GUIDE FOR SEALING ABANDONED WATER WELLS IN MANITOBA

Technical Information For Well Owners

Manitoba

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Guide for Sealing Abandoned Water Wells in Manitoba

The earliest recorded water wells in Manitoba were drilled during the late 1800s to provide water supplies for an expanding rural population. Since that time, more than 200,000 water wells, monitoring wells and test holes to explore for groundwater have been drilled throughout the province. While most test holes were sealed immediately after being drilled, thousands of abandoned water wells have not been properly sealed in both urban and rural areas of the province over the past century.

The proper sealing of abandoned wells is of considerable importance if we are to maintain and protect the integrity of our groundwater supplies and protect human health and safety. This publication provides information for the proper sealing of abandoned water wells in Manitoba.

An **abandoned well** means a well not in present use and not maintained for future use.

Abandoned wells in Manitoba can vary in their construction and form.

Unsealed abandoned wells may:

- act as conduits for the movement of near-surface contaminants such as bacteria and nutrients into an aquifer
- flow uncontrollably at the surface resulting in water waste, nuisance or flooding problems
- interconnect fresh water and saline water aquifers, allowing saline water to enter into fresh water zones
- pose a threat to people or animals who may fall into large diameter openings and become trapped
- present a hazard to farm machinery and vehicles

The well drilling and sealing industry in Manitoba by and large uses imperial units in its work. Subsequently this document contains imperial units. Conversion units from imperial to metric measurements are provided below.

Conversion Units

1 inch = 2.54 centimetres	1 Imperial gallon = 4.55 litres	1 cubic ft = 0.028 cubic metres
1 foot = 0.305 metres	1 pound = 0.454 kilograms	1 cubic yd = 0.765 cubic metres

The Landowner's Responsibility

According to The Groundwater and Water Well Act, the responsibility to seal an abandoned well rests with the owner of the land on which the well is located (the landowner). The owner must ensure the well is sealed **"in a manner that is sufficient to prevent the vertical movement of water or other substances in it"**. A well which is not currently in use but may be used for water supply purposes in the future is not considered to be abandoned as long as it is properly maintained for future use. Such wells should have proper casing stick-up and be properly capped so that no foreign materials may enter the well, but need not be permanently sealed.

The legislation governing the sealing of wells is contained in The Groundwater and Water Well Act, and supporting General Matters and Well Standards regulations.

In some cases, landowners may properly seal an abandoned well on their own property using simple methods and materials. In other cases, proper sealing may be a complex procedure and should only be carried out by an experienced individual. In general, it is recommended that due to a landowner's lack of knowledge and experience, and difficulties that might arise during the sealing process, that a Manitoba licensed well drilling contractor or an experienced well sealer be contracted for any well sealing work.

A list of licensed well drilling contractors in Manitoba is available from Manitoba's public register of licensed well drilling contractors.

Some Manitoba Conservation Districts also operate well sealing programs. Information on the programs can be obtained by contacting your local Conservation District office.

Under no circumstances can a landowner seal:

- a flowing artesian well
- an injection well
- a contaminated well
- a well containing saline water
- a well that contains any equipment (such as an old pump), debris or an obstruction that cannot be removed from the well

These types of wells must be sealed by a licensed well drilling contractor.

Any person sealing an abandoned well must adhere to the rules and standards developed for the sealing of wells. They also must fill out and submit a well sealing report.

Flowing artesian well means a well in which water rises above the surface of the ground, either continuously or intermittently.

Injection well means a well constructed for the purpose of
(a) disposing of saline or waste water; or
(b) injecting water into an aquifer for storage or any other purpose;
but does not include an open loop geothermal well.

Saline water means, in relation to the sealing of a well, water that has
(a) a concentration of total dissolved solids in excess of 3,500 mg/l; or
(b) an equivalent electrical conductivity in excess of 5,000 micro-Siemens/cm.

Aquifers In Manitoba

An **aquifer** is defined as a water-bearing geological formation that is capable of producing water to wells or springs in sufficient quantities to serve as a source of water supply.

Aquifers can be formed by loose materials such as sand and gravel, or by bedrock materials such as limestone, sandstone, fractured shale or granite. Some familiar aquifers in Manitoba include the extensive sands in the Carberry, Oak Lake, Winkler and Birds Hill areas, the limestone bedrock which underlies the Interlake and areas to the east and southeast of Winnipeg, the shale bedrock in portions of southwestern Manitoba and sandstone aquifers such as the fresh water portions of the Winnipeg and Swan River formations.

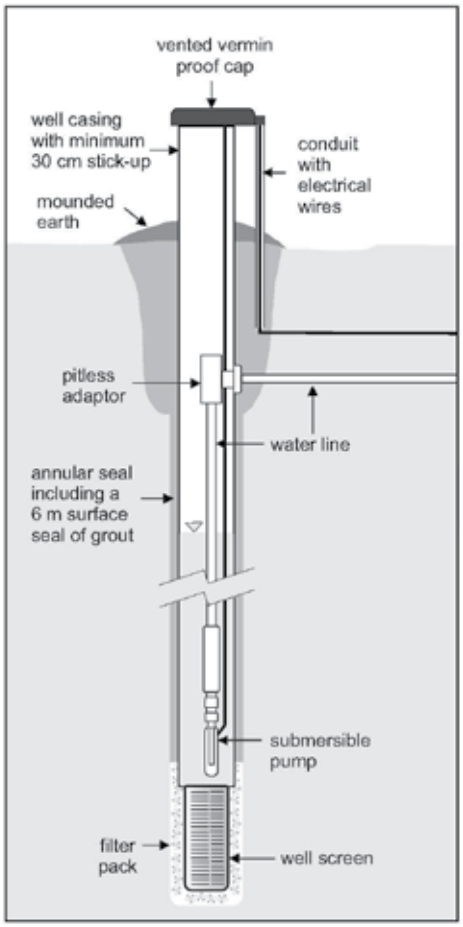
The Carberry Sand Hills form an extensive sand aquifer in south-central Manitoba. This aquifer is a major source of irrigation water supply.

The Carbonate Rock Aquifer of Manitoba's Interlake region. This is the largest aquifer in the province and is formed by limestone and dolomite from 375 to 450 million years old.

Typical Well Construction

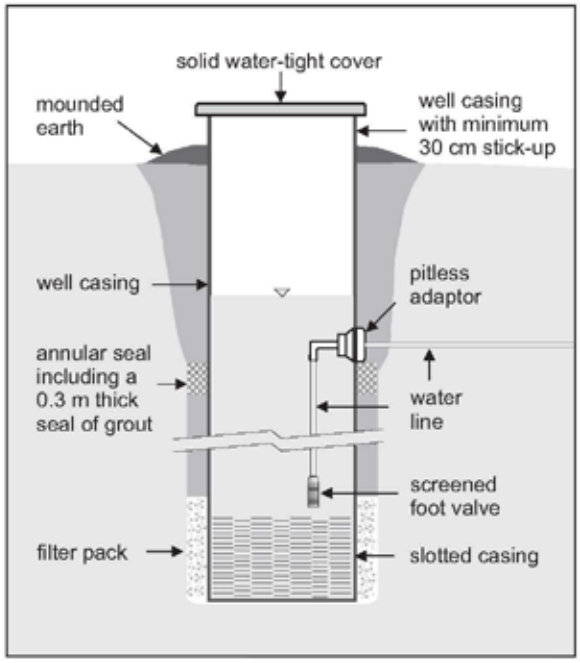
Water wells are constructed of a well casing and intake zone to allow groundwater to flow into the well. The well casing prevents soil from entering the well and accommodates pumping equipment. Below the casing, an intake zone such as a well screen or open hole socket allows water to move from an aquifer into the well.

Small diameter wells typically include two to six inch diameter production wells and six to 12 inch diameter higher capacity production wells. **Large diameter wells** are usually 24 to 30 inches in diameter.



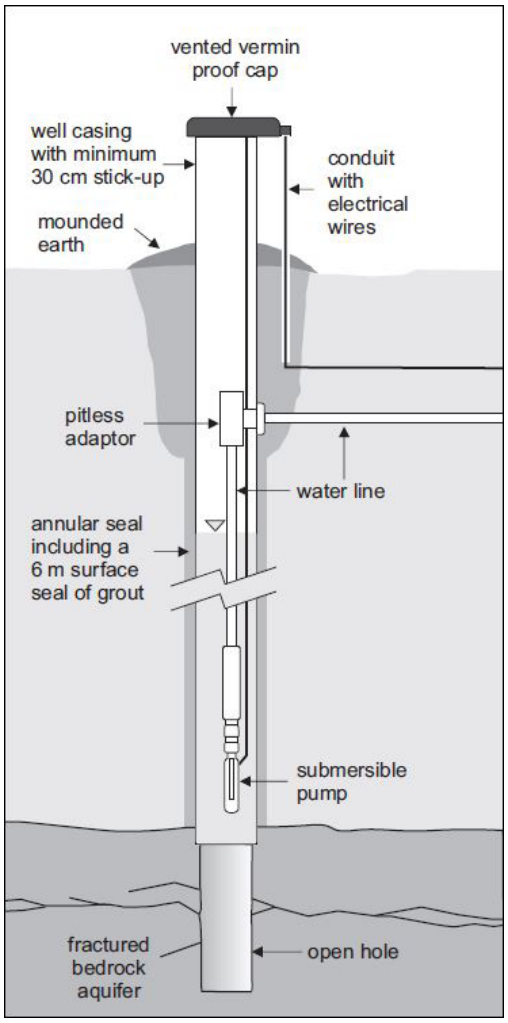
Most small diameter wells completed in sand and gravel are screened wells. A well screen is a section of finely slotted pipe attached to the bottom of a PVC or steel well casing which allows water into the well while excluding the surrounding sand or gravel.

Figure 1: Typical construction for a screened well completed in a sand and gravel aquifer.



Large diameter wells are commonly constructed in shallow sand aquifers or in clay-rich sediments that will produce only very low yields of groundwater. Some older large diameter wells do not have a screen but rely on water entering the well through perforations and joints in culvert sections, or spaces between rock or brick cribbing. Modern wells of this design are bored wells and include a slotted casing or well screen.

Figure 2: Typical construction for a bored (large diameter) well.



Wells drilled into bedrock aquifers (such as limestone or shale) are mostly small diameter wells and not normally screened. In these situations a PVC or steel casing is installed to the top of, or some distance into, the bedrock and the well is deepened until sufficient water is encountered within the bedrock. Wells constructed in this manner are referred to as open hole wells. Wells drilled into bedrock aquifers may pass through more than one water producing zone, separated by low-permeability zones which produce little or no water.

Figure 3: Typical construction for an open hole well in a bedrock aquifer.

Three Steps To Sealing Your Abandoned Well

In some instances the proper sealing of an abandoned well can be accomplished by the landowner using appropriate techniques and materials to fill and seal the well.

It must be emphasized that if well sealing is not done properly, the well may continue to act as an unrecognized environmental liability far into the future. If you are unsure about sealing your abandoned well properly, contact an individual or agency with proper training and experience for advice. If you choose not to seal your own well, you should contract the services of a licensed well drilling contractor or experienced well sealer. These professionals have the materials and equipment to properly seal wells.

STEP 1 - Do Your Homework

Gather information on how the well was constructed including: its depth, diameter, the amount of casing, the type of aquifer and details on whether it was screened or constructed as an open hole below the casing.

Check the Well Construction Report

If you are the original well owner, you may have been provided with a well construction (or well driller's) report when the well was drilled. If not, this information may have been filed with Manitoba Sustainable Development and can be obtained by contacting the Groundwater Management Section under the Contact Us section at the end of this document. The report provides valuable information such as the well depth, size and depth of casing, and type of aquifer and intake zone.

If no report is available, information on the well may be able to be obtained from the driller, the previous land owner or through examination of the well.

Examine the Well

Confirm that any electrical service to the well is disconnected at the source. If a pump or hoses still remain within the well, these must be removed. The well should then be plumbed to determine its depth, the water level and if any obstructions remain in the well. This can be done by tying a weight securely to a measuring tape or rope and carefully lowering it down the well. Record the current well depth and depth to water.

If any equipment such as a pump, debris or an obstruction cannot be removed from the well, and the sealing work is not being done under the authority of a licensed well drilling contractor, a professional engineer or professional geoscientist, then the landowner must retain one of these professionals so that they may determine the method required to properly seal the well.

Removing pumping equipment from an abandoned well prior to sealing.

Compare the measured depth to the expected depth from the information gathered above. If the well is significantly more shallow than expected there may be an obstruction which may have to be removed prior to sealing. This may require the services of a licensed well drilling contractor. Finally, measure the diameter of the well casing. The well depth and diameter will be used in step 2 to estimate the amount of material required to seal the well.

Considerable caution should be exercised if it is necessary to enter a well pit in the process of examining or sealing an abandoned well. The walls of some pits may be unstable and subject to collapse or, in some instances, the air in a pit may have decreased oxygen content or contain toxic gasses.

Well located in a well pit.

A **well pit** means a large diameter pit constructed below the ground surface for the purpose of housing a well. Prior to the mid-80s, it was common practice to construct a well pit around a small diameter well to provide winterized access to the well. This practice is no longer allowed for wells constructed for domestic purposes.

Do not enter a pit if you are uncertain about its stability or air quality. In these instances, a contractor trained and equipped for confined space entry work should be contracted to carry out the inspection.

STEP 2 - Plan and Seal

Sealing an abandoned well requires that key portions of the well are filled with low-permeability materials that prevent the movement of water within the well. Any service lines connected to the well must also be disconnected and sealed in a manner that prevents the movement of water or any other substance within the lines.

If an abandoned well allows the interconnection or mixing of groundwater of distinctively different characteristics within the same aquifer (such within a carbonate rock aquifer) or between different aquifers (such as between the Winnipeg Formation sandstone and an overlying carbonate rock aquifer), low-permeability material must be properly placed within the well to prevent the movement of groundwater within or between these aquifers.

The most commonly used low-permeability sealing materials are bentonite chips and clay. Other portions of the well may be filled using locally available materials such as clean sand and gravel. All materials used must be free of contaminants. Refer to the Hole Size And Volume table below to calculate the volume of material required to fill the well.

Hole Size and Volume Table

(Conversion units from imperial to metric measurements are provided on page 2)

Well Diameter (inches)	Hole Volume (cubic ft/foot of well depth)	Feet filled by one cubic yard of material	Feet filled by 100 lb. (approx. 1 cubic ft) of sand/pea gravel	Feet filled by 50 lb. bag (0.7 cubic ft.) of bentonite chips
2	0.022	1200	45	31.3
4	0.087	310	11.5	7.9
5	0.136	200	7.4	5.1
6	0.196	138	5.1	3.5
8	0.349	77	2.9	2.0
10	0.545	50	1.8	1.3
12	0.785	34	1.3	0.89
18	1.77	15	0.5	0.39
24	3.14	8.6	0.3	0.22
30	4.91	5.5	0.2	0.14
36	7.07	3.8	0.1	0.10

Knowing the well diameter and depth and the method of sealing, the amount of each material required can be estimated. For example, 1 cubic yard of clay will fill 8.6 feet of a 24 inch diameter well.

While filling an abandoned well, check the well depth regularly. Be careful not to leave your measuring device near the bottom of the well for too long – it will invariably become stuck.

Types of Sealing Materials

Bentonite Chips (or pellets) are a processed form of bentonite, which is a clay that swells many times its dry volume when wet. Bentonite chips are generally available in 50 pound (0.7 cubic feet) bags. Only medium to coarse (1/4 to 3/4 inch) sizes should be used. Suppliers can be found under Water Well Equipment and Suppliers in the yellow pages or through an internet search.

Bags of bentonite chips typically contain some dust and fine grained particles. Protective breathing equipment such as a dust mask should be worn when working with bentonite chips. Caution should also be taken to minimize the amount of bentonite dust and fine grained particles introduced into a well during sealing. Dust and fine particles can mix with water in a well which could subsequently impede the downward movement of the sealing material within the well.

Examples of bentonite chips.

Clay is typically used in the sealing of large diameter wells. It should be excavated from below the root zone so that it is free of organic matter. Clay must be carefully shoveled into the abandoned well and tamped continually. The need for tamping limits the use of native clay to the top portion of the well only (approximately the top 12 feet).

The use of **slurry grout** (bentonite and/or cement mixtures with fresh water) to seal abandoned wells should only be considered by an experienced well driller or well sealer. Specialized equipment is required to properly place the slurry grout below the water level.

Although the easiest and most effective way to seal a well is to fill it completely with low-permeability material, the cost may be prohibitive. If a well has a large diameter or is very deep, then the use of low cost filler material such as sand and/or gravel, carefully placed in certain portions of the well with alternating layers of bentonite, is acceptable.

Sand and/or gravel should be clean and free of lumps. Gravel coarser than 1/4 inch in diameter (such as pea gravel) is a better choice of material than sand for sealing small diameter wells as sand tends to settle more slowly. Sand is suitable for sealing large diameter wells. Sand and gravel must be used in combination with either bentonite chips or clay to reduce the potential for vertical movement of groundwater in the abandoned well.

Caution

Although uncommon, sealing your well may cause a temporary silty or cloudy appearance to the water in nearby wells, particularly in areas where wells are located in close proximity and constructed in fractured bedrock aquifers such as limestone. Bacteria may also be introduced into the subsurface when adding sealing materials.

In situations where neighbouring wells may be affected, shock chlorinate (disinfect) the abandoned well by adding approximately 0.2 gallons of household bleach (containing 5.25 per cent sodium hypochlorite) for every 50 gallons of water in the well prior to adding the sealing materials. The chlorine in the bleach will destroy bacteria. Check the label on the bottle to make sure the bleach does not have any kind of additives (ex: scent, detergent).

If neighbouring wells do become silty or cloudy, impacts are generally short-term and can be mitigated by pumping water from the well to waste. A bacterial analysis should be carried out. If bacteria are present, these wells should be disinfected.

Sealing Small Diameter Wells

The biggest challenge with sealing smaller diameter wells is adding the sealing material to the well without having it bridge and create an obstruction. It is best to add material slowly, a shovel-full or less at a time, and pause frequently to allow the materials to settle to the bottom of the well. Remember, you can always add more material to the well but you cannot remove material once it has been added.

Sealing a small diameter water well using bentonite chips.

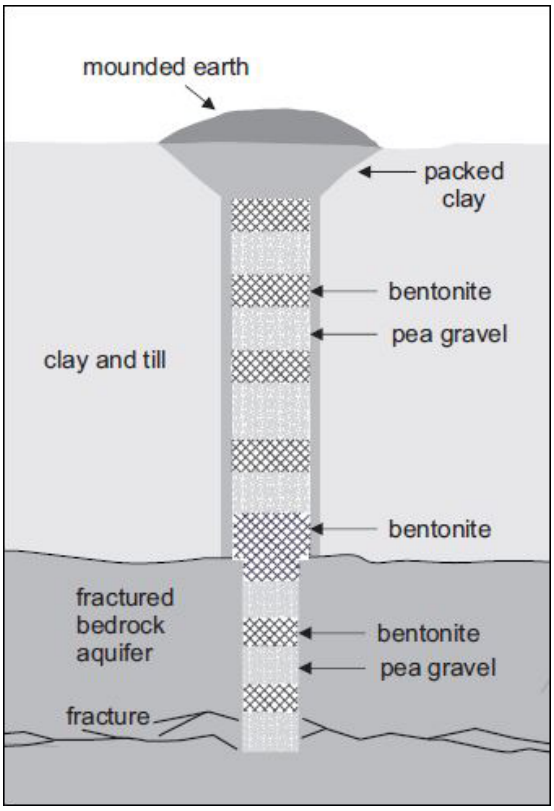
The simplest method of sealing a smaller diameter well is to fill it from the bottom to within about four feet of ground surface with bentonite chips. This is relatively inexpensive for shallow wells up to 6 inches in diameter. For example, an 80 foot deep well that is four inches in diameter could be sealed with about 10 bags of bentonite chips (refer to Hole Size and Volume Table , see page 9). The well casing should also be cut and removed to a depth of about four feet below ground surface and the remainder of the hole filled with clay, tamped in one foot layers. This will help prevent any future excavation from potentially disturbing the sealed well. Finally, the well should be covered with a layer of topsoil, mounded and graded to allow for some settlement and to promote runoff.

If the well is deep (greater than 100 feet) or more than six inches in diameter, a significant amount of material will be required to fill the well and gravel can be used as a filling material. In the case of an open hole well, fill the well slowly with alternating layers of 10 to 15 feet of gravel and three feet of bentonite chips to a depth approximately 10 feet below the bottom of the casing. This creates a series of low-permeability layers which will prevent the vertical movement of water within the well.

After filling the well to approximately 10 feet below the bottom of the casing, slowly add bentonite chips until the level of chips is about 10 feet above the bottom of the casing. This seals the interface between the bottom of the casing and open hole portion of the well.

Resume filling the remainder of the well slowly with alternating layers of 10 to 15 feet of gravel and three feet of bentonite chips to near ground surface.

Next, a surface seal of bentonite chips must be placed in the topmost five feet of casing. The placement of the surface seal will depend on whether any casing is removed. As it is recommended to remove an upper portion of the casing (typically to a depth of four feet below ground surface), in this case the surface seal is placed to a depth of five feet below the top of the cut casing (ex. from four to nine feet below ground surface if the casing will be cut off at four feet below ground). Fill the resulting hole above the cut casing with tamped clay and topsoil at the surface. Sealing an open hole well in this manner is illustrated in Figure 4. If casing is not removed, then the surface seal of bentonite must extend down into the casing a minimum of five feet below ground surface.



Alternating layers of gravel and bentonite are used. It is important to have a bentonite seal at the base of the casing. A surface seal of bentonite must be placed in the topmost five feet of remaining casing.

Figure 4: Sealing a small diameter open hole well.

If sealing a screened well, add alternating layers of 10 to 15 feet of gravel and three feet of bentonite chips throughout the length of the well to near ground surface then complete the abandonment procedure for the surface seal as discussed above.

Sealing Small Diameter Wells in a Well Pit

Only a licensed well drilling contractor or well sealer trained and equipped for confined space entry work should be contracted to carry out the sealing of a well located in a well pit. In these situations, the small diameter well should be sealed as discussed above.

The cribbing forming the large diameter pit must also be removed unless

(a) its method of construction does not allow for removal or allows only partial removal; or

(b) removing or partially removing the cribbing might cause an adjacent structure to be destabilized, damaged or to become a risk to human safety or health.

Following removal, or partial removal of the cribbing, the remaining excavation should be backfilled with materials that have a lower permeability than the surrounding soil. If local clay is used, it should be free of organic matter (ex: topsoil) and compacted by tamping every foot or so. Finally, the excavation should be covered with a layer of topsoil, mounded and graded to allow for some settlement and to promote drainage.

Removing a well pit cribbing using a back hoe.

Restrictions on Sealing Small Diameter Wells

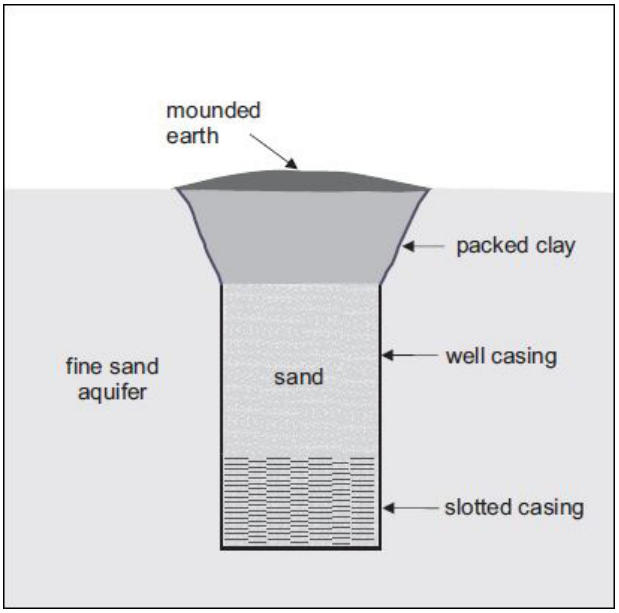
Some water wells are constructed using two inch diameter well casing and screen. Examples include sand points in sand and gravel aquifers and open hole wells in bedrock aquifers. Any well having an inside diameter of two inches or less and a depth greater than 30 feet must be sealed using slurry grout over the full length of the well. This measure reduces the risk of bridging sealing material in these types of wells. Sealing under these conditions requires specialized equipment and should only be undertaken by a licensed well driller or experienced well sealer.

Sealing a two inch diameter well by tremie grouting.

Slurry grout includes suitable mixtures of high-solids bentonite or cement with fresh water that can be forced through a tremie line or other method of grout placement, and which may also include additives to meet certain grouting requirements.

Sealing Large Diameter Wells

It is often not economical to seal a large diameter well in a similar manner as a small diameter well due to the large volume of bentonite chips that would be required. The initial step in sealing a large diameter well should be to carefully fill it with sand and/or gravel to a depth approximately 12 feet below ground surface. The upper 12 feet of casing or cribbing should then be removed, if possible. This will generally involve excavation with a back hoe. If removal of the casing or cribbing to this depth is impractical, then at least the upper four feet should be excavated and removed.



The well should then be filled to slightly above ground surface with local clay. The clay should be shoveled carefully into the hole and compacted by tamping every foot or so. Finally, the well should be covered with a layer of topsoil, mounded and graded to allow for some settlement and to promote drainage. Sealing a large diameter well in this manner is illustrated in Figure 5.

Figure 5: Typical abandonment method for a large diameter well in a shallow sand aquifer.

In some very sandy areas of the province, it may be difficult to obtain clay locally. In these areas, a one foot thick layer of bentonite or compacted clay should be placed at the 12 foot depth and the well filled with sand up to about four feet below ground. A second one foot layer of bentonite chips or compacted clay should be placed at this depth and the rest of the well filled with sand and/or gravel or, if possible, compacted clay. The well should be covered with a layer of topsoil, mounded and graded to allow for some settlement and to promote drainage.

Sealing Flowing Artesian Wells

An abandoned flowing artesian well.

Flowing artesian wells must be sealed by a licensed well drilling contractor. The entire length of the well must be sealed using cement grout or a suitable mixture of sand-cement or bentonite-cement grout.

Contamination Found During Sealing

If, during the sealing of an abandoned well, contamination or suspected contamination of groundwater or soil adjacent to groundwater is found, the person performing the work must immediately:

(a) stop the sealing work; and

(b) report the finding of contamination or suspected contamination by calling Manitoba's emergency response office at 204-944-4888.

The sealing work cannot resume unless authorized by Manitoba Sustainable Development.

Suspected contamination means that groundwater or soil

- emits an odour; or
- is visibly discoloured or otherwise altered in appearance

in such a manner that a reasonable person would believe the groundwater or soil to be contaminated.

The requirements of (a) and (b) above do not apply in respect to the sealing of an environmental well.

An **environmental well** means a monitoring well used for the purpose of obtaining information on soil or groundwater contamination, or for remediation of contaminated groundwater.

STEP 3 - Reporting

During the sealing process keep a written record of how the well was sealed. Once the sealing work is complete, prepare a Well Sealing Report and send it to the Groundwater Management Section. Refer to the Contact Us section at the end of this document for information on how to obtain a blank Well Sealing Report form and where to submit the completed form.

The Groundwater Management Section maintains a province-wide data base of wells constructed in Manitoba. It is important to update these records so that in future, if there are questions about the status of a well, records are available as to which wells have been sealed and the method of sealing.

Manitoba's well sealing report requires the well sealer to provide information on:

- the owner of the well and contact information
- whether a well construction report exists
- location of the well
- type of well and water use
- type of well casing
- measured well depth and diameter
- depth to water in the well
- sealing method and types of materials used

Resources

Manitoba Water Well Association

The association is an industry based group that supports the water well drilling industry. Membership includes licensed well drillers, well sealers, pump installers, manufacturers and suppliers, and groundwater scientists and engineers. Contact by telephone at 204-589-6166 or by email at www.mwwa.ca

To obtain contact information on licensed well drilling contractors in Manitoba refer to Manitoba's public register of licensed water well drilling contractors:

Manitoba Conservation Districts Association

The association provides a leadership role and unified voice between districts, Manitoba Sustainable Development and partners in watershed management for Manitobans. Many districts have active well sealing programs and experience in local conditions. Website: www.mcda.ca.
Contact by telephone a 204-570-0164 or by email at info@mcda.ca

Contact Us

Groundwater Management Section

Questions or concerns regarding the sealing of abandoned water wells can be directed to Groundwater Management by telephone at 204-945-6959 or by email at groundwater@gov.mb.ca

How to obtain a Well Sealing Report form

By phone: 204-945-6959
By email: groundwater@gov.mb.ca

Where to Submit a Well Sealing Report

Submit a completed and signed report by mailing it to:

Well Drilling Liaison Officer
Water Science & Watershed Management Branch
Box 18, 14 Fultz Blvd,
Winnipeg, MB
R3Y 0L6

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