NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

WATER WELL

(No.)

CODE 642

DEFINITION

A hole drilled, dug, driven, bored, jetted or otherwise constructed to an aquifer for water supply.

PURPOSE

- Provide water for livestock, wildlife, irrigation, and other agricultural uses
- Facilitate proper use of vegetation, such as keeping animals on rangeland and pastures and away from streams; and providing water for wildlife

CONDITION WHERE PRACTICE APPLIES

This practice applies on all land uses where the underground supply of water is sufficient in quantity and quality for the intended purpose.

This practice applies only to production water wells. Specifically excluded are any types of wells installed solely for monitoring or observation purposes, injection wells, and piezometers. The standard does not apply to pumps installed in wells; above ground installations, such as pumping plants, pipelines, and tanks; temporary test wells; and decommissioning of wells (refer to Illinois Conservation Practice Standard 351, Water Well Decommissioning).

CRITERIA

Laws and Regulations. The investigation, design, or installation of water wells according to this standard shall adhere to all applicable local, State, Tribal, and Federal laws and regulations.

Utilities and Permits. The landowner and/or contractor shall be responsible for locating all buried utilities in the project area, including drainage tile and other structural measures.

The landowner shall obtain all necessary permissions from regulatory agencies, including the Illinois Department of Agriculture, US Army Corps of Engineers, US Environmental Protection Agency, Illinois Environmental Protection Agency and Illinois Department of Natural Resources – Office of Water Resources, or document that no permits are required.

Suitability of Site. The availability of groundwater for its intended use at the site shall be determined by using reliable local experience and reviewing all available relevant geologic maps and reports; well records maintained by State and Federal agencies; and design, construction, and maintenance records of nearby wells. An appropriate level of investigation, including test well drilling, is conducted on-site, as needed, prior to well construction to determine site-specific hydrogeologic conditions.

The site shall be suitable for safe operation of the drilling equipment.

Well Head Protection. Wells shall be located at safe distances from potential sources of pollution, including unsealed abandoned wells. The allowable distance shall be based on consideration of site-specific hydrogeologic factors and shall comply with requirements of all applicable local, State, Tribal, or Federal regulations or construction codes, including the Illinois Water Well Construction Code.

Surface runoff and drainage that might reach the wellhead from potential areas of contamination, such as those used by livestock, shall be diverted.

Wells must be readily accessible for repair and

maintenance and shall be located a safe distance from both overhead and underground utility lines and other safety hazards.

The well shall be provided with a watertight cover or seal to prevent the entry of contaminated water or other objectionable materials.

Borehole. Drilled, jetted, bored, and driven wells shall be sufficiently round, straight, and of adequate diameter to permit satisfactory installation of inlet, well casing, filter pack, and annular seal, and passage of tremie pipe (including couplings), if used. When an oversized drill hole is constructed for the installation of the casing, the diameter of the drill hole shall be a minimum of 3 inches greater than the outer diameter of the casing or coupling, whichever is greater.

Use of Casing. Casing shall be installed to seal out undesirable surface or shallow groundwater and to support the side of the hole through unstable earth materials. The intake portion of a well through stable geologic materials may not require casing.

Casing Diameter: Casing diameter shall be sized to permit satisfactory installation and efficient operation of the pump, and large enough to assure that uphole velocity is 5 feet per second or less for the designed discharge to protect against excessive head loss.

Materials. Casings may be steel, iron, stainless steel, copper alloys, plastic, fiberglass, concrete or other material of equivalent strength and durability consistent with the intended use of the water and the maximum anticipated differential head between the inside and outside of the casing, which can be determined using depth and material tables as described in Casing Strength.

Steel well casings shall meet or exceed requirements specified in ASTM A 589. Steel pipe manufactured for other purposes may be used if the quality of the pipe meets or exceeds requirements specified in ASTM A 589.

Only steel pipe casings shall be used in driven wells.

To prevent galvanic corrosion, dissimilar metals shall not be joined in direct contact.

Plastic casings made of acrylonitrile-butadiene-styrene (ABS), polyvinyl chloride (PVC), or styrene-rubber (SR) shall conform to material, dimensional and quality requirements specified in ASTM F 480.

Filament-wound fiberglass casings (glass-fiber-reinforced-thermosetting-resin pipe, RTRP) may be used if material meets requirements specified in ASTM D 2996. Tests for long-term cyclic pressure strength, long-term static pressure strength, and short-term rupture strength as required in ASTM D 2996 are not needed because the pipe is to be used for well casing. Joints shall meet requirements specified in section 3.8, ASTM F 480.

Fiberglass pressure pipe (also called reinforced plastic mortar pipe, RPMP, or fiberglass pipe with aggregate) shall meet or exceed requirements specified in ASTM D 3517.

Casing shall meet or exceed the requirements of the Illinois Water Well Construction Code. Selected requirements are shown in Tables A and B.

Casing Strength. Well casing wall thickness shall be sufficient to withstand all anticipated static and dynamic pressures imposed on the casing during installation, well development, and use. Required casing strength shall be determined as shown in NEH Part 631, Chapter 32, Well Design and Spring Development.

Joint Strength. Joints for well casings shall have adequate strength to carry the load due to the casing length and still be watertight, or shall be mechanically supported during installation to maintain joint integrity. Such mechanically supported casings shall terminate on firm material that can adequately support the casing weight.

Screen. Well screens shall be installed in any aquifer material likely to produce silt or sand. Well screens may be constructed of commercially manufactured screen sections, well points, or field-perforated sections.

Table A. Steel Casing and Liner Pipe Weights and Dimensions

Nominal Size	Outside Diameter	Inside Diameter	Wall Thickness
in	in	in	in
1	1.315	1.049	0.133
1 ¼	1.660	1.380	0.140
1 ½	1.900	1.610	0.145
2	2.375	2.067	0.154
2 ½	2.875	2.469	0.203
3	3.500	3.068	0.216
3 ½	4.000	3.548	0.226
4	4.500	4.026	0.237
5	5.563	5.047	0.258
6	6.625	6.065	0.280
8	8.625	8.071	0.277
10	10.750	10.136	0.307
12	12.750	12.090	0.330
14	14.000	13.250	0.375
16	16.000	15.250	0.375

For pipe sizes not listed:

- less than 8 inches in diameter shall be Schedule 40 pipe as a minimum.
- 8 inches in diameter or greater shall be Schedule 30 pipe as a minimum.
- Pipes for driven wells shall be schedule 40 as a minimum.

Table B. Plastic Casing and Liner Pipe Specifications

Size	SDR (or Schedule)	External Diameter	Minimum Wall Thickness
in		in	in
2	Sch. 40	2.375	0.154
2 ½	Sch. 40	2.875	0.203
3	Sch. 40	3.500	0.216
3 ½	Sch. 40	4.000	0.226
4	Sch. 40	4.500	0.237
4 ½	Sch. 40	4.950	0.248
5	21	5.563	0.265
6	21	6.625	0.316
8	26	8.625	0.332
10	26	10.750	0.413
12	26	12.750	0.490
14	26	14.000	0.539
16	26	16.000	0.616

The screen shall be constructed with the slot width determined from aquifer samples. Perforation by any method is allowable provided proper slot size and entrance velocity limits can be met. Screen open areas can range from 1%for field-perforated screens to 25% or more for continuous wire-wrapped screens. To assure good well efficiency, open areas should be designed to approximate aquifer porosity. High percentages of open area also make well development more effective.

The length and open area of the screen shall be sized to limit entrance velocity of water into the well in order to maximize water yield, while simultaneously preventing sand from being pumped into the well, and preventing screen corrosion and encrustation.

A conservative water well design will have a well screen entrance velocity of about 0.1 foot per second, which has historically been used as the common industry standard. The American Water Works Association (AWWA) Standard A-100-06, however, no longer

stipulates a maximum screen entrance velocity and cites recent research and testing that indicate allowable well screen velocities are a function of aquifer characteristics, the overall well design and intended performance, and the quality of the groundwater being pumped. For the purposes of this standard, the maximum recommended entrance velocity shall be less than or equal to 0.7 foot per second.

Depth of the aquifer below ground surface and the thickness of aquifer to be penetrated by the well shall govern the position of the screen in the well.

Maximum drawdown shall not be permitted below the top of the highest screen or pump intake.

Seals (Packers). Telescoped screen assemblies shall be provided with one or more sand-tight seals between the top of the telescoped screen assembly and casing.

Filter Pack. Installation of a filter pack around the well screen shall be considered under the following conditions: presence of a poorly graded, fine sand aquifer; presence of a highly variable aquifer, such as alternating sand and clay layers; presence of a poorly cemented sandstone or similar aquifer; a requirement for maximum yield from a low-yielding aquifer; or holes drilled by reverse circulation. Design procedures for the filter pack can be found in NEH Part 631, Chapter 32, Well Design and Spring Development.

Pre-packed Well Screens. For heaving or caving sands, silty or fine-grained aquifers, and for horizontal or angled wells, a commercial pre-packed well screen may be substituted for a conventionally installed (by tremie) filter pack.

Installation. Casing shall extend from above the ground surface down through unstable earth materials to an elevation of at least 2 feet into stable material or to the top of the screen.

All wells shall be cased to a sufficient height (minimum of 12 inches) above the ground surface to prevent entry of surface and near-surface water.

Casing for artesian aquifers shall be sealed into overlying, impermeable formations in such a manner as to retain confining pressure.

If a zone is penetrated that is determined or suspected to contain water of quality unsuitable for the intended use, the zone shall be sealed to prevent infiltration of the poor-quality water into the well and the developed portion of the aquifer.

Water well drillers shall adhere to all State licensing requirements and regulations.

Well Development. Well development shall be performed to repair damage done to the formation by the drilling process, and to alter the physical characteristics of the aquifer surrounding the borehole so that water will flow more freely to the well.

The method of well development used shall be selected based on geologic character of the aquifer, type of drilling rig used, and type of screen installed.

Aquifer Development. For massive, unfractured rock that is unresponsive to well development procedures, the use of aquifer stimulation techniques may be considered to improve well efficiency and specific capacity. Techniques may include dry ice, acidizing, explosives, or hydrofracturing, depending on the composition and structure of the formation.

Grouting and Sealing. The annulus surrounding the permanent well casing at the upper terminus of the well shall be filled with mortar containing expansive hydraulic cement (ASTM C 845), bentonite-based grout, or bentonite chips and pellets, in accordance with State requirements. The depth/length of the grout seal shall be no less than 10 feet and not less than the minimum specified in state or locally applicable construction codes.

The casing shall be surrounded at the ground surface by a 4-inch thick concrete slab extending at least 2 feet in all directions from the outside of the casing to prevent contamination. The slab shall slope away from the well.

A positive seal (grouted in place) or packer shall be provided between the casing and the less pervious material overlying the aquifer of artesian wells, and in all aquifers where co-mingling of waters is undesirable.

Access Port. An access port with a minimum diameter of 0.5 inch shall be installed to allow

for unobstructed measurement of depth to the water surface, or for a pressure gage for measuring shut-in pressure of a flowing well. Access ports and pressure gages or other openings in the cover shall be sealed or capped to prevent entrance of surface water or foreign material into the well. Removable caps are acceptable as access ports.

Disinfection. Wells shall be disinfected immediately following their construction or repair to neutralize any contamination from equipment, material, or surface drainage introduced during construction. The disinfection process shall comply with all Local or State requirements.

Water Quality Testing. Sampling and testing shall comply with all applicable Federal, State and Local requirements. These requirements vary according to the water quality parameters associated with the intended water use(s).

CONSIDERATIONS

The potential for adverse interference with existing nearby production wells should be evaluated in planning and design of the water well.

The potential for groundwater overdraft and the long-term safe yield of the aquifer should be considered in planning.

If practicable, wells shall be located in higher ground and up-gradient from sources of surface contamination or flooding. In determining gradient, both pumped and unpumped conditions should be considered.

When planning, consider potential effects of installation and operation of the well on cultural, historical, archeological, or scientific resources at or near the site.

Fencing of the well and associated equipment should be considered to prevent contamination and damage by wildlife, livestock, or human activity.

PLANS AND SPECIFICATIONS

Plans and specifications shall be prepared for specific field sites in accordance with this standard and shall describe the requirements for applying the practice to achieve its intended uses. A record of the installation of this practice shall be made and shall include the following information:

- Location of the water well by Global Positioning System, latitude/longitude, township/range, or other georeferencing convention, of such precision that it can be readily re-located
- Date of completion of the water well
- Name of landowner
- Name, title, and address of person responsible for the water well
- Total depth of the water well
- Length of casing and screening
- Inside diameter of well bore or casing
- Type of casing material or schedule (e.g., standard weight steel, or PVC sch-80)
- Static water level measured from ground surface
- Water chemistry data before and after disinfection

OPERATION AND MAINTENANCE

A plan for maintenance of the water well shall be prepared. The well construction records shall be kept on file with the maintenance plan by the owner/operator. As a minimum, the plan shall include a statement of identified problems, corrective action taken, date, and specific capacity (yield per unit drawdown) of water well before and after corrective action was taken.

REFERENCES

Illinois Water Well Construction Code 415 ILCS 30/.

National Engineering Handbook, Part 631, Chapter 32, Well Design and Spring Development.