Oklahoma Agricultural Experiment Station,

STILLWATER, OKLAHOMA.

BULLETIN NO. 67, JUNE, 1905.

MISCELLANEOUS WATER ANALYSES.

INTRODUCTION.

During the past five years 126 samples of water have been sent in for a chemical analysis. In no case has a complete analysis of any single sample been made. Either an organic analysis, with the total mineral solids, or a purely mineral analysis of the solid residue has been usually determined. In many cases, only the total mineral solids have been quantitatively estimated, and generally, with this estimation, a qualitative analysis of the solids in solution has been carried through. Sufficient time has always been given to every sample to enable the station to answer all questions involved, and, at times, analyses have been made, the results of which could have no bearing upon the information requested, but were done for the purpose of extending the knowledge of the station relative to Oklahoma waters.

In passing upon the fitness of a water for general domestic use, three points are to be considered,—first, the total quantity of solid material found by analysis; second, the quantity and kind of organic matter detected; and, third, the presence, or absence, of certain kinds of some bacteria, and the number of some other kinds. (See Bulletin No. 66.)

New wells in new countries need have no other analysis made than that of total solids in solution. New and old wells in towns may often require a complete potable analysis, depending often upon the location of the well relative to good or bad sanitary conditions. River and creek waters that are to be used for city supplies should be fully analyzed at not too infrequent intervals.

In the discussion and reports of analysis given herein, only the mineral constituents of waters will be taken up. It is desirable to consider only the contamination that nature has given our waters and not that due to the negligence or carelessness of people.

Of the 126 analyses that follow, ninety-five are from wells, thirteen from springs, five from rivers or creeks, and two from cisterns.

There are, also, eleven miscellaneous samples that could not be classified on account of insufficient information regarding their origin.

The kind of water, by whom sent, and the post office address, and, in some cases, the detailed location of the water supply, and the date received by the station, will constitute the record of water samples. It is as follows:

RECORD OF WATER SAMPLES FROM MAY 10, 1900 TO MAY 10, 1905.

Station No.

2109. Hydrant water, from Kansas City Stock Yards, Kansas City, Mo., May 10, 1900.
2110. Well, Friends' Mission, Otoe, Okla., May 10, 1900.
2111. Spring, W. A. Hallingsworth, Quincy, Okla., May 10, 1900.
2112. Spring, W. A. Hallingsworth, Quincy, Okla., May 10, 1900.
2115. Spring, Samuel Crocker, Oklahoma City. Located on Sec. 13, Twp. 10, R 5 W., May 10, 1900.
2116. Spring, Samuel Crocker, Oklahoma City. Located on Sec. 13, Twp. 10, R 5 W., May 10, 1900.
2117. Spring, Samuel Crocker, Oklahoma City. Located on Sec. 13, Twp. 10, R 5 W., May 10, 1900.
2121. Well, C. L. Lyons, west Stillwater, June 5, 1900.
2125. Well, Chas. Rogers, Stillwater, two miles southwest, June 18, 1900.
2194. Well, A. & M. College, Stillwater, 150 feet north west of main building, September 5, 1900.
2195. Spring, Samuel Crocker, Oklahoma City, September 5, 1900.
2204. Well, Samuel Hull, Cleveland, September 22, 1900.
2243. Well, J. E. Bennet, Enid, October 16, 1900.
2246. Well, 30 feet deep, Geo. Stiles, Jr., located on S. W. 1-4, Sec. 31. Twp. 18, R. 5 E., October 22, 1900.
2307. Well, W. S. Moore, Pawnee. Located on N. W. 1-4 Sec. 18, Twp. 21, R. 6 E., December 3, 1900.

2312. Well, 47 feet deep, G. W. Thompson, Stillwater, Lot 14, Block 19, December 7, 1900.
2380. Well, W. Little, Perry, 704 Seventh St., January 2, 1901.
2473. Well, G. A. Akers, Waukomis, February 8, 1901.
2492. Well, W. J. Renner, Wellston, February 18, 1901.
2515. Well, Dr. W. H. Scott, Granite, February 21, 1901.
2532. Well, 97 feet deep, J. P. Nelson, Tecumseh. Located on N. E. 1-4, Sec. 1, Twp. 6, R. 4 E., February 28, 1901.
2603. Well, 36 feet deep, E. W. Clark, Skelleton. Located on S. W. 1-4 Sec. 10, Twp. 21, R. 5 E., March 19, 1901.
2651. Well, 31 feet deep, H. L. Zuck, North Enid. Located on N. W. 1-4 Sec. 4, Twp. 23, R. 5 W., April 18, 1901.
2652. Well, 180 feet deep, John E. Hart, Hurley, April 27, 1901.
2665. Well, 135 feet deep, Z. W. Hoge, Billings. Located on S. W. Sec. 24, R. 2 W., April 30, 1901.
2676. Well, 89 feet deep, Eva Vinson, Remus. Located on N. E. Sec. 13, Twp. 7, R. 4 E., May 3, 1901.
2677. Well, I. N. Hutto, Stillwater, Lot 6, Block 2, East Col. Add., May 6, 1901.
2678. Artesian well, 267 feet deep, C. E. Smith, Marshall., May 8, 1901.
2687. Artesian well, T. C. Gates, Pawnee. Located on N. E. Sec. 34, Twp. 21, R. 4 E., May 9, 1901.
2696. Hydrant, Stillwater National Bank, May 13, 1901.
2697. Well, 55 feet deep, S. W. McFeaters, Ripley. Located on N. 1-2 Sec. 31, Twp. 18, R. 4 E., May 15, 1901.
2724. Well, D. C. West, Stillwater, June 17, 1901.
2730. Well, Rev. Crable, Geary. Located two miles north, July 1, 1901.
2731. Well, J. C. North, Stillwater, Block south of Campus, July 1, 1901
2732. Hydrant at pump house, Stillwater, July 2, 1901.
2733. Reservoir at pump house, Stillwater, July 2, 1901.
2734. Well, J. I. Hastings, Stillwater, north end, July 8, 1901.
2735. Well, 30 feet deep, E. A. Jones, Stillwater, 4 miles west, July 9, 1901.
2776. Well, Lewis Westenhoffer, Orlando, August 12, 1901.
2781. Well, R. L. Pool, Dunbar. Located on N. E. 1-4, Sec. 20, Twp. 1, N. R. 19 W., August 13, 1901.
2782. Creek, known as Stinking Creek, R. L. Pool, Dunbar. Located on N. E. 1-4 Sec. 20, Twp. 1, N. R. 19 W., August 13, 1901.
2797. Spring, J. R. Mouthfort, Gage, August 30, 1901.
2798. Well, Mrs. M. B. Tuite, Ocate, August 30, 1901.
2799. Well, Hospital, Winfield, Kansas, September 2, 1901.
2827. Well, 6 feet deep, M. A. Duff, Lawton, September 25, 1901.
2828. Well, 50 feet deep, D. A. McGregor, Youst, September 25, 1901.
2829. Unknown, E. Howard, Earlsboro, September 25, 1901.
2869. Well, 72 feet deep, J. H. Norwood, Ingalls. Located on N. E. 1-4 Sec. 27, Twp. 19, R. 4 E., October 10, 1901.
2870. Spring, C. B. Jordan, Enid, 14 miles north west, October 10, 1901.
2891. Well, M. D. Johnson, Lawton, part of city supply, December 3, 1901.
2904. Unknown, John E. Miller, Front Royal, Va., December 10, 1901.
2968. Well, R. G. McCain, Richburg, January 10, 1902.
2976. Well, 8 feet deep, T. F. Hill, Stillwater. Located 2 1-2 miles north west, January 20, 1902.
2977. Well, D. W. Gibbs, Oklahoma City. Sample from City of Lawton, January 20, 1902.
2982. Well, R. G. McCain, Richburg, January 22, 1902.

3024. Well, 42 feet deep, W. A. Gorton, Stillwater. Located Lot 1, Block 6, E. College Add., February 5, 1902.
3052. Well, 42 feet deep, J. R. Scott, Eden, February 24, 1902.
3057. Well, Canadian Co. Mill and Elevator Co., El Reno, February 28, 1902.
3089. Well, D. Luginbill, Karoma, April 15, 1902.
3094. Water residue, M. Dare, Hobart, April 21, 1902.
3112. Well, 31 feet deep, Mrs. W. A. Phelps, Hobart. Located on Lot 4, Block 1, May ,5 1902.
3114. Well, 90 feet deep, Lake More, Weleetka, Ind. Ter., May 8, 1902.
3122. Well, 104 feet deep, J. A. Weiss, Taupa. Located on N. E. 1-4 Sec. 1, Twp. 1, N. R. 13 W., or 6.5 miles west of Lawton, July 16, 1902.
3131. Well, J. M. VanWinkle, Roff, Ind. Ter., August 20, 1902.
3145. Well, 165 feet deep, H. Custer, Stillwater. Located 9 miles south west, September 10, 1902.
3153. Same as above, but drawn a few days later, September 12, 1902.
3189. Unknown, A. B. Axtel, Pawnee, October 27, 1902.
3191. Well, 60 feet deep, D. E. Cripe, Clarkson, November 1, 1902.
3228. Well, Jim Means, Cushing, November 12, 1902.
3247. Well, Orient Ginnery Co., Lone Wolf, November 20, 1902.
3350. Well, W. S. Moore, Pawnee, February 14, 1903.
3361. Well, W. S. Anderson, Guthrie, February 25, 1903.
3423. Well, 245 feet deep, and full of water, J. B. Lenertz, Granite, April 22, 1903.
3425. Well, 125 feet deep, T. T. Sears, Youst, May 6, 1903.
3428. Well, Elmer Wadsack, Munger, May 11, 1903.
3430. Well, 15 feet deep, A. J. Burnidge, Stillwater. Located 5 miles west, and 1 miles north, May 15, 1903.
3431. Well, J. N. Miller, Morrison, City well, July 2, 1903.
3440. Well, S. W. Freeman, Yale, June 16, 1903.
3443. Well, Lew E. Darrow, Medford, City supply, July 2, 1903.
3450. Well, O. M. Morris, Stillwater. Located one block west of court house, July 1, 1903.
3515A. Spring, W. D. Shallenberger, Weleetka, Ind. Ter., August 3, 1903.
3515B. Spring, W. D. Shallenberger, Weleetka, Ind. Ter., August 3, 1903.
3519. Well, deep, The Rummeli-Braun Co., Guthrie, September 7, 1903.
3520. River, Cottonwood, Rummeli-Braun Co., Guthrie, September 7, 1903.
3524. Well, A. F. Markel, North Enid, September 9, 1903.
3543. Spring, M. F. Stallard, Stillwater. From Boston Mts. in Ark., September 19, 1903.
3544. Spring, M. F. Stallard, Stillwater. From Boston Mts. in Ark., September 19, 1903.
3547. Artesian, John Swally, Newkirk. Produces 400 gallons an hour. Located on N. W. 1-4 Sec. 17, Twp. 28, R. 2 E., September 30, 1903.
3556. Well, 55 feet deep, M. H. Hall, Handley Lincoln Co. Located on S. W. 1-4 Sec. 32, Twp. 14, R. 5 E., October 17, 1903.
3566. Artesian, F. R. Morgan, Pryor Creek, City supply, October 30, 1903.
3580. Creek, Little Boggy, R. B. Strong, Era, Greer Co., November 12, 1903.
3581. Creek, Big Boggy, R. B. Strong Era, Greer Co., November 12, 1903.
3637. Well, J. Crawford, Luther, December 31, 1903.
3638. Well, Mrs. J. L. Roberson, Newkirk, January 4, 1904.
3700. Well, two miles north of Stillwater. By L. L. Lewis.
3707. Creek, Lee Jud, Chandler, being a part of the City supply, February 22, 1904.
3708. Well, Lee Jud, Chandler, being a part of the City supply, February 22, 1904.
3763. Unknown, Custer Co. State Bank, Custer, City supply, March 19, 1904.

3764. Well, 40 feet deep, J. W. Arrowsmith, Davidson. Locted on S. W. 1-4, Sec. 25, Twp. 3, R. 19 W., March 21, 1904.

3768A. Well, T. Munhall, Stillwater. Located on Lewis St., between 7th and 8th Ave. This water was boiled, April 2, 1904.

3768B. Same as above except the sample was not boiled,April 2, 1904.

3782. Well, Simon Smith, Oklahoma City, April 8, 1904.

3795. Well, S. V. Mulkey, Waynoka, April 11, 1904.

3819. Well, E. L. Cruzan, Cushing. Located 9 miles north east of City. April 26, 1904.

3820. Well, I. R. Heasty, Medford, April 28, 1904.

2821. Spring, I. R. Heasty, Medford, April 28, 1904.

3825. Well, G. B. Rogers, Vinco, May 4, 1904.

3834. Well, W. L. Stump, Curtis, May 27, 1904.

3844. Well, Benj. Shaeffer, Sinnett, July 26, 1904.

3847. Well, P. E. Brooks, Bridgeport, Augusa 25, 1904.

3850. Well, Robt. O. Sumter, Atoka, Ind. Ter., August 22, 1904.

3876. Well, 650 feet deep, The Cushing Trading Co., Cushing. This is an "oil well," October 20, 1904.

3879. Well, E. A. Jones, R. No. 3, Stillwater, October 27, 1904.

3900. Well, O. W. Frager, Perry, December 28, 1904.

3939. Well, John Fritchman, Enid, January 3, 1905.

3940. Well, John Fritchman, Enid, January 3, 1905.

3993. Well, C. R. Roberts, Cheyenne, February 9, 1905.

4060. Well, John Youst, Stillwater. Hotel supply, located just south of building. February, 1905.

4061. Well, Smart's, Stillwater. Located on 5th & Duck, February, 1905.

4062. Well, Jack Hartenbower, Stillwater. Located in south east part of City. February, 1905.

4063. Cistern. Located just north of the old College building.

4064 Hydrant. Taken from City supply in the Chemistry building, Stillwater. February, 1905.

4065. Cistern, Nelson's, Stillwater. Located on Duck and 3rd.

4066. Well, F. A. Hutto, Stillwater. Located one mile east of City. Feb., 1905.

4067. Well, C. O. Preston, Stillwater. Located 1.5 miles east of City. Feb., 1905.

4068. Well, Mrs. Johnston, Stillwater. Located in west part of City. Feb. 1905.

METHODS OF ANALYSIS.

The solid residue obtained from all natural waters that have passed through the earth usually consists of a few very common salts. These well known salts have been taken out of the soil by the solvent action of the water. The kind and amounts of these salts in the water will depend generally upon the quantity contained in the soil, and the length of time the water has been in contact with them. This general statement will be modified by the temperature of the water, by the effect that one salt in solution has upon the solubility of another, and by the chemical changes that may take place after the salts have gone into solution. It is not possible to determine just what salts are in solution in the water. The acids and metals may be determined separately, but no one knows with any certainty how they are combined to form salts. Various methods of calculation have been proposed for combining these acid and basic radicals to form salts. These calculations depend upon the supposed affinity that a metal possesses for an acid. The strongest metal is supposed to be combined with the strongest acid.

The method used by this laboratory for calculating the union of the bases with the acids to form salts is, to take up first the calcium, then the magnesium, then the sodium; and to combine, respectively, these with the carbonic, sulphuric, and hydrochloric acids, in the order given. The carbonic acid combined with the sodium is found by titrating the washed residue of a water with a tenth-normal acid. The total solid residue is determined by evaporating a known volume of the water in question to dryness in a platinum dish, on a water bath, then drying this dish and residue for five hours in a water oven at 100 degrees Centigrade.

The station number of the sample, the total solid residue, and the various salts found by analysis, and calculation, of all the waters analyzed for the past five years by the station will be found in the following table:

SOLIDS, AND THEIR COMPOSITION.

From May 10, 1900, to May 10, 1905.
In Parts Per 100,000

Numb.	Solids	CaCO3	MgCO3	CaSO4	MgSO4	CaCl2	MgCl2	Na2SO4	NaCl	Na2CO3	Undet.
2109	41.2	A						B			
2110	207 6							B	C	A	
2111	44.0	B								A	
2112	35.2	B								A	
2115	59.2	20.0	14.7		3.4		3.2			11.1	6.8
2116	43.6	16.4	13.7		0.9		1.6			9.7	1.3
2117	41.6	11.4	12.4		0.6		1.6			9.4	6.2
2121	33.6	A								B	
2125	160.4							B	C	A	
2194	454.4							A	B		
2195	66.6	9.3	5.1					30.0	4.9	10.6	6.7
2204	32.8	11.8	0.2		0.5		0.4		1.6	7.4	10.9
2243	95.6	35.5		2.2	15.8		12.7		8.0	15.9	5.5
2246	59.4	11.1	7.5		3.9		1.4		2.7	26.5	6.3
2307	292.4	5.0		2.4	10.9			0.8	218.6	42.5	12.2
2312	20.0	2.5	0.7		1.8		2.7			12.3	
2380	27.6										
2473	249.6			A				B	C		
2592	220.8	9.0		7.0		6.5	6.2		136.3	39.8	16.0
2515	37.2										
2532	96.0	2.5		6.8	3.6			9.4	7.2	40.9	25.6
2603	274.0	18.0		24.7		15.3	21.0		158.2	3.2	33.6
2651	466.8			B					A		
2652	36.0	A									
2665	225.2							A			
2676	121.0	B							A	C	
2677	238.0			A					B		
2678	611.0							A	B		
2687	205.6								A		
2696	45.2	10.0	1. 8		2.7		0.4		4.1	23.9	2.3
2697	360.4			B					A		
2724	21.0	A								B	
2730	231.0							A			
2731	28.6	A									
2732	44.4										
2733	27.0										
2734	169.2	15.3	3.1		26.9				85.8	22.3	15.8
2735	56.4								A		
2776	248.2							A			
2781	623.2			A				B			
2782	456.4			A				B			
2797	46.4	A									
2798	41.0	A									
2799	444.2	11.0		36.4				25.6	359.2	3.2	8.8
2827	34.1	26.9		0.7		0.9	1.2		0.1	4.3	
2828	331.4	26.0		125.6	93.9				18.1	3.2	64.6
2829	88.8	A									
2869	136.4	B							A		
2870	23.2	13.9	0.6				5.0		0.5	2.7	1.2
2891	48.1	17.5		1.9	0.2		9.8		0.1	18.6	
2904	23.2	11.4		4.8	2.3				2.5	0.5	1.7
2968	403.2										
2976	60.8	20.7	5.8		4.3			9.1	8.2	4.3	8.4
2977	605.8			B				C	A		
2982	55.6	A									
3024	83.5	20.0		32.9	18.3			3.4	2.5	6.4	
3052	247.0										
3057	808.0			A	B			C			
3089	26.4								A		
3094	184.1			A					B		
3112	323.7	15.0		67.9	53.3		4.3		177.4	5.8	
3114	603.6								A		
3122	1042.4	22.5	7.3		26.7			138.9	825.6	6.4	15.0

Continued on Next Page.

SOLIDS, AND THEIR COMPOSITION—Continued.

Numb.	Solids	CaCO3	MgCO3	CaSO4	MgSO4	CaCl2	MgCl2	Na2SO4	NaCl	Na2CO	Undet.
3131	32.8	16.6	6.7		0.7		1.9			6.8	0.1
3145	174.8	5.5		7.0	52.8		11.5		76.4	16.9	4.7
3153	73.2				B				A		
3189	61.2	23.2	3.2		12.0			2.5	10.9	2.2	7.2
3191	321.4	24.6		55.3	56.1		63.6		95.2	2.7	23.9
3228	391.6							A			
3247	708.4	5.3		243.9	46.4		58.7		315.1	3.5	35.5
3350	55.4	17.0		10.3		7.1	8.3		4.1		8.6
3361	35.2	A								B	
3423	129.0	0.4		3.4		0.9	2.0		51.0	58.9	12.4
3425	306.0	8.4		1.9	5.1			160.2	119.8	10.6	
3428	30.0	8.2	9.3				4.8			7.7	
3430	73.8	20.7	20.0		23.3				3.0	6.1	0.7
3431	38.4	5.0	0.4		0.2		2.0			29.1	1.7
3440	396.4	6.5		99.4	47.4			206.8	13.1	5.8	17.4
3443	53.4	16.0			5.1		2.4		21.4	8.5	
3450	74.8	A							B		
3515A	10.2	A and suspended clay.									
3515B	20.5		"	"					A		
3519	139.2	12.5	2.1		9.3			25.2	68.3	15.0	6.8
3520	75.0	26.8			25.8			3.7	8.4	2.7	7.6
3524	346.6	5.7		86.1	68.1			89.8	86.1	2.2	8.6
3543	76.6	C			A			B			
3544	5.2									A	
3547	272.0	19.3		186.0	29.6		8.3		4.5	4.8	19.5
3556	44.4	18.6	0.8		5.7		8.0			4.3	7.0
3566	670.4	32.1		1.0		7.3	29.2		590.8	6.8	3.2
3580	636.8	9.6		240.8			66.9		260.4	4.8	54.3
3581	563.0	7.0		230.1	54.0		6.3		230.0	5.8	29.8
3637	11.2	A									
3638	134.8			A			B				
3700	61.4	A							B		
3707	37.5	14.4	17.7		1.0		4.4				
3708	32.1	15.6	12.1		0.4		4.0				
3763	38.6	15.0	16.0				1.2				6.4
3764	86.2	19.5		11.2	1.7		18.7		15.5	5.8	13.8
3768A	30.8	B							A		
3768B	41.0	A							B		
3782	32.7	6.1	3.8		5.1		0.2		7.6	9.9	
3795	638.4			A			B		C		
3819	48.2	A			B						
3820	55.8	10.4	7.1					5.9	11.4	13.0	8.0
3821	50.7	5.0	6.5					4.1	16.8	18.3	
3825	43.4	A								B	
3834	130.0	10.0		50.7	30.3			1.1	17.8	5.3	14.8
3844	400.01			A			B	D	C		
3847	53.8	25.0	5.8		9.2			4.4	5.4	4.0	
3850	50.4										
3876	70.8			A				B			
3879	53.8	B		A							
3900	249.6							A	B		
3939	184.4	16.3		51.7	32.7		8.5		46.0		29.2
3940	271.0	12.5		160.8	49.2		10.4		53.5		34.6
3993	278.0	9.1		156.9	63.1		1.9		12.5		34.5
4060	63.1										
4061	58.0										
4062	29.6										
4063	8.5										
4064	10.0										
4065	7.8										
4066	40.8										
4067	32.0										
4068	33.3										

EXPLANATION OF TERMS.

CaCo3 is the chemical formula for calcium carbonate, or carbonate of lime.

MgCO3 is the chemical formula for magnesium carbonate.

CaSO4 is the chemical formula for calcium culfate, or "gyp," (gypsum.)

MgSO4 is the chemical formula for magnesium sulfate, or Epsom salts.

CaCl2 is the chemical formula for calcium chlorid.

MgCl2 is the chemical formula for magnesium chlorid.

Na2SO4 is the chemical formula for sodium sulfate, or Glauber's salts.

NaCl is the chemical formula for sodium chlorid, or common table salt.

Na2CO3 is the chemical formula for sodium carbonate.

Undet. means undertermined matter, and is that part of the residue which was not made the subject of chemical analysis. It is mostly water in combination with the salts in such a manner as not to be driven off at the heat used in drying; there is also some silica and traces of the rarer elements included in this undetermined matter. Any errors in the methods of calculation or analysis are included under this heading.

The letters A, B, C, and D, occurring in the columns under the chemical formulas, mean that A is in the largest quantity, B is second in amount, etc.

INTERPRETATION OF RESULTS.

The largest amount of solids allowable in a good potable water is not stated to be the same by different sanitary chemists. If an average be taken from the best authorities, about eight-five parts in one hundred thousand will represent that number. This figure is used by this laboratory as representing the dividing line between a good and a poor water. If the total quantity of solid material in solution in a water is more than eighty-five parts in one hundred thousand, but not greater than one hundred parts, the water is considered a poor one; and when the amount of salts is greater than one hundred, its use for drinking purposes is condemned. In this latter case, either a new well should be put down or a cistern provided.

It is by no means certain that this quantity, or even twice this quantity, of mineral matter would do harm if drunk in waters, but physicians, boards of health, and sanitary experts are of the opinion that it would cause some trouble if continued for any great length of time. All of the salts except the carbonates of lime and magnesia and the sulfate of calcium are said to produce various medicinal effects when taken into the body. It is well known that magnesium and sodium sulfates act as physics when used in sufficient quantities, hence, a water that contains large amounts of either of these salts would be expected to physic the drinker. If a person's health be normal, it would then seem best to avoid use of these salts until necessity required them.

The results of analyses, as given in the foregoing table, show that, of the ninety-five well waters examined, the lowest in total solids is 11.2, the highest is 1042.4, and the average of all samples is 201.5 parts in 100,000 of the water. Forty-four, or 46 per cent, of these wells are considered good. Three are poor. Forty-eight, or 50 per cent should be condemned. More than one-half of the creek and river waters are unfit for use, and any amount of filtering would not make them more desirable. The thirteen spring water analyses give for the lowest solid content 5.2, for the highest 76.6, and an average for all of 40.2. All spring waters are good for domestic use. All the cistern waters show, as would naturally be expected, a very low solid content, the average being 8.1 parts in 100,000. They are the best potable waters that can be obtained.

Upon examining the constituents of these solid residues, it is found that thirty-three, or 30 per cent, predominate in calcium carbonate; twenty-six, or 24 per cent, in sodium chlorid, or common salt; eighteen, or 16 per cent, in calcium sulfate, or "gyp"; twelve, or 11 per cent, in sodium sulfate, or Glauber's salts; four in magnesium carbonate, and two in magnesium sulfate.

PREVIOUS ANALYSES.

Since the establishment of the Station, there have been four publications of the results of water analyses. In Bulletin number 7, by Geo. L. Holter, are given organic and total solid determinations on thirty-six well waters, six springs, and four river or creek waters. The total mineral matter for wells averaged 96.8 parts in

100,000; for springs, 33.5, and for rivers and creeks, 140.5. Nearly all of these samples came from Payne county, and generally from the immediate vicinity of Sitllwater. There were twenty-eight good samples of well water; two were poor, and six should be condemned. All the springs were good.

In Bulletin number 29, by Geo. L. Holter and John Fields, there are given thirty-eight analyses of waters, twenty-six being mineral analyses, and twelve potable analyses. The total solids from the nineteen wells reported on show an average of 70.7 parts in 100,000. There are thirteen good waters, two poor ones, and four are condemned. The eleven creek or river waters averaged 254.8 parts of solids. Six were potable and five should be condemned. There are also analyses of five pond and two cistern waters. All of these thirty-eight samples came from widely separated points in the Territory.

In Bulletin number 38 are given forty-four analyses; seventeen are well waters, with solids averaging 139.6. There are eleven potable samples and six are unfit for use. Twelve rivers or creeks show good waters, three poor ones and nine should not be used. The average solids are 222.9. The average mineral residue from springs is 33.3, and all are good waters. These thirty-eight samples are general samples from Oklahoma.

In the Station Report for 1900 are given eighteen analyses, coming from various parts of the Territory. Fourteen are well waters, containing 297.1 parts of solids. There are eight good waters, one poor one, and five that are not suitable for use that come from the wells. The river and creek waters give 113.9 average solids, one sample is good and the other bad. Two spring waters show average solids amounting to 45.0 parts in 100,000. Both are good waters.

Bringing together all analyses, as published in Bulletins 7, 29, 38, in the 1900 Report, and in this Bulletin, it will be seen that 181 well waters have been analyzed for total solid matter. The smallest amount for any well is 7.2 parts in 100,000 ,the largest amount is 2066.8, and the average amount for all analyses of well waters is 168.5 parts of mineral matter in 100,000 of the water. Fifty-seven per cent of these waters are easily classed as potable, and thirty-eight per cent are not fit for domestic use.

Twenty-four spring waters show a maximum solid content of 66.6, a minimum of 5.2, and an average of 38.1 parts in 100.000. All of these twenty-four springs supply good, potable waters.

Excluding the water from one cistern which shows evidence of leakage, the other four contain an average mineral residue equivalent to 10.5 parts in 100,000 of the water.

The water from forty-six creeks or rivers gave a minimum of 17.2, a maximum of 1139.2, and an average of 232.7 parts of solid residue in 100,000. Fifty-two per cent are potable and 41 per cent are unfit for use.

The following table is given merely as a matter of reference and suggestion. It shows the county, post office address of the sender, the number of the sample, and the total solid residue of all samples analyzed by the Station since it began operation, up to May 10, 1905, The figures are given in parts per 100,000.

It must be remembered that this table does not show with any degree of conclusion that any town or county is supplied with good or bad waters. It merely gives indications. It is known that points not over one hundred feet apart will produce, on the one hand, water with less than 40 parts per 100,000 of mineral matter, and, on the other, more than 160 parts. It should be recognized, too, that the waters coming from any one section probably represent the worst waters found in that section rather than the better kind.

TOTAL SOLIDS IN ALL WATERS.

In parts per 100,000.

County	Towns.	Number	Solids
Blaine			
	Geary	2730	231.0
Caddo			
	Bridgeport	3847	53.8
Canadian			
	El Reno	1543	54.6
	El Reno	3057	808.0
Cleveland			
	Slusher	1876	38.0
Comanche			
	Davidson	3764	86.2
	Lawton	2827	34.1
	Lawton	2891	48.1
	Lawton	2977	650.8
	Taupa	3122	1042.4
Dewey			
	Hurley	2652	36.0
	Taloga	754	30.0

Garfield	Number	Solids
Enid	2243	95.6
Enid	3939	184.4
Enid	3940	271.0
N. Enid	2651	466.8
N. Enid	3524	346.6
Skelleton	2603	274.0
Waukomis	2473	249.6
Grant		
Medford	3443	53.4
Medford	3820	55.8
Pond Creek	746	151.0
Pond Creek	747	153.4
Pond Creek	748	34.1
Greer		
Dunbar	2781	623.2
Granite	2515	37.2
Granite	3423	129.0
Kay		
Newkirk	889	81.0
Newkirk	3547	272.0
Newkirk	3638	134.8
Kingfisher		
Downs	760	45.0
Excelsior	1927	72.0
Excelsior	1928	91.4
Kingfisher	758	117.6
Kingfisher	759	86.0
Omega	757	195.8
Lincoln		
Handley	3556	44.4
Wellston	2492	220.8
Chandler	3708	32.1
Kiowa		
Hobart	3094	184.1
Hobart	3112	323.7
Lone Wolf	3247	708.4
Logan		
Guthrie	1980	2066.8
Guthrie	1981	1777.6
Guthrie	3361	35.2
Guthrie	3519	139.2
Langston	762	75.9
Marshall	2678	611.0
Orlando	129	542.0
Orlando	2776	248.2
Noble		
Billings	2065	225.2
Morrison	3431	38.4
Otoe	1982	51.6
Otoe	1983	47.6
Otoe	2110	207.6
Perry	127	136.0

		Number	Solids
	Perry	1120	785.6
	Perry	2380	27.6
	Perry	3900	249.6
Pawnee			
	Cleveland	2204	32.8
	Jennings	1128	50.6
	Pawnee	788	292.0
	Pawnee	2307	292.4
	Pawnee	2687	205.6
	Pawnee	3350	55.4
	Sinnett	3844	400.0
	Valley	1191	232.4
Oklahoma			
	Luther	3637	11.2
	Munger	3428	30.0
	Oklahoma	890	227.6
	Oklahoma	1174	37.6
	Oklahoma	1175	65.4
	Oklahoma	1176	35.5
	Oklahoma	1177	76.7
	Oklahoma	2115	59.2
	Oklahoma	3782	32.7
Payne			
	Clarkson	121	26.1
	Clarkson	122	30.5
	Clarkson	123	47.3
	Clarkson	124	15.8
	Clarkson	3191	321.4
	Clayton	103	31.4
	Cushing	2246	59.4
	Cushing	3228	391.6
	Cushing	3819	48.2
	Cushing	3876	70.8
	Eden	3052	247.0
	Ingalls	100	7.4
	Ingalls	1931	206.4
	Ingalls	2869	136.4
	Perkins	106	28.3
	Perkins	125	41.8
	Perkins	852	146.6
	Richburg	2968	403.2
	Richburg	2982	55.6
	Ripley	2697	360.4
	Stillwater	75	145.0
	Stillwater	76	38.9
	Stillwater	78	32.4
	Stillwater	93	29.4
	Stillwater	94	40.5
	Stillwater	95	123.4
	Stillwater	96	59.0
	Stillwater	97	22.5
	Stillwater	98	46.3

	Number	Solids
Stillwater	101	16.1
Stillwater	110	56.5
Stillwater	111	39.5
Stillwater	112	36.3
Stillwater	113	57.7
Stillwater	114	49.0
Stillwater	115	91.7
Stillwater	116	11.3
Stillwater	117	92.1
Stillwater	118	56.5
Stillwater	119	14.0
Stillwater	126	22.7
Stillwater	130	63.4
Stillwater	131	73.7
Stillwater	132	1122.3
Stillwater	133	212.8
Stillwater	134	24.3
Stillwater	764	45.1
Stillwater	Y	31.4
Stillwater	X	32.1
Stillwater	W	27.3
Stillwater	V	32.1
Stillwater	U	32.5
Stillwater	T	53.4
Stillwater	S	47.1
Stillwater	854	20.4
Stillwater	G	17.7
Stillwater	1129	37.2
Stillwater	1321	56.7
Stillwater	1337	77.6
Stillwater	2121	33.6
Stillwater	2125	160.4
Stillwater	2194	454.4
Stillwater	2312	20.0
Stillwater	2677	238.0
Stillwater	2724	21.0
Stillwater	2731	28.6
Stillwater	2734	169.2
Stillwater	2735	56.4
Stillwater	2976	60.8
Stillwater	3024	83.5
Stillwater	3145	174.8
Stillwater	3153	73.2
Stillwater	3430	73.8
Stillwater	3450	74.8
Stillwater	3700	61.4
Stillwater	3768B	41.0
Stillwater	3879	53.8
Stillwater	4060	63.1
Stillwater	4061	58.0
Stillwater	4062	29.6
Stillwater	4066	40.8

	Number	Solids
Stillwater	4067	32.0
Stillwater	4068	33.3
Vinco	3825	43.4
Yale	3440	247.0
Youst	2828	331.4
Youst	3425	306.0
Pottawatomie		
Tecumseh	2532	96.0
Remus	2676	121.0
Roger Mills		
Cheyenne	3993	278.0
Woods		
Cleo	750	37.1
Karoma	3089	26.4
Leslie	752	91.1
Weynoka	3795	638.4
Washita		
Burns	2090	36.1
Woodward		
Curtis	3834	130.0
Ocate	2798	41.0

SOURCES OF WATER.

Cisterns.—A well built cistern, carefully looked after, is probably the best water supply the people of Oklahoma can obtain. No contamination can get into this supply except through the top of the cistern, and if the top is kept closed tightly, any other contamination must come through the down spouts from the roof. If the first water from every rain is not allowed to run into the cistern, and the water which is caught is made to pass through a cleanable screen, made of fine wire gauze, the cistern will be kept in a good, pure condition. Where cisterns are used, all birds should be discouraged from congregating about the home; they will pollute any cistern. Some kind of pump, preferably a chain bucket pump—since it tends to prevent the woody taste that is characteristic of rain waters—should be used to draw the water. Drawing water by means or a rope and bucket will introduce filth, and the cistern must be opened, and, at times, will be negligently left so. The cistern should be cleaned out occasoionally, and when it is, the cleaner should have on his feet either new or well-washed shoes.

Springs.—A spring, when obtainable, is a good source of water. since it is usually constant in its supply. It can be looked after better than a well, and spring waters usually contain less mineral matter than wells. Cultivating the land or using manures on the soil above the spring's supply are liable to pollute it. Weeds should not be allowed to grow near the spring, or be permitted to fall or blow into it. It should be walled up and covered in the same way that a well is arranged.

Wells.—A well is the most common source of the water supply, and it should be given most careful attention. It should be located on the highest ground obtainable so that all water, whether rained or poured near the well, will drain rapidly away from it. In case a new home is being started, the well should be put down first and the balance of the improvements follow. If the ground is level around the well, it should be filled in, first with clay and then on top a little soil for grass growing. This filling should be about one foot high at the well curbing, sloping evenly away for fifteen or twenty feet. The ground should be packed closely in around the curbing so that small animals and insects cannot fall in around it. The curbing should extend as high above the ground as is practicable for convenient use. A cover should be kept on the well at all times, and a pump should be used in preference to a rope and bucket. If a bucket and rope are used, a windlass should carry the rope. The use of a pulley, rope and hands is not conducive to healthful conditions in the well. Use metal bucket when possible, and it is best to keep it out in the open air when not in use. If a wooden curbing is used, do not allow it to become rotted before putting in another. Stone, brick, or metal, curbings are the best. Do not hang meats, butter or milk in the well. Do not locate the well nearer than seventy-five feet from the barn or privy, or better, do not locate any of these buildings nearer than seventy-five feet if the well is fifty feet deep. Keep such buildings one and one-half times as far from the well as the well is deep. Do not cultivate the ground that is near the well. Never have barns, privies, or hen houses on ground that slopes down toward the well, or water supply. If the well runs low in water. do not dig deeper, but dig a new well. The deeper a well is dug in Oklahoma the more mineral matter it will contain, as a rule, and in the majority of cases the water is poorer or even unfit for use. If the water in a well is unfit for use on account of the solid mineral matter held in solution, there is no remedy for it. The solids cannot be removed, except in a very small part, by any chemical or physical process, except by distillation. The form of the salt may be changed by adding chemicals, bu tthe water has not been benefitted for domestic use. All that can be done is to dig a new well or else build a cistern.

Since creek and river waters are not generally used except by towns and cities, and, when used by such, are subjects for consideration by sanitary engineers, they will not be discussed here. It might be well to add, however, that no town or city should use such waters without their being filtered through well constructed filter beds.

IRRIGATION WATERS.

The materials dissolved in irrigation waters are left in the soil when the waters evaporate. It is not possible to say with certainty that any given water is unfit for irrigation unless it contains a large amount of dissolved matter. This fact is due to two conditions—the kind of soil upon which the water is used, and the amount of rainfall that falls upon the irrigated soil. Any kind of a loose, open soil, such as a sandy soil, may be safely irrigated with waters that contain greater quantities of dissolved solid matter than could be used upon a stiff, close soil, such as a clay. If the irrigated soil is flushed with rains at any time of the year, this will wash out much of the salty matter left by the irrigation waters; naturally, then, a poorer irrigation water may be used when this condition is prevalent.

Waters containing more than one hundred parts of total dissolved matter, or ten parts of black alkali (sodium carbonate) are not considered desirable for irrigation. These allowances may be slightly increased under favorable conditions, such as mentioned above.

All persons wishing to have waters analyzed for any purpose are requested to write to the Experiment Station for information regarding the sampling, shipping, and other conditions that must be complied with before waters will be analyzed.

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