, drive and wash, or Geoprobe® type drilling that uses a dual wall sampling system, the borehole should be hydraulically sealed while the drilling tools remain in the boring.

Method 1 - The soil boring should be tremie grouted beginning from the boring bottom and continuing upward to the ground surface. The plugging material should consist of either:

1. cement with a 2% - 5% by weight bentonite mixture; or
2. high solids bentonite grout.

The cement/grout mixture should be mixed according to manufacturer's specification to produce a flowable (i.e., pumpable) consistency. The minimum volume of grout should be equal to that of the well bore. The well bore should be filled with grout to within 2 feet of the top of the cut down casing. The last 2 feet of casing should be filled with cement or clean soil to ensure a solid surface exists at ground surface.

Method 2 – The soil boring can be abandoned by pouring bentonite or other plugging material in from the top of the hollow stem augers, or casing, when drive and wash or dual wall Geoprobe® type equipment is used. This method requires care and patience because it is susceptible to bridging within the auger and casing. Bentonite chips/pellets should be added to the borehole slowly. As each lift of bentonite is added, the auger or casing must be pulled up a corresponding height to prevent bridging within the auger/casing. Continuous measuring of the seal height within the borehole is necessary as each lift of bentonite is added to ensure bridging doesn't occur. If bridging does occur, the driller must clear the bridge without removing the drilling tools from the borehole. The sealing material should be added to the borehole until it is within one foot of the ground surface. The last one foot of borehole should be filled with clean soil to avoid the mess

associated with bentonite on the ground surface. It is not acceptable to use alternating layers of sand and bentonite to seal the borehole.

**Rock corings**:
The rock core should be tremie grouted beginning from the well bottom and continuing upward to the ground surface. Due to the small diameter typical of rock cores, pouring bentonite chips, or other plugging material from the top down is not recommended. The plugging material should consist of either:

1. cement with a 2% - 5% by weight bentonite mixture; or
2. high solids bentonite grout.

The cement/grout mixture should be mixed according to manufacturer's specification to produce a flowable (i.e., pumpable) consistency. The minimum volume of grout should be equal to that of the well bore. The well bore should be filled with grout to within 2 feet of the top of the cut down casing. The last 2 feet of casing should be filled with cement to ensure a solid surface exists at ground surface.

**Monitoring wells**: There are two basic types of monitoring wells: bedrock and overburden. Abandonment method for each depends on how the wells were installed. Proof of well construction in the form of a boring log and construction diagram is required to determine whether a well was properly installed.

*Type A wells* - If it can be demonstrated that a well was properly constructed, meaning that hydraulic seals were placed to prevent hydraulic short-circuiting between separate water-bearing zones (i.e., when breaching a confining layer or a continuous section of un-fractured bedrock), the well screen and riser can be abandoned in place by either of following methods:

Method 1 - The well should be tremie grouted beginning from the well screen bottom and continuing upward to the ground surface. The plugging material should consist of either:

1. cement with a 2% - 5% by weight bentonite mixture; or
2. high solids bentonite grout.

The cement/grout mixture should be mixed according to manufacturer's specification to produce a flowable (i.e., pumpable) consistency. The well should be filled with grout to within 2 feet of the top of the cut down casing. The last 2 feet of casing should be filled with cement or clean soil to ensure a solid surface exists at ground surface. The surface casing should be cut down to grade (preferably below).

Method 2 – If the well casing is at least 2 inches in diameter, the well can be abandoned by pouring bentonite or other plugging material in from the top of the

well casing. This method requires care and patience because it is susceptible to bridging. Bentonite chips/pellets should be added to the borehole slowly. Continuous measuring of the seal height within the borehole is necessary as each lift of bentonite is added to ensure bridging doesn't occur. It is acceptable as a cost-saving measure, to use alternating layers of sand and bentonite to seal the well riser. For well screens that are 10 feet in length or less, an instance of bridging must be noted by the onsite inspector. As long as the riser above the screen is sufficiently sealed from the potential of surface leakage, it is not necessary to fully seal the screened interval. However, if bridging occurs in bedrock monitoring wells with screens longer than 10 feet prior to fully sealing the screened interval, the well must be drilled out and sealed via the tremie method.

*Type B wells* – If it can not be demonstrated that a well was properly constructed regardless of whether it is installed in the bedrock or overburden, the well must be drilled out and sealed via the tremie method.

> *Note: Methods of drilling out may include pulling the well out, re-drilling, overdrilling, etc. as long as the sand pack or other non-sealing material is removed and the seal will directly contact native material.*

**Drinking water wells**: Typical drinking water wells are 6-inch diameter drilled bedrock boreholes. Pumps, drop pipes, wires and all apparatus within the well casing must be removed from the well. Well depth and diameter must be measured in order to calculate the necessary volume of plugging material. The surface casing should be cut down to grade (preferably below).

Method 1 - The preferred method of well abandonment is by tremie grouting. The well bore should be tremie grouted beginning from the well bottom and continuing upward to the ground surface.

The plugging material should consist of either:

1. cement with a 2% - 5% by weight bentonite mixture; or
2. high solids bentonite grout.

The cement/grout mixture should be mixed according to manufacturer's specification to produce a flowable (i.e., pumpable) consistency. The minimum volume of grout should be equal to that of the well bore. The well bore should be filled with grout to within 3 feet of the ground surface. The remaining casing should be cut down to below grade. The remaining portion of open casing should be topped off with Portland cement. The remaining portion of the boring should be filled with clean soil to ensure a solid surface exists at ground surface.

> *Note: If possible, it is recommended that the casing be removed from the borehole following tremie grouting.*

Method 2 – A less preferred alternative method of well abandonment involves pouring bentonite chips, or other plugging material into the well from the top down. This method should be used with extreme care and patience to avoid bridging of the bentonite. If this method is to be used, it will need to be demonstrated (via field notes) that the entire borehole is filled with bentonite. It is not acceptable to use alternating layers of sand and bentonite to seal the borehole. If the volume of bentonite chips installed is less than the volume of the well bore, the well bore must be re-drilled to clear the bridge. Well abandonment will be considered by the Department to be successfully complete only if is can be demonstrated that there is a continuous seal throughout the borehole (via volume calculation comparison). Bentonite chips/pellets should be added to the borehole 1-Cup at a time. Continuous measuring of the seal height within the borehole will be required as each bag of bentonite is added to the borehole to ensure bridging doesn't occur. Voids spaces caused by bridging are not acceptable.

*(Note: To avoid bridging in a 6-inch diameter well, it may be beneficial to use a 2" drop pipe, such as PVC threaded monitoring well riser. The 2" threaded riser sections are lowered to just above the bottom of the well. Bentonite chips/pellets are added slowly to the drop pipe. The pipe is slowly removed from the borehole as more bentonite is added. If a bridge does occur, it will likely occur within the riser. Once bridged, the riser is removed from the borehole and the section containing the bridge is removed and replaced with a new section of pipe. The 2" pipe is lowered back into the borehole and the process of adding bentonite resumes until the borehole is completely filled.*

**WELL ABANDONMENT RECORD**
Maine Department of Environmental Protection
Bureau of Remediation and Waste Management

1. **Date of Abandonment:**_____

2. **Abandonment Contractor:**

_____
Company

_____
Printed Name of Individual Abandoning Well

3. **Well Location:**

_____
Address

_____
County

_____
Nearest Town

_____
Latitude (D,M,S or DD format)

_____
Longitude

4. **Well Type:**

□ direct push □ drilled

5. **Well Use:**

□ monitoring □ residential □ industrial

□ injection □ recovery □ geotechnical

6. **Reason for abandonment:**

_____

_____

_____

_____

7. **Are boring logs available?**

□ Yes, attached □ No

8. **Are well construction logs available?**

□ Yes, attached □ No

9. **Well Depth (ft):**_____

10. **Boring Diameter (in):**_____

11. **Riser/Casing Diameter (in):**_____

12. **Type of Casing:**

□ steel □ PVC

13. **Was any casing removed?**

□ Yes □ No

If yes, length removed (ft.):_____

14. **Was well abandoned in place?**

□ Yes □ No

If yes, was casing perforated?

□ Yes □ No

15. **Abandonment Material:**

□ bentonite grout □ dry bentonite

□ cement grout □ native soil

16. **Quantity of Material Used:**

# of bags_____, or

cubic feet _____

17. **Explain Method of Material Placement:**

_____

_____

_____

_____

_____

18. **Signature of Person Abandoning the Well:**

_____