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EC71-702 Nebraska Minimum Standards for Artificially Gravel Packed Irrigation Wells

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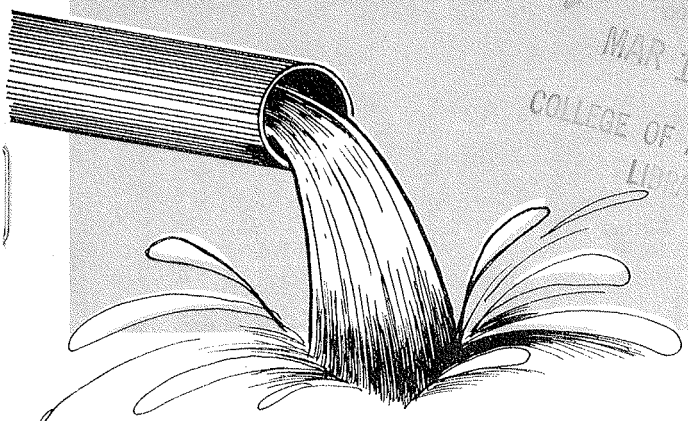
Nebraska Minimum Standards for

ARTIFICIALLY GRAVEL PACKED IRRIGATION WELLS



EXTENSION SERVICE
UNIVERSITY OF NEBRASKA COLLEGE OF AGRICULTURE
COOPERATING WITH THE U.S. DEPARTMENT OF AGRICULTURE
AND THE COLLEGE OF HOME ECONOMICS
E. F. FROLIK, DEAN; J. L. ADAMS, DIRECTOR

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Introduction

The purpose of Minimum Standards for Artificially Gravel Packed Irrigation Wells is to facilitate an understanding or agreement between the purchaser of an irrigation well and the well driller so that the best possible well may be obtained under existing natural conditions.

The potential purchaser and the well driller should consult all information made available by the University of Nebraska, County Extension Agents, and Soil Conservation Service prior to drilling the test well. A series of test wells may be necessary in areas where water producing aquifers[1] are poor in order to determine the best possible site for a well.

It is not the intent of these standards to limit the type of drilling, individual drilling methods or arts, nor to hinder future research on drilling methods. Neither is it the intent of these standards to limit the well screens to perforated metal and concrete casings. Fabricated well screens of other materials, properly constructed and selected, can be used on artificially gravel packed irrigation wells or in the development of a natural gravel packed well. Some of the finer water-bearing aquifers may need a specially fabricated well screen in order to retain 85% of the gravel pack or sand pack to make the well a non-sand pumper.

Gravel pack or sand pack selection can be larger than Class A road gravel if the water-bearing aquifer warrants its use. Likewise, the finer water-bearing formations may need a finer pack.

The standards for developing the well do not rule out the possibility of using surging, dry ice, air pressure, raw hiding, acid treatment, sodium hexametaphosphate, or any other suitable method of well development if the driller and the purchaser decide it is necessary in order to increase the production of the well. This decision should be made at the time of development.

[1] All water bearing formations.

NEBRASKA MINIMUM STANDARDS FOR artificially gravel packed irrigation wells

P. E. Fischbach, P. E. Schleusener,
and
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It is the intent of this publication to show that all sections must be complied with to obtain a properly constructed irrigation well that will last at least 20 years under normal conditions.

SPECIFICATIONS

Test Drilling

A. One or more test holes shall be drilled to locate a suitable aquifer, with a test hole being drilled at the site of the proposed irrigation well.

B. A complete and accurate log shall be kept of the test hole and a copy furnished the purchaser. The log shall be based on sample description, drilling time and drilling action. Samples of water-bearing formations shall be compared to standard samples. Notation of circulation or fluid losses shall be recorded in the log.

C. The location of the test hole shall be given by location in a quarter section, section, township, and range.

D. The static water level shall be measured after the water level has stabilized and shall be recorded. If the test hole cannot be measured accurately a reasonable estimate based on known water levels in the area shall be made.

E. The test hole shall have a minimum diameter of four inches.

F. In rotary drilled test holes circulation shall be maintained a sufficient length of time to allow all samples to be cleaned from the test hole after a maximum of each five feet of drilling in water-bearing formations and after a maximum of each 10 feet in other formations below the water table. Samples shall be saved for examination and description after each formation change and after a maximum of each five feet in water-bearing formations and 10 feet in other formations below the water table.

G. The test hole shall be of a sufficient depth to determine the thickness of

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the last favorable water-bearing formation as indicated by local conditions.

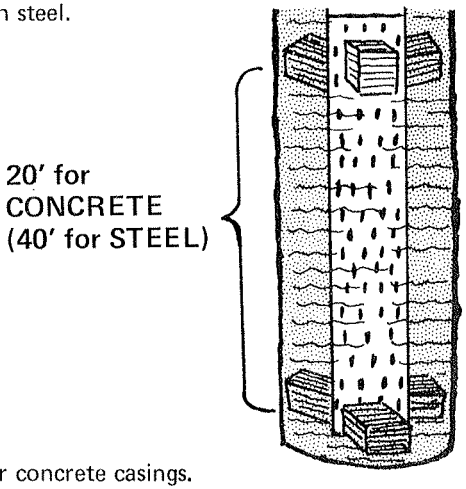
H. A sample of water shall be secured from the test hole after pumping in unusual areas where ground water may have a recognized salt or other chemical hazard, such as in southeastern Saline, western Lancaster, Burt, and Dundy Counties.

Drilling the Well

A. Plumbness and alignment. A well shall be considered sufficiently straight if the pump shaft can be turned freely without apparent bind and if a 20 foot bucket with a diameter of two inches less than the inside diameter of the well casing can be lowered freely to the total depth of the well.

B. Diameter of the well. The diameter of the drilled hole shall be a minimum of nine inches greater than the outside diameter of the casing.

C. Centering of the perforated casing. All perforated casing shall be centered in the hole by means of spacers placed at vertical intervals of about 20 feet on concrete and about 40 feet on steel.



Casings

A. Minimum standards for concrete casings.

Table A. Strength test requirements for perforated reinforced concrete well casings.

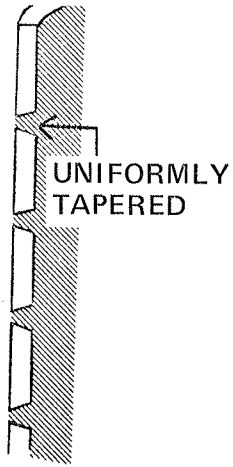
Internal diameter inches	Shell thickness inches	Load to produce 0.01 inch crack, lb./lin. ft. of barrel	Ultimate load, lb./lin. ft. of barrel	Minimum area of outside opening sq. ft./vertical foot	
				Opening width 3/16"	Opening width 1/8"
12	2	1620	2430	0.30	0.20
13	2	1665	2630	0.22	0.14
17	2½	1920	2880	0.33	0.24
18	2½	1980	2970	0.40	0.26
25	3	2200	3300	0.42	0.28
26	3	2250	3360	0.44	0.29

1. Strength test requirements (Table A) to be determined by three-edge bearing method as specified under A.S.T.M., designation C-76-56, or subsequent revisions. For plain casing sections apply factor of 1.1 to the above load requirements (concrete to have a minimum compressive strength of 4,000 pounds per square inch in 28 days).

2. Maximum setting depth for reinforced concrete well casings is 500 feet for diameters 18 inches or less and 250 feet for diameters over 18 inches.

3. Standard plain casing shall be, in the case of any one manufacturer, identical in dimensions and fully interchangeable with perforated sections. Length of sections shall be four feet, except for special plain casing lengths to enable completion of well to the correct elevation.

4. Minimum width on inside surface of uniformly tapered perforations in casing shell shall be 3/8 inch. The inside cross-sectional area of perforations shall be at least 1.2% of the outside area.



5. Casing sections shall be provided with two or more oversize vertical holes in the shell for 5/16 inch minimum diameter galvanized alignment cables. Spacers must be furnished and used as required.

6. Casing foundation base of reinforced concrete shall be provided.

7. (a) Where highly mineralized soil and/or water having pH factors less than 5.5 are encountered, a protective coating shall be used on all casing sections.

(b) Casing shall be manufactured with Type II cements where soil and/or water is encountered having more than 3,000 parts per million of the sulfates of sodium and/or magnesium, single or in combination.

8. Casing sections shall be cured with steam at 100^{o} to 130^{o} F. for 24 hours in accordance with A.S.T.M. designation C-76-56 or subsequent revision.

9. All concrete casing manufacturers shall be required to mark as seconds all casing not of first grade quality. Marking shall be made on the outside with paint.

Table B. Minimum area of opening, square feet per vertical foot.

Diameter, inches	Width of opening 3/16"	Width of opening 1/8"
12	0.25	0.16
14	0.30	0.20
16	0.35	0.23
18	0.40	0.25

B. Minimum standard for metal casing.

1. Material: Material used in the fabrication of hot rolled painted or galvanized irrigation well casing shall be prime quality, commercial grade or better, metal sheets of standard gauge.

2. Coating: Hot rolled metal well casing shall be coated with a rust inhibitive paint.

3. Fabrication: The circumferential, longitudinal or spiral seams of the metal casing shall be welded or riveted in such a manner to develop strength equal to the parent metal.

4. Perforations: The perforations shall be machine punched, be of reasonably uniform size and, except on those locations which require special size openings, shall conform to the minimum opening requirement of Table B.

5. Workmanship: The metal casing shall be free from defective material or poor workmanship.

6. Handling: All casing shall be properly and carefully handled during loading, unloading and installation.

7. Corrugated metal pipe used for well casing: All corrugated metal pipe shall conform to the minimum requirements of the AASHO Specifications M-36 or Federal Specifications QQC-806-A.

8. Recommended gauge of metal irrigation well casing (Table C).

Table C. Recommended gauge of metal irrigation well casing.

Depth of well, feet	Diameter of plain & perforated casing inches				Diameter of corrugated metal pipe inches		
	12	14	16	18	12	15	18
0-100	16 Ga.	14 Ga.	14 Ga.	14 Ga.	16 Ga.	16 Ga.	16 Ga.
100-200	14 Ga.	12 Ga.	12 Ga.	12 Ga.	16 Ga.	16 Ga.	14 Ga.
200-500	12 Ga.	10 Ga.	10 Ga.	10 Ga.	16 Ga.	16 Ga.	12 Ga.

Table D. State highway Class A gravel gradations.

Sieve size	Size of opening		Total percent retained	
	inches	mm.	Minimum	Maximum
1 inch sieve	1.000	25.4	---	0
No. 4 sieve	0.187	4.76	5	50
No. 10 sieve	0.0787	2.00	70	100
No. 200 sieve	0.0029	0.074	95	100

9. All steel casing manufacturers shall be required to mark as seconds all casing not of first grade quality. Marking shall be made on the outside with paint.

C. Fabricated well screens.

1. The openings shall be tapered with the smaller opening on the outside of the casing.

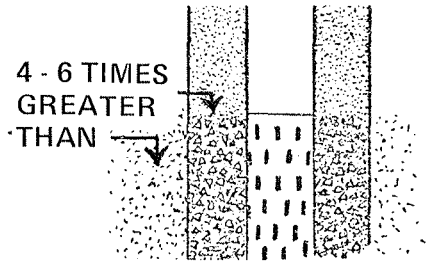
2. The strength requirements shall at least be equal to that stated in Table C.

3. The open area in square feet per vertical foot of casing shall at least be equal to the requirements of Table B. Openings smaller than 1/8 inch may be desirable for use in the fine water-bearing aquifers.

Gravel Pack

A. Gravel pack in relation to the water-bearing aquifer.

1. The average particle size of the gravel pack shall be four to six times the average particle size of the aquifer.



B. Minimum open perforated area in relation to gravel pack (Table E).

Table E. Minimum open perforated area required in various gravel pack materials for each 100 gpm.

Description of gravel pack	Mesh	Size of particles		Minimum[a] open area
		inches	mm.	sq. ft.
Very fine sand	250	0.00246 - 0.00492	0.0625 - 0.125	8.1
Fine sand	115	0.00492 - 0.00984	0.125 - 0.25	3.6
Medium sand	60	0.00984 - 0.01968	0.25 - 0.5	2.0
Coarse sand	32	0.01968 - 0.0394	0.5 - 1.0	1.2
Very coarse sand	16	0.0394 - 0.0787	1.0 - 2.0	0.74
Fine gravel	9	0.0787 - 0.1574	2.0 - 4.0	0.47
Medium gravel	5	0.1574 - 0.3148	4.0 - 8.0	0.34
Coarse gravel	2.5	0.3148 -	8.0	0.26

[a]Based on: (1) water velocity required to move particles of the gravel pack and (2) 50 percent of the perforated area blocked by the gravel pack.

Table F. Total open area in casing of various sizes having 10% open area.

Outside diameter, in.	Open area, sq. ft./ft.	Outside diameter, in.	Open area, sq. ft./ft.
12	0.31	13	0.47
14	0.37	22	0.58
15	0.39	23	0.60
16	0.42	31	0.81
17	0.45	32	0.84

1. Water-bearing aquifers larger than medium sand may be packed with Nebraska State Highway Class A gravel for road surfacing having gradation as specified in Table D.

C. Procedure for selection of length of perforated casing:

Assume the aquifer is capable of yielding 900 gallons per minute and that aquifer is gravel packed with Nebraska State Highway Class A gravel. For each 100 gallons per minute the perforated casing should have at least 0.47 square feet of open area (Table E). Total minimum open area of perforated casing is 9 x 0.47 = 4.2 square feet.

If casing has 0.25 square feet of open area per vertical foot of casing, then 4.2 ÷ 0.25 or at least 16.8 feet of perforated casing are required to keep the gravel pack material from entering the well. Use minimum of the nearest section length greater than 16.8 feet (Table B).

If the casing has 18-inch outside diameter and has 7% open area, it has 0.7 x 0.47 (Table F) or 0.33 square feet of open area per vertical foot. For 900 gallons per minute a minimum open area of 4.2 square feet are required. Then 4.2 ÷ 0.33 or at least 12.8 feet of perforated casing are required. Use minimum of nearest section length greater than 12.8 feet.

In any case the minimum length of perforated casing should be submerged under water while pumping. If, in the example above, only 10 feet of the perforated casing would be submerged, then perforated casing with a greater percentage of open area or larger diameter casing must be used—or both.

D. Maximum perforation size in relation to gravel pack. The perforation size shall be small enough to retain 85% of the gravel pack during well development.

Well Development

A. The driller shall be responsible for developing the well with a test pump as soon as possible after completion of the well.

B. The well shall be pumped slowly at first and gradually at higher and higher rates. At each rate the pumping shall be continued until the water is relatively free of foreign matter. The procedure shall be continued until the

maximum capacity of the well is reached or a capacity 20% greater than the anticipated pumping rate.

C. The well shall be pumped at the above mentioned maximum development rate until the water is relatively free of foreign material and the pumping water level is stabilized a minimum of 15 minutes.

Well Testing

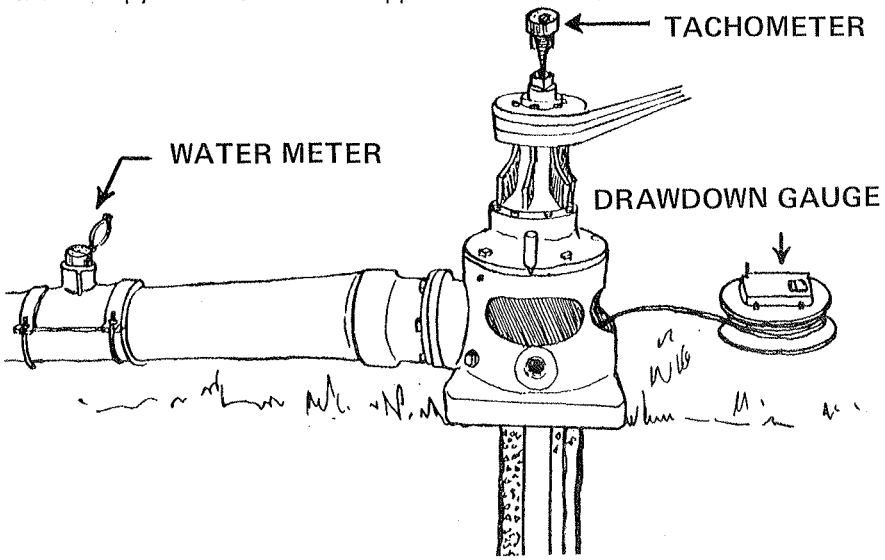
A. It is the driller's responsibility after the well is developed and the discharge free of foreign matter to test the well with the test pump for output and drawdown characteristics.

B. The pumping water level shall be determined at five different discharge rates starting at the maximum development rate and decreasing each testing point at approximately 20% of the maximum rate. The pumping level shall be stabilized at each pumping rate.

C. The pumping water level shall be measured with a standard electrical or air pressure measuring device. The discharge rate shall be measured with a standard orifice or equivalent with a recommended accuracy of a plus or minus 5%.

Completion Test

A completion test shall be run on the pumping installation after the permanent pump is installed. The test shall show the discharge in gallons per minute, the depth to water in feet while pumping, and the revolutions per minute of the pump at which the pumping plant is intended to operate. A written copy of the test shall be supplied to the owner.



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