ENVIRONMENTAL PROTECTION AGENCY

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ADMINISTRATIVE PROCEDURE #11

TITLE: Monitor Well Design Criteria

PURPOSE: To ensure consistency and integrity of groundwater samples.

BACKGROUND: It should be recognized that laboratory studies of the effects of well casing materials on either inorganic or organic dissolved constituents in groundwater are still relatively inconclusive and incomplete. Well casing and screen material selection should be made carefully to prevent serious errors in analytical results collected for groundwater quality monitoring. The Agency discourages the practice of selecting well construction materials based on historical preference.

The Agency will make the final recommendation regarding the appropriate well casing and screening materials on a site-specific basis. Furthermore, the owner or operator may need to conduct site-specific comparative performance studies to justify their preference for a particular well casing or screening material.

DISCUSSION: At a minimum, a properly designed monitor well ~~design~~ satisfies the following six objectives:

1. Provides access from the surface of the ground to a specified interval in the subsurface.
2. Is constructed of materials with sufficient strength to prevent casing collapse.
3. Permits groundwater level measurements and groundwater sampling.
4. Prevents hydraulic communication between zones within the subsurface.
5. Is constructed in a manner which does not adversely impact subsurface water quality and/or sample integrity.
6. Meets Illinois Department of Public Health standards as set forth in 77 IAC 920.170 Monitor Wells.

PROCEDURE:

I. Drilling Methods and Fluids

The drilling method introduces the least possible foreign material into the borehole, produces the least possible disturbance to the subsurface and permits the proper construction of the well.

II. Casing and Screen Material Selection

A. Casing and screen materials must maintain their structural integrity and durability in the environment in which they are used over their expected operating life.

1. PVC well casing and screen materials must carry either the "NSF wc" (well casing) or "NSF pw" (potable water) specifications.

2. Stainless steel well casing and screen materials must be Type 304 or 316.

B. Casing and screen materials must be resistant to chemical and microbiological corrosion and degradation in contaminated and uncontaminated groundwaters.

1. Stainless steel is not recommended in corrosive environments.

2. PVC is not recommended in investigations involving high concentrations of organics.

C. Casing and screen materials must not interfere with groundwater sample integrity with respect to the analytes of concern, as a result of their sorbing, desorbing, or leaching of analytes.

1. PVC should not be used when monitoring low molecular weight ketones, aldehydes, amines and chlorinated alkenes and alkanes. However, PVC may be used when it can be shown that the degree to which the material may sorb/desorb the constituent of concern is at an extremely low level (i.e., nanograms).

2. PTFE tends to be more sorptive of organics than PVC and should not be used to monitor hydrophobic organics ($\log K_{ow} \geq -2$).

D. Any material leaching from the casing or screen must not be an analyte of interest, or interfere in the analysis of an analyte of interest. Stainless steel has the potential to leach or sorb the following metals: Nickel, Copper, Chromium, Cadmium, Arsenic, and Lead.

E. Casing materials should be chosen with a knowledge of existing and anticipated groundwater chemistry. The choice of appropriate well casing materials should be contingent upon preliminary water quality analyses. When water quality is unknown, it is prudent initially to use conservative materials (i.e. the most chemically inert).

III. Casing and Screen Coupling

A. Threaded, flush-joint casing is used when joining PVC, SS 304 or SS 316, and PTFE casing and screen material. The male threads (except on PTFE casing materials) are wrapped with fluoropolymer tape prior to joining sections to improve the watertightness of the joint. Also, an O-ring may be added for extra security on casing materials. When joining casing or screen material, no adhesives, solvents or grease are used.

B. A composite well design may be utilized in situations where considerable cost savings can be achieved by the use of noninert casing material (i.e., PVC) that does not come in contact with groundwater being sampled. The inert/noninert material interface is located approximately two (2) feet above the highest fluctuation of the potentiometric surface. In a composite well design, dissimilar metallic components are not used unless an electrically-isolating design is incorporated (i.e., a dielectric coupling).

IV. Casing and Screen Diameter

Casing and screen materials have a minimum inside diameter of two (2) inches and not more than four (4) inches (does not apply to recovery wells). If a diameter larger than four (4) inches is desired (e.g. to improve sample integrity), then substantive justification must be provided before installation.

V. Casing and Screen Cleaning

A. Casing and screen materials are decontaminated prior to installation to remove any coatings or manufacturing residues. Decontamination includes a wash with a mild non-phosphate detergent/potable water solution and a rinse with potable water. Hot pressurized water or steam cleaning is used to remove organic solvents, oils, or lubricants from casing and screens composed of materials other than plastic. At sites where volatile organic contaminants may be monitored, the cleaning of casing and screen materials includes a final rinse with deionized water.

B. If the casing or screen material has been sterilized by the manufacturer, proof of sterilization (e.g. NSF certification) is provided with the Agency Well Construction Report.

VI. Well Intake Design

A. Screens are kept to a minimum length appropriate for intercepting a contaminant plume. The screen length must not exceed ten (10) feet and not be less than five (5) feet. Any deviation from these lengths shall require initial Agency approval.

B. Screen slot size is selected to retain from 90% to 100% of the filter pack material in artificially filter packed wells, or from 50% to 100% of the formation material in naturally packed wells, unless it can be demonstrated that turbidity-free water (i.e., <5 NTUs) can be obtained using a larger slot size.

C. Screens must be continuous slot wire wound. Screens that are field slotted are unacceptable.

VII. Filter Pack Material

A. Filter pack material is chemically inert, (i.e., flint sand or silica) well rounded and of uniform grain size. The filter pack around the screen filters out sediments and is 2 1/2 - 3 times larger than the 50% grain size of the zone being monitored. However, in sand and gravel deposits where cave-in occurs, the natural sand and gravel is acceptable.

B. A filter cloth or sock around the screen is not recommended. It may inhibit well development, in-situ field permeability and may, clog the well over time.

C. Filter pack material must be installed in a manner that prevents bridging and particle-size segregation. Filter pack material installed below the potentiometric surface should generally be tremied into the annular space.

D. In artifically filter-packed wells at least two inches of filter pack is installed between the well screen and the borehole wall. The filter pack extends no greater than two feet above the top of the well screen.

VIII. Annular Sealants

A. Annular sealant materials are chemically inert with respect to the highest anticipated concentration of chemical constituents expected in the groundwater at the facility.

B. The sealing material above the filter pack prevents the migration of fluids from the surface and between subsurface units. A minimum of two feet of sealant material such as raw (i.e., >10% solids) bentonite is placed immediately overlying the filter pack or the protective fine sand layer if a protective layer is installed.

C. Granular bentonite, bentonite pellets, and bentonite chips are placed around the casing by means of prehydrating at the surface and pumping through a tremie pipe for deep wells (i.e., greater than approximately 30 feet deep below surface), or by dropping them directly down the annulus in shallow wells (i.e., less than approximately 30 feet deep). In shallow monitor wells, a tamping device should be used to prevent bridging. When installing annular sealants in slurry form (e.g., cement grout, bentonite slurry) by the side-discharge tremie/pump (i.e., from the bottom up) method, special care is taken so as not to force the slurry into the filter pack.

D. The bentonite seal is allowed to completely hydrate, set, or cure in conformance with the manufacturer's specifications prior to installing the grout seal in the annular space. When the annular sealant above the bentonite seal is installed in the unsaturated zone, the Agency recommends that neat cement or shrinkage-compensated neat cement mixtures be used for the annular sealant. Bentonite mixed with neat cement does not compensate for shrinkage. Use of bentonite as an annular sealant in the unsaturated zone is not recommended unless the bentonite is fully hydrated at the surface.

E. No quick setting cements or bentonite slurries which contain additives that would affect sample integrity may be used.

IX. Surface Completions

A. Monitor wells are completed at the surface as either above-ground completions or as flush-to-ground completions. The purpose of both types of completions is to prevent infiltration of surface runoff into the well annulus and to prevent accidental damage to or unlawful entry into of the well.

B. A monitor well surface seal is installed on top of the grout seal and extends vertically up the well annulus between the well casing and the borehole to the land surface. Where appropriate, the lower end of the surface seal extends at least one foot below the frost line to prevent damage from frost heaving. This seal is tapered to allow precipitation to drain away from the well and to prevent surface liquids from migrating into the annulus.

C. A locking protective casing is installed around the well casing to prevent damage or unlawful entry. The protective casing is anchored below the frost line (where applicable) into the surface seal and extends at least 18 inches above groundsurface. A vent hole toward the top of the protective casing is recommended to allow the escape of any potentially explosive gases that may accumulate within the well and to allow water levels within the well to adjust to barometric pressure changes. Also, a drain hole is installed in the protective casing to prevent water from accumulating and, in freezing climates, freezing around the well casing.

D. A suitable cap must be placed on the well casing to prevent the entry of any foreign material. A vent hole in the pipe towards the top of the well casing is mandatory.

E. Wells located in high traffic areas must be provided with additional protection. Concrete or steel bumpers must be installed within three (3) or four (4) feet around the edge of the concrete apron. Bumperguards should be painted orange or fitted with reflectors to enhance visibility and reduce the possibility of vehicular damage.

F. The use of flush-to-ground surface completions should be avoided. This design increases the potential for surface water infiltration into the well. In cases where flush-to-ground well completions are unavoidable, such as active roadways or gasoline service stations, a protective structure such as a utility vault or meter box is installed around the well casing. The flush-to-ground protective structure is also outfitted with a steel lid or manhole cover that has a rubber seal or gasket, that ensures the bond between the cement surface seal and the protective structure is watertight.

G. See attached well construction diagram.

X. Well Surveying and Identification

A The location of all wells are surveyed to determine their location as well as their distances from the units being monitored and their distances from each other.

B. The height of the reference survey datum is permanently marked and visable upon opening the top of the inner well casing. This point is determined within ± 0.01 foot in relation to mean sea level, which in turn is established by reference to an established National Geodetic Vertical Datum. The reference mark on top of the inner well casing should be resurveyed at least once every 5 years.

C. Wells are identified by a monitor point number. The well identification number is clearly and permanently marked on the outside of the protective cover. See attached Agency suggested procedures for designating monitor point numbers.

XI. Other

All water used in the drilling, cleaning, and construction process shall be obtained from a source that is free of contaminants and will not result in the contamination of the monitor well or the groundwater.

PROGRAMS AFFECTED: Permits
Compliance
FOS
RPMS
LUST

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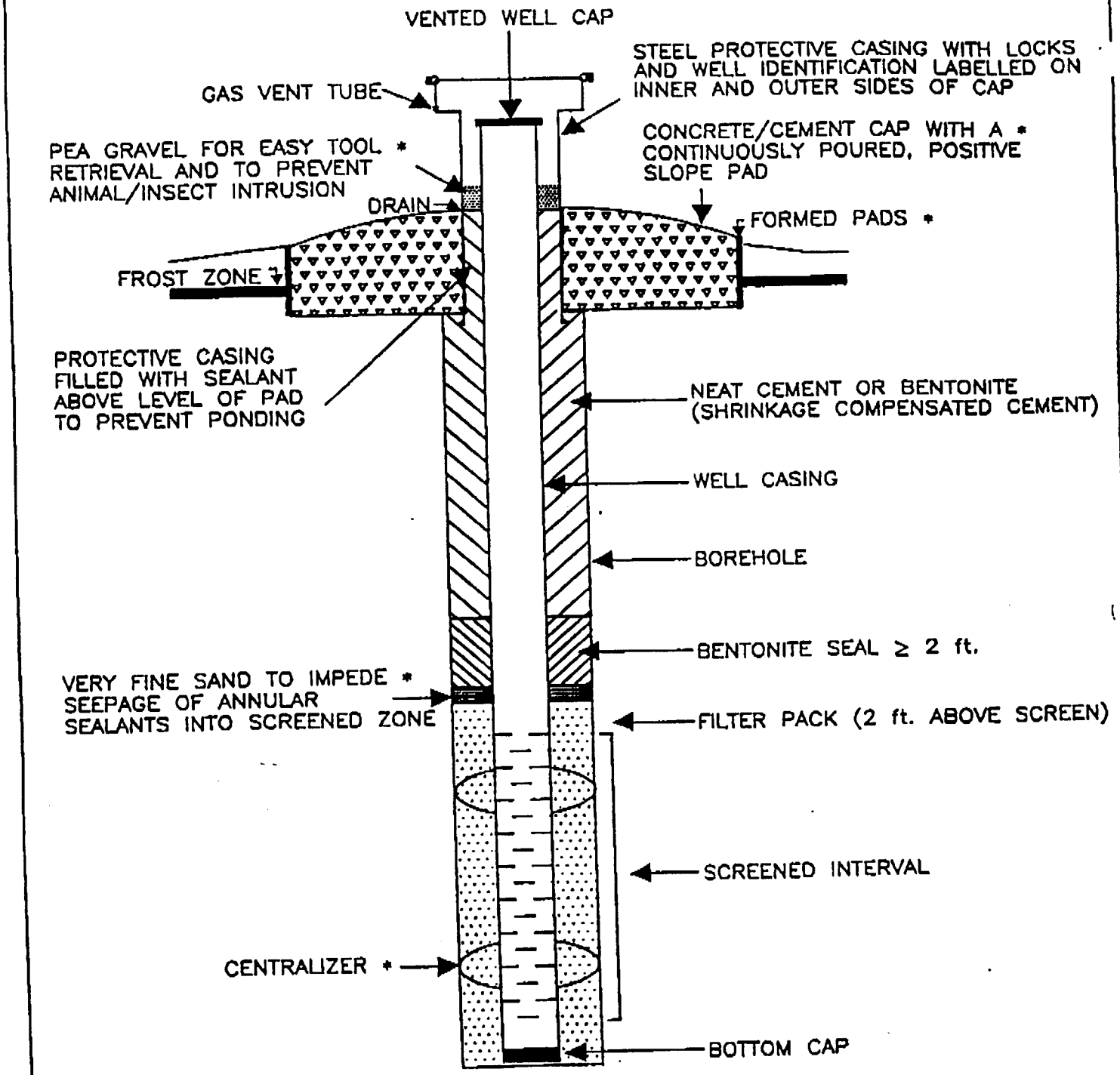


CROSS-SECTION OF TYPICAL MONITORING WELL

* = OPTIONAL

NOTE: FOR WELLS INSTALLED FOR SHORT TERM INVESTIGATORY PURPOSES ONLY, THE CONSTRUCTION OF THE CONCRETE/CEMENT CAP MAY BE OMITTED. (NOT TO SCALE)

Revised from: USEPA, 1992. RCRA Ground-Water Monitoring: Draft Technical Guidance, pg.6-

Illinois Environmental Protection Agency — Field Boring Log

Page ____ of ____

Site File No.: _____ County _____ Boring No. _____ Monitor Well No _____

Site File Name _____ Surface Elev. _____ Completion Depth _____

Fed. ID No. _____ Auger Depth _____ Rotary Depth _____

Quadrangle _____ Sec. ____ T. ____ R. ____ Date: Start _____ Finish _____

Boring Location _____

Drilling Equipment

Elev.	DESCRIPTION	Depth in feet	SAMPLES: Sample No	Sample Type	Sample Recovery	Penetrometer	N Values (Blows)	OVA or PID readings	Personnel: INITIALS	REMARKS

TABLE 1

IEPA MONITOR WELL PLUGGING PROCEDURES (test boring)

	Well Construction	Plugging Procedure
I. Unconsolidated Sediment Wells	I-A. ...if backfilled with cement grout above bentonite seal and/or sandpack:	1. Cut casing off at desired depth. 2. Mix neat cement slurry (5 gal. water per 94 lb. bag cement) 3. Insert tremi pipe (1" i.d. pvc) into well and extend to bottom. 4. Slowly pump slurry under low pressure through tremi pipe. 5. Slowly withdraw tremi pipe - making sure bottom of pipe remains below pure slurry. 6. Continue slow pumping until all formation water and the watery slurry mix is displaced from top of casing.
	I-B. ...if backfilled with soft sediments (cuttings) above bentonite seal and/or sandpack:	1. Knock out and remove thin surface concrete plug, if present. 2. Re-auger entire length of well. 3. Remove well casing from re-augered borehole. 4. Mix neat cement slurry (5 gal. water per 94 lb. bag cement). 5. Insert tremi pipe (1" i.d. pvc) into augers and extend to bottom. 6. Slowly pump slurry under low pressure through tremi pipe. 7. Continue slow pumping until all formation water and the watery slurry mix is displaced from top of casing. 8. Slowly withdraw tremi pipe - making sure bottom of pipe remains below pure slurry. 9. Pull a flight of augers (5' if in unstable materials and hole collapse is likely or 10' if in competent material and collapse is unlikely). 10. Top off cement slurry after each flight is removed.
	I-C. ...if monitor well construction is unknown:	1. Follow procedures in I-A.
II. Bedrock Wells	II-A. ...All bedrock monitor wells:	1. Cut casing off at desired depth. 2. Mix neat cement slurry (5 gal. water per 94 lb. bag cement). 3. Insert tremi-pipe (1" i.d. pvc) into well and extend to bottom. 4. Slowly pump slurry under low pressure through tremi pipe. 5. Slowly withdraw tremi pipe making sure bottom of pipe remains below pure slurry. 6. Continue slow pumping until all formation water and the watery slurry mix is displaced from top of casing.

JM:tk:2/6/31

Illinois Environmental Protection Agency — Well Completion Report

SITE #: _____ COUNTY: _____ WELL #: _____ BOREHOLE #: _____

SITE NAME: _____ WELL POSITION – UPGRAD, DNGRAD, UNION (CIRCLE ONE)

STATE PLANE COORDINATE: X _____ Y _____ (m) LATITUDE: _____ ° _____ ' _____ " LONGITUDE: _____ ° _____ ' _____ "

SURVEYED BY: _____ I.L. REGISTRATION #: _____

DRILLING CONTRACTOR: _____ DRILLER: _____

GEOLOGIST: _____ FIRM: _____

DRILLING METHOD: _____ DRILLING FLUIDS (TYPE): _____

DATE STARTED: _____ DATE FINISHED: _____

REPORT FORM COMPLETED BY: _____ DATE: _____

ANNULAR SPACE DETAILS

TYPE OF SURFACE SEAL: _____

TYPE OF ANNULAR SEALANT: _____

INSTALLATION METHOD: _____

SETTING TIME: _____

TYPE OF BENTONITE SEAL – GRANULAR, PELLET, SLURRY (CIRCLE ONE)

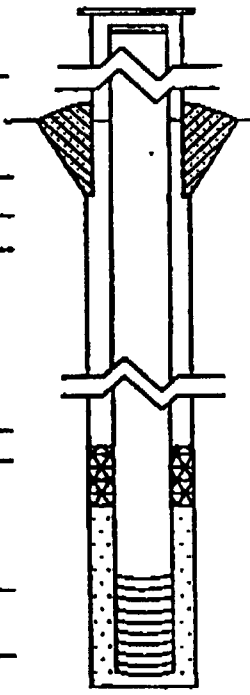
INSTALLATION METHOD: _____

SETTING TIME: _____

TYPE OF SAND PACK: _____

GRAIN SIZE: _____ (SIEVE SIZE)

INSTALLATION METHOD: _____



ELEVATIONS (MSL)*	DEPTHS (BGS) (.01 ft)	
_____	_____	TOP OF PROTECTIVE CASING
_____	_____	TOP OF RISER PIPE
_____	_____	GROUND SURFACE
_____	_____	TOP OF ANNULAR SEALANT
_____	_____	DEPTH TO WATER
_____	_____	TOP OF SEAL
_____	_____	TOP OF SANDPACK
_____	_____	TOP OF SCREEN
_____	_____	BOTTOM OF SCREEN
_____	_____	BOTTOM OF WELL
_____	_____	BOTTOM OF BOREHOLE

* REFERENCED TO A NATIONAL GEODETIC VERTICAL DATUM

WELL CONSTRUCTION MATERIALS (CIRCLE ONE)

PROTECTIVE CASING	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE ABOVE W.T.	SS304, SS316, PTFE, PVC OR OTHER:
RISER PIPE BELOW W.T.	SS304, SS316, PTFE, PVC OR OTHER:
SCREEN	SS304, SS316, PTFE, PVC OR OTHER:

MEASUREMENTS

DIAMETER OF BOREHOLE (in)	
ID OF RISER PIPE (in)	
PROTECTIVE CASING LENGTH (ft)	
RISER PIPE LENGTH (ft)	
BOTTOM OF SCREEN TO END CAP (ft)	
SCREEN LENGTH (1st SLOT TO LAST SLOT)	
TOTAL LENGTH OF CASING (ft)	
SCREEN SLOT SIZE **	

** HAND-SLOTTED WELL SCREENS ARE UNACCEPTABLE

(9408SS)