Rules of
Department of Natural Resources
Division 23—Division of Geology and Land Survey
Chapter 4—Monitoring Well Construction Code

Title 10—DEPARTMENT OF NATURAL RESOURCES
Division 23—Division of Geology and Land Survey
Chapter 4—Monitoring Well Construction Code

10 CSR 23-4.010 Definitions

PURPOSE: This rule specifically defines words used in Chapter 4 concerning monitoring wells, otherwise the definitions contained in 10 CSR 23-1.010 apply.

(1) Concrete means a slurry mixture with a ratio of ninety-four pounds (94 lbs.) of cement, equal volumes of dry sand and gravel, and five to six (5–6) gallons of water from a known safe and uncontaminated source. The ratio of sand and gravel to cement may not exceed three parts to one (3:1).

(2) Cone penetrometer means a device used to gather any subsurface information. The device penetrates the ground surface by direct push as a general method of installation.

(3) Direct-push well means a monitoring well that is ten feet (10') or greater in depth that is installed by pushing or hammering drive rods as opposed to drilling or augering. Direct-push wells tend to be smaller in diameter than their conventionally drilled counterparts leading to differences in annular space, casing, and sealing dimensions. Various screening or data collection devices, such as a cone penetrometer or lysimeter, may be used in a direct-push well.

(4) Extraction well is a monitoring well that is ten feet (10') or greater in depth utilized in the remediation of a site. These include, but are not limited to, the following: wells serving pump and treat systems, including multi-well systems, wells to capture a contaminant plume or alter the direction or magnitude of groundwater movement, and other associated wells. Passive and active methane wells that terminate within landfill trash are exempted from these rules but are regulated by the Missouri Solid Waste Management Program. Passive and active methane and leachate extraction wells that are located outside of trash or extend through trash into the underlying bedrock formations are regulated under these rules.

(5) Gas-migration well is a monitoring well that is ten feet (10') or greater in depth and designed for the sampling, detection, and analysis of a gas or vapor that is potentially present or migrating away from a contaminant source.

(6) Injection well is a monitoring well that is ten feet (10') or greater in depth into which fluid or other media is injected, to clean, treat, or prevent contamination of groundwater. All other types of injection wells are defined by the Environmental Protection Agency (EPA); these wells may be regulated by other department programs or state agencies.

(7) Lysimeter is a device used to measure the percolation of water through soils and/or for determining what soluble constituents are in the fluids moving through the soils.

(8) Monitoring well means a well that is ten feet (10') or greater in depth which is constructed during assessment, characterization, and/or remediation of a site to obtain site-specific water quality, contaminant movement, or geologic or hydrologic data. This includes, but is not limited to:
(A) Extraction wells;
(B) Injection wells;
(C) Soil borings;
(D) Direct-push wells;
(E) Piezometers;
(F) Observation wells;
(G) Gas-migration wells; and
(H) Subsurface penetrations associated with field screening devices such as cone penetrometers and lysimeters.

(9) Nested well is a cluster of two (2) or more single riser limited interval monitoring wells installed at different depths in a single borehole with a grout seal separating each screened interval.

(10) Nominal diameter means the term used to describe the standard sizes for casing. Depending on the wall thickness, the inside diameter of the casing may be less than or greater than the number indicated. For example, two-inch (2") nominal Schedule 40 polyvinyl chloride (PVC) casing has a standard outside diameter of 2.375 inches, and an inside diameter of 2.067 inches; two-inch (2") nominal Schedule 80 PVC casing has the same outside diameter, but has an inside diameter of only 1.939 inches.

(11) Observation well means any monitoring well that is ten feet (10') or greater in depth, in which the screen intersects a water table, for the specific purpose of determining either the elevation of the water table or the physical, chemical, biological, or radiological properties of groundwater. Observation wells constructed in the tank pit used as a part of an underground storage tank leak detection system are excluded from this definition.

(12) Open-hole completion means a monitoring well cased through all overburden material and upper water producing zones, completed in bedrock, with no well screen or filter pack.

(13) Piezometer means a monitoring well that is ten feet (10') or greater in depth and used to measure the pressure of a fluid or the degree of compressibility of a substance when subjected to pressure or used to collect water samples for laboratory analysis. It is most commonly a small diameter well used to measure the hydraulic head of groundwater in subsurface water bearing zones. Piezometers used to monitor the geotechnical performance of dams are excluded from the requirements of this rule.

(14) Casing means an industry-standard-sized pipe for the purpose of sealing off a specific zone of geology or contaminants.

(15) Riser pipe means the pipe extending from the well screen into the surface completion.

(16) Shallow monitoring means obtaining groundwater samples from a monitoring well within five feet (5') of ground surface.

(17) Temporary well means a monitoring well used for field screening purposes that is ten feet (10') or greater in depth and is plugged within thirty (30) days of completion.

AUTHORITY: sections 256.603, 256.606, and 256.626, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.603, RSMo 1985, amended 1991; 256.606, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-4.020 Certification and Registration for Monitoring Wells

PURPOSE: This rule sets required standards for certification report form submittal.

(1) A certification report form, supplied by the division, shall be used to report new monitoring well construction, except that no certification report form is required for a temporary well. The certification report form shall be completed and submitted to the division by

the permittee within sixty (60) days after the completion of any well. The certification report form shall be accompanied by the certification fee (see 10 CSR 23-2 for applicable fees). The certification report form shall contain all required information specified thereon.

(2) The certification process involves the review of the certification report form to be sure that the well meets minimum construction requirements. Upon successful completion of review of the certification report form, a certification number will be assigned by the division and sent to the well owner. The issuance of the certification number indicates that the well has met the minimum standards set out in these rules.

(3) A registration report form, supplied by the division, shall be used to report the plugging of a monitoring well or the major repair or alteration of a monitoring well and must be submitted to the division by the permittee within sixty (60) days after completion of such operations. The registration report form shall be accompanied by the registration fee. Temporary monitoring wells are required to be plugged within thirty (30) days after initial completion. The registration report form shall contain all required information specified thereon.

(4) When temporary wells are installed, usually multiple wells per monitoring site are used. All temporary wells per monitoring site may be reported on one (1) registration report form if the wells are plugged the same way. Only one (1) registration fee is required per site. The submittal of this type of registration report form and fee is required within one hundred eighty (180) days of completion of the plugging of temporary wells. The registration report form shall contain all required information specified thereon.

(5) Certification and registration report forms shall include the geographic location of the well. The geographic location shall have a format in degrees, minutes, and seconds for latitude and longitude relative to the North American Datum 1983 (NAD1983) geodetic datum. Location accuracy shall be at least one (1) place after the second's decimal point in this format: latitude 38°59'59.9"N, longitude 94°01'01.0"W.

AUTHORITY: sections 256.606, 256.614, and 256.626, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.606, RSMo 1991; 256.614, RSMo 1985, amended 1991; and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-4.030 Location of Wells

PURPOSE: This rule sets criteria for the locations where monitoring well should be placed.

(1) A monitoring well shall be—

(A) Located, if possible, so proper drainage in the vicinity of the well shall be provided to prevent the accumulation and pooling of surface water within ten feet (10') of the well;

(B) If at all possible, located in areas that do not flood; and

(C) When located in areas of traffic, an above-ground surface completion must either be protected by protective posts to prevent damage or the well must be completed as a surface flush mount as described in 10 CSR 23-4.060(10)(B).

AUTHORITY: sections 256.606 and 256.626, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-4.040 Drilling Methods for Monitoring Wells

(Rescinded July 30, 2011)

AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Rescinded: Filed Nov. 18, 2010, effective July 30, 2011.

10 CSR 23-4.050 General Protection of Groundwater Quality and Resources

PURPOSE: This rule prevents the use of monitoring wells for any purpose other than the purpose for which they were designed and allows certain modifications to the application of these rules.

(1) Monitoring wells shall not be converted to any other type of well unless approved in advance by the division.

(2) When strict application of these rules presents practical difficulties or unusual hardships, the division, on a case-by-case basis, may modify the application of these rules consistent with the general purpose and intent of these rules and the law. The division may then impose certain conditions as are necessary, in the opinion of the division, to protect the groundwater of the state and health, safety, and general well-being of persons using, or potential users, of the groundwater (see 10 CSR 23-1.040 Modification by the Division for procedures concerning variances).

(3) It is the obligation and responsibility of the monitoring well installation contractor to ensure that the monitoring well is constructed according to these rules and that the annular space, if one exists, is sealed. The monitoring well must be properly plugged or repaired when the annular space is no longer sealed or the well is no longer performing its intended function.

(4) When drilling water is needed, it must be of potable quality.

AUTHORITY: sections 256.606 and 256.626, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-4.060 Construction Standards for Monitoring Wells

PURPOSE: This rule describes the minimum standards for a properly constructed monitoring well.

(1) Riser Pipe and Screen Material.

(A) Chemical Compatibility. If used in a monitoring well, the riser pipe and screen material selected must resist chemical corrosion for the life of the proposed monitoring program. Well construction material must not alter the results of any groundwater analysis.

(B) Types of Riser Pipe and Screen Materials. The types of riser pipe and screen materials are divided into four (4) categories—

1. Thermoplastic materials, including polyvinyl chloride (PVC) and acrylonitrilebutadiene-styrene (ABS);

2. Metallic materials, including carbon steel, low-carbon steel, galvanized steel, and stainless steel (304 and 316);

3. Fluoropolymer materials, including polytetrafluoroethylene (PTFE), tetrafluoroethylene (TFE), fluorinated ethylene propylene (FEP), perfluoroalkoxy (PFA), polyvinylidene fluoride (PVDF), and polamides (such as Nylon); and

4. Other types of riser pipe and screen may be used if approval is obtained in advance from the division.

5. Industry standard mesh material or pre-manufactured slotted screen is the only approved material for screening; hand-cut solid wall pipe is not allowed.

(C) All thermoplastic and fluoropolymer riser pipe must meet the requirements set out in 10 CSR 23-3.070(1)(D). Thermoplastic and fluoropolymer riser pipe used in monitoring well construction must meet the following minimum standards:

1. The minimum nominal diameter for riser pipe and screen installed in monitoring wells is two inches (2") except that direct-push wells may have riser pipe and screen with a minimum nominal diameter of three-quarters of an inch (3/4"). Monitoring wells that are greater than one hundred feet (100') in depth must use Schedule 80 pipe;

2. The wall thickness of the riser pipe or screen must not be less than the Schedule 40 for the nominal size riser pipe or screen selected, except for gas-migration wells utilizing a soil gas implant and tubing;

3. Thermoplastic riser pipe and screen must be joined by a mechanical type joint. The joint must be watertight. If O-rings or fluoropolymer tape is used, they must be of inert materials which will not adversely affect the function of the monitoring well; and

4. Riser pipe and screen must be new and free from contaminants that would affect the quality of the groundwater or would adversely affect the monitoring.

(D) All metallic riser pipe must meet the following minimum standards:

1. The minimum nominal diameter for riser pipe and screen installed in monitoring wells is two inches (2") except that direct-push wells may have riser pipe and screen with a minimum nominal diameter of three-quarters of an inch (3/4");

2. The wall thickness for carbon, low-carbon, and galvanized steel must not be less than Schedule 40. The wall thickness of stainless 304 and 316 must not be less than Schedule 5. The joint wall thickness must not be less than Schedule 40, with exception for soil gas-monitoring wells utilizing a soil gas implant and tubing;

3. Metallic riser pipe must be joined by a watertight mechanical joint or welded. The well should be checked for the presence of explosive gases before welding begins; and

4. Riser pipe and screen material must be new and free from contaminants which would affect the quality of the groundwater or would adversely affect the monitoring.

(2) Casing Material. If geologic conditions require the installation of casing material, the following requirements must be met:

(A) Chemical Compatibility. The casing and casing joints selected must resist chemical corrosion for the life of the proposed monitoring program. The joining of two (2) dissimilar metals is not allowed;

(B) Types of Casing Materials. The types of casing materials are divided into four (4) categories—

1. Thermoplastic materials, including polyvinyl chloride (PVC) and acrylonitrilebutadiene-styrene (ABS);

2. Fluoropolymer materials, including polytetrafluoroethylene (PTFE), tetrafluoroethylene (TFE), fluorinated ethylene propylene (FEP), perfluoroalkoxy (PFA), and polyvinylidene fluoride (PVDF). All thermoplastic and fluoropolymer casing material must meet the requirements set out in 10 CSR 23-3.070(1)(D);

3. Metallic materials, including carbon steel, low-carbon steel, galvanized steel, and stainless steel (304 and 316). Steel casing material must meet the requirements set out in 10 CSR 23-3.030(1); and

4. Other types of casing may be used if approval is obtained in advance from the division;

(C) Casing Diameter. The inside diameter of the casing must be a minimum of four inches (4") larger than the nominal outside diameter of the riser pipe being installed;

(D) Casing Borehole Diameter. When installing casing, the borehole for casing must be a minimum of four inches (4") larger in diameter than the nominal outside diameter of the casing being used; and

(E) Casing Grouting Requirements. If casing is required to be installed for a monitoring well completion, the casing must be grouted full-length utilizing high solids bentonite slurry or cement slurry as approved under 10 CSR 23-4.060(9). The casing must be grouted full-length utilizing the tremie method or one (1) of the pressure grouting methods set out in 10 CSR 23-3.030(3). If the casing cannot be sealed to prevent surface contamination from entering the well, the annular seal for the riser must extend from a point at least two feet (2') below the base of the casing up to the base of the surface completion.

(3) Monitoring Well Borehole Preparation.

(A) All boreholes constructed in the installation of monitoring wells must be clean and free of obstructions.

(B) Boreholes constructed for the installation of gas-migration type wells utilizing soil vapor implants must be a minimum of one inch (1") in diameter.

(C) Boreholes constructed for direct-push wells must be a minimum of three and one-quarter inches (3.25") in diameter.

(D) The diameter of a borehole constructed for the installation of other types of monitoring wells must be at least four inches (4") larger than the outside diameter of the riser pipe and screen. Field testing methods such as gas-migration monitoring and direct-push wells are exempt from these borehole standards if properly plugged within thirty (30) days of completion. When constructing a monitoring well that utilizes hollow-stem augers to bedrock, then rock drilling to total depth, the following exceptions apply:

1. When using an industry-standard-size six and one-quarter-inch (6 1/4") internal diameter hollow stem auger to drill the unconsolidated material portion of the well, the bedrock portion of the well must be drilled with a bit which creates a hole that is at least six inches (6") in diameter for a well constructed using a nominal two-inch (2") diameter riser pipe; and

2. When using an industry standard size eight and one-quarter-inch (8 1/4") internal diameter hollow stem auger to drill the unconsolidated material portion of the well, the bedrock portion of the well must be drilled with a bit which creates a hole that is at least eight inches (8") in diameter for a well constructed using a nominal four-inch (4") diameter riser pipe.

(4) Open-Hole Completions. Open-hole completed monitoring wells are allowed only upon written approval in advance from the division. In all cases, the open-hole portion of the well must be in competent, consolidated bedrock, and the casing must extend from the surface to the minimum total depth and minimum depth into bedrock required, under 10 CSR 23-3.090 or 10 CSR 23-3.100 for a domestic well at that location. The casing must be grouted full-length using methods and materials as required under 10 CSR 23-4.060(2)(E).

(5) Installation of Well Screen and Riser Assembly. The well screen and riser assembly must be centered in the borehole before the installation of the filter pack, unless a prepack filter is used. The riser pipe must extend from the well screen into the surface completion. In a flood prone area, the riser

pipe must be at least two feet (2') above the finished surface grade and be equipped with a watertight cap. Wells installed in traffic ways may be flush mounted (subsection (11)(B)). Unless they are direct-push wells, monitoring wells in excess of fifty feet (50') in depth must have centralizers to ensure the well string is properly plumbed. A centralizer must be placed at the base of the well screen and on the riser at the top of the filter pack. The specific placement intervals for additional centralizers on the riser should be based on site-specific conditions and ensure the placement of the filter pack, bentonite seal, and annular seal will not be hindered. The use of centralizers in wells constructed through hollow stem augers is not required.

(6) Installation of Primary Filter Pack. After the well screen and riser assembly are installed in the well, the filter pack materials must be emplaced.

(A) Artificially Constructed Filter Pack Placement. The filter pack material must be placed evenly around the well screen via a tremie pipe. The tremie pipe must be placed near the bottom of the well screen and the filter pack material poured into the tremie pipe while the pipe is slowly removed. A weighted measuring device must be used to ensure that the filter pack is properly installed to the desired depth. All volumes of filter pack material anticipated for construction must be calculated prior to placement. The filter pack material must fill from the bottom of the borehole to within one to five feet (1'–5') above the well screen. If the well is drilled utilizing the hollow stem auger method, the filter pack material may be poured through the hollow stem auger as it is removed from the borehole. If the screen is set more than twenty-five feet (25') into the saturated zone or placed into drilling fluid other than clean water or air, the filter pack placement must be via tremie, unless hollow stem augers are used. Prepacked filter pack assemblies and prepack seals which are hydrated may be used.

(B) Naturally Developed Filter Pack Placement. Allowing the existing geologic material to collapse around the well screen is an acceptable method of filter pack emplacement in only a few geologic conditions. Naturally developed filter packs are only allowable when they can be developed properly.

(C) When installing a monitoring well for shallow monitoring, the primary filter pack must extend a minimum of six inches (6") above the top of the well screen.

(D) Soil vapor implants are required to have a minimum primary filter pack of six inches (6") above and below each implant.

(7) The installation of a secondary filter pack is required unless non-slurry bentonite is used as a bentonite seal or annular seal. The purpose of a secondary filter pack, which is placed directly on top of the primary filter pack, is to ensure that annular seal slurry grouts do not infiltrate into the primary filter pack. The secondary filter pack must extend from one foot to two feet (1'–2') above the primary filter pack and shall consist of one foot to two feet (1'–2') of clean fine sand.

(8) The installation of a bentonite seal is required if the annular seal is composed of slurry grout material and a secondary filter pack is not used. The purpose of the bentonite seal is to keep the slurry grout which is emplaced above from mixing with the primary and secondary filter pack materials. If required, the bentonite seal must be a minimum of two feet (2') thick.

(A) Placement of the Bentonite Seal in the Saturated Zone. When the bentonite seal is to be emplaced in the saturated zone, only chipped or pelletized bentonite that is designed to fall through standing water before it hydrates may be used. To avoid flash swelling and bridging, the fine bentonite material, which may develop during transport, must not be introduced into the well bore. A weighted measuring device must be utilized to ensure the bentonite chips are evenly placed around the riser pipe.

(B) Placement of the Bentonite Seal in the Unsaturated Zone. When the top of the secondary filter pack is in the unsaturated zone, the use of chipped, pelletized, or granular bentonite is permitted only if the bentonite is hydrated in place with potable water. Bentonite slurry may be used and must fill the annular space from the top of the secondary filter pack to the surface seal. The bentonite slurry must be emplaced through a tremie pipe. If the total depth of the slurry being placed exceeds five feet (5'), a side discharge is required so as to limit disruption of the filter packs.

(C) Nested well construction will be considered on a case-by-case basis. Pre-approval by the division is required, via the variance process, before construction begins, except that gas-migration wells constructed using soil vapor implants do not require a variance as long as they meet the requirements of subsection (6)(D) of this rule, have a minimum bentonite seal of one foot (1') between each primary filter pack and a minimum of one and one-half feet (1.5') of bentonite seal between the uppermost primary filter pack and that base of the surface completion.

(9) Installation of the Annular Seal. The monitoring well environment may contain many chemicals or organic compounds that could affect the sealing capabilities of various kinds of grout. The type of grout used must be able to function to one hundred percent (100%) of its designed sealing capabilities until the well is properly plugged. The type of grout used must not influence, contaminate, or hinder the use of the monitoring well for its designed purpose. The annular seal must extend from the secondary filter pack or bentonite seal to the base of the surface completion. The combined annular seal and bentonite seal (if a bentonite seal is utilized) must be at least two feet (2') thick unless monitoring for shallow contaminants. Monitoring wells constructed for shallow monitoring, as defined in 10 CSR 23-4.010, must have a minimum combined annular seal and bentonite seal (if a bentonite seal is utilized) of at least one foot (1'). The following grout types are permitted in monitoring wells:

(A) Bentonite Slurry-Grout. High solids sodium bentonite slurry, at least twenty to thirty percent (20%–30%) by weight solids, must be tremie grouted from the bottom to the top of the annular space in one (1) continual operation;

(B) Nonslurry Bentonite. Sodium bentonite comes in many shapes and sizes. Nonslurry bentonite includes chips, pellets, granules, and powdered varieties. Chipped or pelletized varieties that are designed to fall through standing water may be used when sealing the annulus of a well that is below the saturated zone. Granulated and powdered bentonite must never be poured through standing water because they will flash swell and bridge off before it gets to the bottom of the annular space. Bentonite chips or pellets may be used to seal portions of the annular space that are in the unsaturated zone. Granulated and powdered varieties are not permitted to be used in the unsaturated zone unless they are used to create a slurry, due to their flash swelling properties which would prevent hydration of the complete column of bentonite. When using bentonite chips or pellets in the unsaturated zone, it must be hydrated after each three feet (3') interval has been emplaced. To properly hydrate the bentonite, a minimum of three (3) times as much water as bentonite must be used. Water used must be of potable quality;

(C) Cement Slurry. Neat cement slurry is a mixture of one (1) ninety-four pound (94 lb.) bag of Portland Type I cement and six (6) gallons of clean water. Five (5) general types of cement are produced: Type I, for general use; Type II, for moderate sulfate resistance or moderate heat of hydration; Type III, for hi-early strength; Type IV, for low heat of

hydration; and Type V, for high sulfate resistance. Following are some problems associated with cement slurry grout usage:

1. Type III cement used to produce a hi-early strength and additives that are used to speed up set times of cement slurries cause higher than normal heat of hydration temperatures. These can only be used in association with metallic casings or riser pipes with prior approval by the division;

2. Cement slurry may only be used if additives are incorporated to minimize shrinkage.

A. Bentonite is the most commonly used additive to prevent shrinkage of cement slurries. The powdered bentonite must be thoroughly mixed with the water before it is added to the cement. Powdered bentonite from two percent to six percent (2%–6%) by weight must be added. The added bentonite improves the workability of the slurry, reduces shrinkage, and reduces the heat of hydration. This additive does reduce the strength of the seal but is adequate for annular sealing. For each percent of bentonite by weight added to a ninety-four pound (94 lb.) bag of Type I cement an additional six-tenths (.6) gallon of water must be added. The following table sets out the amount of bentonite and water needed to be a ninety-four pound (94 lb.) bag of Type I cement to get from one to six percent (1%–6%) cement-bentonite mixture.

CEMENT/BENTONITE SLURRY CALCULATIONS

Product	% bentonite added/ sk cement	total water requirement (gallons)
Type I Portland 1 sack=94 lbs.		
	1% bentonite=.94 lbs. bentonite/sk of cement	5.8 to 6.6
	2% bentonite=1.9 lbs. bentonite/sk of cement	6.4 to 7.2
	3% bentonite=2.8 lbs. bentonite/sk of cement	7 to 7.8
	4% bentonite=3.8 lbs. bentonite/sk of cement	7.6 to 8.4
	5% bentonite=4.7 lbs. bentonite/sk of cement	8.2 to 9
	6% bentonite=5.7 lbs. bentonite/sk of cement	8.8 to 9.6

B. Other shrinkage reducing additives must be approved in advance by the division;

3. The water used to mix cement slurry must be of potable quality; and

4. Cement slurry must be emplaced in the annulus via a tremie pipe placed to the bottom of the annular space. The tremie pipe must have a side discharge which directs the grout away from the bentonite seal, reducing the potential for infiltration. Care must be taken so as not to dislodge the bentonite seal that is above the primary filter pack. The grouting of the annular space must be completed in one (1) continual operation, lifting the tremie pipe as the space fills. If determined necessary by the division, a staged grouting procedure will be approved;

(D) Other types of grout may be used when necessary and for good cause if prior approval by the division is granted; and

(E) When zones of high grout loss are anticipated or experienced, contact the division for alternative methods to seal the annulus.

(10) Well Protection. Surface protection on all monitoring wells is required to deter unauthorized entry, prevent surface water from entering the annular space, and protect the well from accidental damage caused by collision from vehicles or heavy equipment. The two (2) types of surface completion designs are above-ground completions and flush-mount completions.

(A) Above-Ground Completions. Above-ground completions must meet the following standards:

1. The protective casing must extend from at least one and one-half feet (1 1/2') above the finished grade of the ground surface to a point at least two feet (2') below the finished grade, except as stated in subsection (11)(B) of this rule for flush-mount completions. The riser pipe must be at least two inches (2") below the top of the above-ground completion. The above-ground completion must be placed in a hole that is at least eight inches (8") in diameter larger than the above-ground completion size. Care must be taken so that the shape of this hole, when filled with concrete, does not encourage frost heaving. The protective casing must be centered in this hole and concrete poured around the casing to secure it. Cement or bentonite slurry is not allowed. All water must be removed from the enlarged hole before concrete is added. The surface of the concrete must slope away from the protective casing so that pooling of surface water does not occur;

2. A weep hole or alternate method must be employed to ensure water does not accumulate inside the protective casing to the point that the top of the riser is submerged, except on temporary wells that are plugged within forty-eight (48) hours of initial installation;

3. A locking well cap and a suitable lock must be attached to the top of the above-ground completion. The riser pipe must be sealed with a watertight cap and must extend at least two feet (2') above the finished surface grade in flood prone areas. Temporary monitoring wells are exempt from this paragraph if they are plugged within forty-eight (48) hours of initial installation; and

4. All monitoring wells must be uniquely identified so as to distinguish one (1) well from another on the monitoring site and on the monitoring well certification form.

(B) Flush-Mount Well Completions. Flush-mount completions must meet the following standards. In a flush-to-ground completion, the flush-mount assembly is installed around the riser pipe that has been cut off below grade. The flush-mount assembly must be at least eight inches (8") in length and have a tamper-resistant watertight lid. The riser pipe must be sealed with a watertight cap. The flush-mount surface completion must be set into a hole that is at least eight inches (8") in diameter larger than the diameter of the flush-mount assembly and set in concrete. This completion must withstand all stresses due to traffic and to freeze thaw processes. If the monitoring well is being placed through asphalt or concrete, a hole that is a least four inches (4") in diameter larger than the diameter of the flush-mount assembly must be constructed. The flush mount must then be set in concrete. Cement or bentonite slurry is not allowed.

(11) Wells must be adequate in size and design for the intended use. Wells should be properly developed in order to allow the collection of representative samples from the horizon being monitored.

(12) Alternate monitoring well construction procedures, methods, or technologies will be considered on a case-by-case basis. Written approval in advance by the division is required.

(13) The installation and use of sampling, development, maintenance, or testing devices and equipment in monitoring wells is not regulated except that the installation of a pumping system in wells used for remediation or clean-up must be performed by a nonrestricted pump installation contractor.

AUTHORITY: sections 256.606 and 256.626, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

10 CSR 23-4.070 Monitoring Well Development
(Rescinded July 30, 2011)

AUTHORITY: sections 256.606, 256.626, and 256.637, RSMo 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Rescinded: Filed Nov. 18, 2010, effective July 30, 2011.

10 CSR 23-4.080 Plugging of Monitoring Wells

PURPOSE: This rule sets standards for the plugging of monitoring wells.

(1) A monitoring well that is abandoned as defined in 10 CSR 23-1.010(1) must be plugged. If a monitoring well has been determined to present a threat to groundwater, or determined to be in such a state of disrepair that the well cannot be used for its intended purpose, the division may order that the well be permanently plugged.

(2) When plugging a monitoring well, the following minimum requirements shall be met:

(A) All pumps, sampling equipment, debris, or other substances must be removed;

(B) All surface completion and permanent casing, riser pipe, and well screen must be removed from the borehole. If, when removing the casing, the borehole begins to collapse, grout must be simultaneously emplaced while the casing is removed to ensure a proper seal;

(C) The well must be filled from bottom to top with grout. 10 CSR 23-4.060(9) sets standards for grout types that may be used when plugging monitoring wells;

(D) If bentonite grout is used, after the grout is fully cured, check for settlement and top off if necessary. Fill with soil and compact the upper two feet (2') of hole or pave. The purpose of the compacted soil is to ensure that dehydration of the bentonite grout does not occur over time. If cement-slurry grout is used, fill the upper two feet (2') with soil or pave; and

(E) A monitoring well that is less than twenty-four feet (24') in total depth may be completely excavated as opposed to being plugged with grout. If the remaining hole is ten feet (10') or more in depth, it must be filled with clean replacement material that is compactable to a permeability less than, or equal to, the minimum permeability of the encompassing native materials. A monitoring well installation contractor must be on site at all times during the excavation and filling operations.

(3) The plugging or complete excavation of a monitoring well must be reported on a registration report form supplied by the division.

(4) Monitoring wells must be plugged by a nonrestricted monitoring well installation contractor.

(5) Temporary monitoring wells ten feet (10') or greater in depth must be plugged by removing any temporary pipe and filling the well from total depth to three feet (3') from the surface with approved grout, with the remainder of the well filled with compacted uncontaminated native material or grout.

AUTHORITY: sections 256.606, 256.615, and 256.623, RSMo 2000. Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Nov. 18, 2010, effective July 30, 2011.*

**Original authority: 256.606, RSMo 1991; 256.615, RSMo 1991; and 256.623, RSMo 1985, amended 1991.*