APPENDIX I

REFERENCE TABLES AND CURVES

ATOMIC WEIGHTS OF THE MORE COMMON ELEMENTS[a]

Element	Symbol	Atomic Weight	Valence
Aluminum	Al	26.98	3
Barium	Ba	137.36	2
Boron	B	10.82	3
Bromine	Br	79.916	1, 3, 5, 7
Cadmium	Cd	112.41	2
Calcium	Ca	40.08	2
Carbon	C	12.011	2, 4
Chlorine	Cl	35.457	1, 3, 5, 7
Chromium	Cr	52.01	2, 3, 6
Cobalt	Co	58.94	2, 3
Copper	Cu	63.54	1, 2
Fluorine	F	19.00	1
Hydrogen	H	1.0080	1
Iodine	I	126.91	1, 3, 5, 7
Iron	Fe	55.85	2, 3
Lead	Pb	207.21	2, 4
Magnesium	Mg	24.32	2
Manganese	Mn	54.94	2, 3, 4, 6, 7
Mercury	Hg	200.61	1, 2
Molybdenum	Mo	95.95	3, 4, 6
Nickel	Ni	58.71	2, 3
Nitrogen	N	14.008	3, 5
Oxygen	O	16.000	2
Phosphorus	P	30.975	3, 5
Potassium	K	39.100	1
Silicon	Si	28.09	4
Silver	Ag	107.880	1
Sodium	Na	22.991	1
Sulfur	S	32.006	2, 4, 6
Tin	Sn	118.70	2, 4
Zinc	Zn	65.38	2

[a] Based on international atomic weights, 1958, published in the *Journal of the American Chemical Society*, Vol. 80, pp. 4121–4124 (1958).

CHEMICAL CONVERSION FACTORS: RESIDUE TO PERTINENT ELEMENT OR RADICAL

Weighed	Sought	Factor
Al_2O_3	Al	0.529
$BaSO_4$	Ba	0.588
$BaSO_4$	SO_4	0.412
CaO	Ca	0.715
CdS	S	0.778
CO_2	CO_3	1.364
CuO	Cu	0.799
Fe_2O_3	Fe	0.699
$KMnO_4$	Mn	0.348
$Mg_2P_2O_7$	Mg	0.219
$Mg_2P_2O_7$	PO_4	0.853
$Mn_2P_2O_7$	Mn	0.387
$(NH_4)_3PO_4 \cdot 12MoO_3$	P	0.0022
Ni-glyoxime	Ni	0.203
PbO_2	Pb	0.866
SnO_2	Sn	0.788
TiO_2	Ti	0.60
ZnO	Zn	0.803

DISSOLVED OXYGEN (SATURATION VALUES)

Temperature, deg Cent	ppm, by weight
10	11.33
15	10.15
20	9.17
25	8.38
30	7.63
35	7.1
40	6.6
45	6.1
50	5.6

DENSITY AND VISCOSITY OF WATER

Temperature, deg Cent	Density, lb per cu ft	Viscosity, centipoises
10	62.40960	1.3077
15	62.37205	1.1404
20	62.31640	1.0050
25	62.24414	0.8937
30	62.15676	0.8007
35	62.05585	0.7225

IONIC EQUIVALENT CONDUCTANCE AT 25 C

Ion	λ_0[a]
K^+	73.52
Na^+	50.11
H^+	349.82
NH_4^+	73.4
$\frac{1}{2}\ Ca^{++}$	59.5
$\frac{1}{2}\ Mg^{++}$	53.06
Cl^-	76.34
NO_3^-	71.44
$\frac{1}{2}\ SO_4^{--}$	79.8
OH^-	198
HCO_3^-	44.48
$\frac{1}{2}\ CO_3^{--}$	83
HS^-	72
HSO_3^-	71
$\frac{1}{2}\ SO_3^{--}$	80
$H_2PO_4^-$	29
$\frac{1}{2}\ HPO_4^{--}$	60
$\frac{1}{3}\ PO_4^{---}$	78

[a] λ_0 = Ionic equivalent conductance at infinite dilution.

TEMPERATURE CONVERSION FORMULAS

Deg Cent = 5/9 (deg Fahr − 32)
Deg Fahr = 9/5 deg Cent + 32

BICARBONATE, CARBONATE, AND HYDROXIDE RELATIONSHIPS

	Bicarbonate	Carbonate	Hydroxide
$P = 0$	M	0	0
$P < \frac{1}{2}\ M$	$M - 2P$	$2P$	0
$P = \frac{1}{2}\ M$	0	$2P$	0
$P > \frac{1}{2}\ M$	0	$2(M - P)$	$2P - M$
$P = M$	0	0	M

M = Methyl orange alkalinity.
P = Phenolphthalein alkalinity.

COMMON CONVERSION FACTORS

Multiply	By	To Obtain
Acres	43,560	square feet
Acre-feet	325,851	gallons
Centimeters	0.394	inches
Centimeters	0.01	meters
Centimeters	10	millimeters
Cubic feet	1728	cubic inches
Cubic feet	7.48	gallons
Cubic feet	28.32	liters
Cubic feet per minute	62.43	pounds of water per minute
Cubic feet per second	0.646	million gallons per day
Cubic feet per second	448.83	gallons per minute
Cubic inches	16.39	cubic centimeters
Feet	30.48	centimeters
Feet of water	0.8826	inches of mercury
Feet of water	62.43	pounds per square foot
Feet of water	0.4335	pounds per square inch
Gallons	3785	cubic centimeters
Gallons	0.1337	cubic feet
Gallons	231	cubic inches
Gallons	3.785	liters
Gallons, Imperial	1.2	gallons, U. S.
Gallons of water	8.345	pounds of water
Grains	0.0648	grams
Grains per gallon	17.12	parts per million
Grains per gallon	142.86	pounds per million gallons
Grams	15.43	grains
Grams	0.001	kilograms
Grams	1000	milligrams
Grams	0.0021	pounds
Grams per liter	58.42	grains per gallon
Grams per liter	8.345	pounds per 1000 gallons
Grams per liter	1000	parts per million
Inches	2.54	centimeters
Inches of mercury	1.133	feet of water
Inches of mercury	0.4912	pounds per square inch
Inches of water	0.0736	inches of mercury
Inches of water	0.036	pounds per square inch
Kilograms	2.205	pounds
Kilograms	1000	grams
Kilometers	3281	feet
Kilometers	0.6214	miles
Liters	1000	cubic centimeters
Liters	0.0353	cubic feet
Liters	61.02	cubic inches
Liters	0.2642	gallons
Meters	100	centimeters
Meters	3.281	feet
Meters	39.37	inches
Milligrams	0.001	grams
Milliliters	0.001	liters
Milligrams per liter	1	parts per million
Million gallons per day	1.547	cubic feet per second
Ounces	437.5	grains
Ounces	28.35	grams
Parts per million	0.0584	grains per gallon
Parts per million	8.345	pounds per million gallons
Pounds	7000	grains
Pounds	453.6	grams
Pounds per cubic foot	0.016	grams per cubic centimeter
Pounds per square inch	2.31	feet of water
Pounds per square inch	2.036	inches of mercury
Square miles	640	acres
Tons, long	2240	pounds
Tons, metric	2205	pounds
Tons, short	2000	pounds

TABLE I.—ANALYSES OF TYPICAL PUBLIC WATER SUPPLIES IN THE UNITED STATES.

(From U. S. Geological Survey Water-Supply Papers 1299 and 1300.)

Water Supply[a]	1	2	3	4	5	6	7	8
Date of Collection	4/9/52	5/12/49	6/4/52	2/6/52	6/30/52	2/11/52	Average 1950 to 51 Year	June 1949
Silica (SiO_2), ppm	2.1	...	2.5	8.6	6.6	17	12	7.5
Iron (Fe), ppm	0.21	0.0	0.03	0.24	0.00	0.0	...	0.02
Manganese (Mn), ppm	0.00	...	0.00	...	...	0.00	...	0
Calcium (Ca), ppm	36	67	5.3	23	31	12	31	13
Magnesium (Mg), ppm	10	26	1.7	9.2	6.1	3.6	12	5.6
Sodium (Na), ppm	3.4	14	1.4	2.7	8.0	139	189	11
Potassium (K), ppm	0.7		0.6			0.4	3	...
Bicarbonate (HCO_3), ppm	135	163	10	25	79	317	121	66
Carbonate (CO_3), ppm	0	...	0	0	0	0	12	0
Sulfate (SO_4), ppm	17	137	11	64	39	5.6	290	13
Chloride (Cl), ppm	6.3	20	2.6	6.6	7.0	56	83	10
Fluoride (F), ppm	0.1	...	0.1	0.0	1.0	0.8	0.4	0.1
Nitrate (NO_3), ppm	...	...	0.3	5.9	2.6	0.0	0.2	0.0
Dissolved solids, ppm	150	461	34	147	156	388	692	93
Hardness as $CaCO_3$, ppm	131	274	20	95	102	45	315	54
Noncarbonate hardness as $CaCO_3$, ppm	20	140	6	75	38	0	197	1
Specific conductance, micromhos at 25 C	225	...	53.4	228	236	660	1040	152
pH	8.2	7.4	6.9	8.1	7.5	7.8	8.4	7.9
Color	3	...	1	5	3	10	...	...
Turbidity	14	...	1.9	...	...	...	...	...
Temperature, deg Fahr	37	...	54	50	...	...	...	...

[a] Water supplies are identified as follows:

1. Chicago, Ill. Lake Michigan: Chicago Avenue pumping station.
2. Jacksonville, Fla. Well supply (finished).
3. New York, N. Y. Catskill supply (finished).
4. Philadelphia, Pa. Schuylkill River supply (finished).
5. Washington, D. C. Potomac River (finished).
6. Houston, Tex. Scott Street well 4; depth, 1756 ft.
7. Los Angeles, Metropolitan District of Southern California. Colorado River (finished).
8. San Francisco, Calif. Crystal Spring lines (finished).

TABLE II.—ANALYSES BY U. S. GEOLOGICAL SURVEY OF TYPICAL SURFACE WATERS OF THE UNITED STATES.

Surface Waters[a]	1			2			3			4		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Date of Collection	Oct. 1 to 9, 1953	May 11 to 20, 1954	1953 to 1954	Jan. 1 to 10, 1954	May 1 to 10, 1954	1953 to 1954	Aug. 1 to 3, 5 to 10, 1955	March 1 to 10, 1955	1954 to 1955	Jan. 4 to 14, 1953	June 10 to 13, 1953	1952 to 1953
Silica (SiO_2), ppm	4.9	5.4	5.8	1.3	0.3	3.6	5.1	6.2	6.7	...	...	...
Iron (Fe), ppm	0.03	0.02	0.03	0.01	0.03	0.02	0.01	0.48	0.08	...	...	...
Manganese (Mn), ppm	...	...	...	...	...	...	0.00	0.32	0.18	...	...	...
Calcium (Ca), ppm	25	8.7	15	26	18	20	62	20	40	80	56	62
Magnesium (Mg), ppm	9.8	1.5	4.6	5.0	2.7	3.4	15	4.9	10	26	12	18
Sodium (Na), ppm	6.8	5.9	5.7	9.5	3.6	5.0	43	4.9	21	73	39	59
Potassium (K), ppm				1.5	1.0	1.1	4.1	1.6	2.6	...	...	...
Bicarbonate (HCO_3), ppm	68	22	38	84	57	66	29	26	26	265	167	191
Carbonate (CO_3), ppm	0	0	0	0	0	0	0	0	0	0	0	0
Sulfate (SO_4), ppm	38	16	24	15	11	11	201	48	120	211	119	177
Chloride (Cl), ppm	12	3.0	7.2	16	4.4	7.8	52	8.0	29	26	9.5	16
Fluoride (F), ppm	0.2	0.1	0.1	0.2	0.2	0.2	0.5	0.1	0.3	...	...	...
Nitrate (NO_3), ppm	5.8	1.8	3.3	0.4	1.7	1.3	3.8	4.5	3.3	3.7	3.8	3.3
Dissolved solids, ppm	156	55	97	121	74	90	409	120	259	589	348	462
Hardness as $CaCO_3$, ppm	103	28	58	86	55	64	219	69	141	306	189	229
Noncarbonate hardness as $CaCO_3$, ppm	47	10	26	17	9	10	195	49	20	89	52	72
Specific conductance, micromhos at 25 C	251	94.0	158	214	129	153	648	185	408	878	538	697
pH	7.6	7.2	...	7.2	7.2	...	6.9	6.8	...	7.9	7.4	...
Color	9	3	4	5	2	9	3	27	...	...	...	...
Temperature, deg Fahr	...	...	...	...	...	...	85	45	...	...	...	...

Surface Waters[a]	5			6			7			8		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Date of Collection	Oct. 5, 1953	May 29, 1954	1953 to 1954	Nov. 7, 1953	July 31, 1954	1953 to 1954	Sept. 21 to 30, 1953	June 21 to 30, 1953	1952 to 1953	March 11 to 20, 1952	June 11 to 20, 1952	1951 to 1952
Silica (SiO_2), ppm	...	...	...	28	6.4	15	11	14	15	15	9.6	13
Iron (Fe), ppm	...	...	...	...	...	...	0.12	0.23	0.14	0.14	0.03	0.06
Manganese (Mn), ppm	...	...	...	...	...	...	...	...	...	...	...	...
Calcium (Ca), ppm	137	38	94	70	...	34	144	64	95	26	17	20
Magnesium (Mg), ppm	40	5.4	24	13	...	4.7	57	15	31	8.1	4.4	6.0
Sodium (Na), ppm	810	45	340	628	...	75	208	28	101	10	4.9	6.9
Potassium (K), ppm	...	...	...				12	4.6	6.8	1.8	1.7	1.9
Bicarbonate (HCO_3), ppm	235	121	209	216	41	105	260	212	243	106	69	85
Carbonate (CO_3), ppm	5	0	...	0	0	...	0	0	0	0	0	0
Sulfate (SO_4), ppm	280	30	180	136	...	40	553	79	262	23	12	15
Chloride (Cl), ppm	1280	62	497	892	21	95	194	24	86	5.8	2.0	3.9
Fluoride (F), ppm	...	...	...	...	...	...	0.5	0.3	0.4	0.4	0.2	0.3
Nitrate (NO_3), ppm	11	5.2	6.8	22	2.8	4.0	3.4	1.4	2.7	1.3	1.1	1.1
Dissolved solids, ppm	2770	285	1300	1900	82	342	1310	335	719	147	91	111
Hardness as $CaCO_3$, ppm	505	117	333	228	36	104	594	221	364	98	60	75
Noncarbonate hardness as $CaCO_3$, ppm	304	18	162	51	2	18	381	48	166	11	4	5
Specific conductance, micromhos at 25 C	4720	470	2230	3170	154	568	1930	541	1100	234	147	177
pH	8.3	8.2	...	8.2	7.6	...	7.5	7.5	...	7.7	7.3	...
Color	...	...	...	...	...	...	...	...	...	15	25	...

[a] Surface waters are identified as follows:

1. Delaware River at Trenton, N. J.
2. Tennessee River at Kentucky Dam, near Paducah, Ky. (WSP-1350).
3. Ohio River at Ravenswood, W. Va. (Water Quality and Flow Variations in the Ohio River 1951–55. Ohio River Valley Sanitation Commission.)
4. Missouri River at Nebraska City, Nebr. (WSP-1291).
5. Arkansas River at Arkansas City, Kans. (WSP-1352).
6. Trinity River at Romayor, Tex. (WSP-1352).
7. Colorado River near Grand Canyon, Ariz. (WSP-1293).
8. Columbia River at Maryhill Ferry near Rufus, Ore. (WSP-1253).

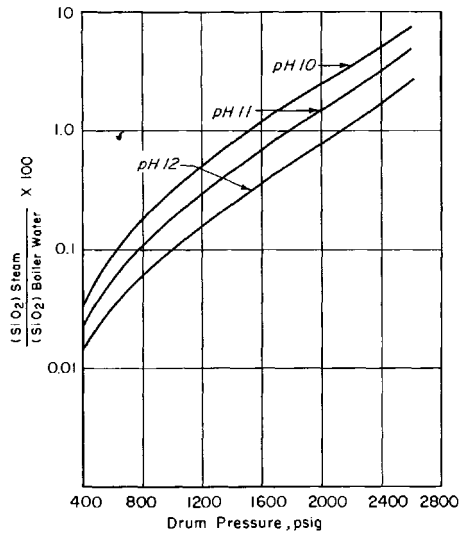
TABLE III.—ANALYSES OF GROUND WATER FROM REPRESENTATIVE AQUIFERS IN THE UNITED STATES.

(From U. S. Geological Survey Water-Supply Papers 1299 and 1300.)

Aquifers[a]	1	2	3	4	5	6	7	8
Date of Collection	1/16/52	10/20/51	4/2/51	1/17/52	5/24/51	5/14/52	1/29/49	10/4/48
Silica (SiO_2), ppm	7.0	11	13	12	21	14	19	27
Iron (Fe), ppm	0.09	0.19	0.43	0.80	1.6	0.00	...	0
Manganese (Mn), ppm	...	0.00	0.0	0.13	...	0.00	0	0
Calcium (Ca), ppm	49	3.0	8.2	72	62	62	56	12
Magnesium (Mg), ppm	9.1	0.8	4.6	28	11	17	12	7.7
Sodium (Na), ppm	9.6	104	17	5.5	56	7.1	71	9.4
Potassium (K), ppm		1.4	1.7	1.0	2.1	1.2	...	...
Bicarbonate (HCO_3), ppm	165	211	85	294	255	244	243	56
Carbonate (CO_3), ppm	0	9	0	0	0	0	0	...
Sulfate (SO_4), ppm	31	9.3	3.7	65	54	15	67	8.9
Chloride (Cl), ppm	9.0	28	2.5	8.0	36	12	51	9.5
Fluoride (F), ppm	0.1	0.9	0.1	0.1	0.3	0.2	...	0
Nitrate (NO_3), ppm	0.2	1.1	0.4	0.7	1.8	5.4	3.5	17
Dissolved solids, ppm	197	274	94	340	370	259	399	115
Hardness as $CaCO_3$, ppm	160	11	39	295	200	225	189	61
Noncarbonate hardness as $CaCO_3$, ppm	24	0	0	54	0	25	0	16
Specific conductance, micromhos at 25 C	342	443	137	565	595	449	...	...
pH	7.7	8.6	6.9	7.6	7.3	7.6	7.7	7.1
Color	2	3	7	2	0	0	...	0
Turbidity	...	2	2	...	...	0	...	...
Temperature, deg Fahr	...	68	...	52	...	78	...	...
Depth, ft	58 to 71	636	400 to 600	108	90 to 265	avg 900	180 to 640	378

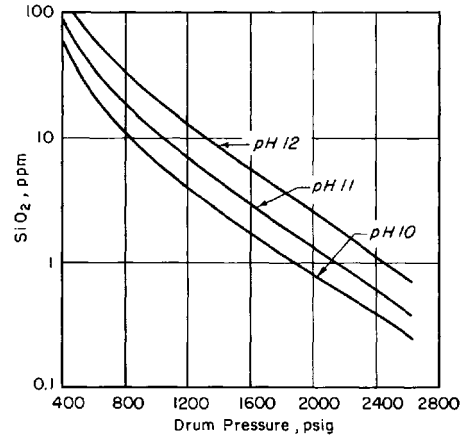
[a] Aquifers are identified as follows:

1. Schenectady, N. Y. Wells.
2. Montgomery, Ala. Well 31.
3. Memphis, Tenn. Parkway well field.
4. South Bend, Ind. Well 2, North Station.
5. Wichita, Kans. Wells.
6. San Antonio, Tex. Brackenridge Park well field.
7. Glendale, Calif. Grandview wells.
8. Tacoma, Wash. Well 5A.



Cyrus Wm. Rice & Co., Pittsburgh, Pa.

FIG. 1.—Percentage of Silica in Steam *versus* Boiler Drum Pressure at Selected Boiler Water pH.



Cyrus Wm. Rice & Co., Pittsburgh, Pa.

FIG. 2.—Maximum Boiler Water Silica Concentration *versus* Drum Pressure at Selected Boiler Water pH. (Based on maintaining 0.02 ppm SiO_2 maximum in steam.)

TABLE IV.—INDUSTRIAL WATER REQUIREMENTS.

The amounts of water or steam required per unit of product in many industrial operations are tabulated below. All cited sources for the values are listed together at the end of the table.

	Water	Steam
Acetic acid from carbide		7300 lb per ton HAc (3)
Acetic acid from pyroligneous acid.	100,000 gal per ton HAc (3)[a]	15,700 lb per ton HAc (3)
Acetic acid from pyroligneous liquor	240 M gal per ton HAc (3)	64,000 to 74,000 lb per ton HAc (3)
Acetic acid, direct (Othmer process)		54,200 lb per ton HAc (3)
Alcohol, industrial	120 gal per gal 100 proof alcohol (5) 52 gal per gal 190 proof alcohol (3) 100 gal per gal alcohol (2) 20,000 gal per ton grain (1) 600,000 gal per 1000 bu grain mashed (5)	50 lb per gal 190 proof alcohol (3)
Alumina (Bayer process)	6300 gal per ton $Al_2O_3 \cdot 3H_2O$ (3)	15,000 lb per ton $Al_2O_3 \cdot 3H_2O$ (3)
Ammonia, synthetic	31,000 gal per ton liquid NH_3 (1, 3)	
Ammoniated superphosphate	27 to 30 gal per ton ammoniated superphosphate (3)	
Ammonium sulfate	200,000 gal per ton salt (1)	
Buna S	173,000,000 gal per day for 100,000 tons Buna S per year (3)	
Butadiene	320,000 gal per ton butadiene (2)	
Calcium metaphosphate	4000 gal per ton $Ca(PO_3)_2$	
Carbon dioxide	23,000 gal per ton CO_2 (1) 20,000 gal per ton solid CO_2 from 18 per cent flue gas (3)	20,000 lb per ton solid CO_2 from 18 per cent flue gas (3)
Casein (grain-curd process)		2400 lb per ton casein
Caustic soda (lime-soda process)	18,000 lb per ton NaOH in 11 per cent solution (3) 21,000 gal per ton NaOH in 11 per cent solution (1)	2700 lb per ton NaOH in 11 per cent solution (3)
Caustic soda (electrolytic)		20,000 lb per ton 76 per cent NaOH (3)
Cellulose nitrate	50 gal per lb cellulose nitrate (3) 10,000 gal per ton cellulose nitrate (1)	
Charcoal and wood chemicals	65,000 gal per ton crude $CaAc_2$ (3)	64,000 lb per ton crude $CaAc_2$ (3)
Cottonseed oil	20 gal per gal oil (3) 0.6 gal per gal hardened oil (3)	15 lb per gal oil (3) 0.5 lb per gal hardened oil (3)
Coumarin (synthetic)		3000 lb per ton coumarin or 0.75 ton salicylaldehyde (3)
Cuprammonium rayon	90,000 to 160,000 gal per ton 11 per cent moisture rayon (3)	
Fatty acid refining, continuous		1390 lb per ton stock charged (3)
Gelatin		400 lb per ton gelatin (3)
Glycerine	1100 gal per ton glycerine (1)	8000 lb per ton glycerine (3)
Gunpowder	200,000 gal per ton gunpowder (1) or explosives (2)	
Hydrochloric acid (salt process)	2900 gal per ton 20 Bé HCl (3)	
Hydrochloric acid (synthetic process)	500 to 1000 gal per ton 20 Bé HCl (3)	
Hydrogen	660,000 gal per ton H_2 (1)	
Lactose (milk sugar)	200,000 to 220,000 gal per ton lactose (1, 3)	80,000 lb per ton lactose (3)
Magnesium carbonate, basic	4320 gal per ton basic $MgCO_3$ (3) 39,000 gal per ton $MgCO_3$ (1)	18,000 lb per ton basic $MgCO_3$ (3)
Magnesium hydroxide from sea water and dolomite	Sea water 58,000 gal and fresh water 500 gal per ton $Mg(OH)_2$ (3)	800 lb per ton $Mg(OH)_2$ (3)
Oxygen, liquid	2000 gal per 1000 cu ft O_2 (3)	
Phenol, synthetic		4000 lb per ton phenol (3)
Phosphoric acid (blast furnace)	75,000 gal per ton 100 per cent H_3PO_4 (3)	
Phosphoric acid (Dorr strong-acid process)	7500 gal per ton 35 per cent P_2O_5 acid (1, 3)	780 lb per ton 35 per cent P_2O_5 acid (3)
Potassium chloride from Sylvinite	40,000 to 50,000 gal per ton KCl (3)	2500 lb per ton KCl (3)
Soap, laundry	230 gal per ton soap (3) 500 gal per ton soap (2)	4000 lb per ton soap (3)
Soda ash (ammonia-soda process)	15,000 to 18,000 gal per ton 58 per cent soda ash (1, 3)	
Sodium bichromate		6000 lb per ton sodium bichromate (3)
Sodium chlorate	60,000 gal per ton sodium chlorate (3)	11,000 lb per ton sodium chlorate (3)
Sodium silicate	160 gal per ton 40 Bé water glass (3)	1040 lb per ton 40 Bé water glass (3)
Sodium sulfate, natural		3650 lb per ton anhydrous Na_2SO_4 (95 + per cent) (3)
Stearic acid and red oil		18,000 lb per ton stearic acid (3)
Sulfur dioxide, liquid	18,000 gal per ton liquid SO_2 (3)	6800 lb per ton liquid SO_2 (3)
Sulfuric acid (chamber process)	2500 gal per ton 100 per cent H_2SO_4 (3)	

[a] The boldface numbers in parentheses refer to the list of references appended to this section of the appendix.

	Water	Steam
Sulfuric acid (contact process)	4000 gal per ton 100 per cent H_2SO_4 (3) 5000 gal per ton H_2SO_4 (2)	
Trisodium orthophosphate		150 lb per ton Na_3PO_4 $12H_2O$ (3)
Vanillin (synthetic)		30,800 lb per ton vanillin (3)
Viscose rayon	180,000 to 200,000 gal per ton viscose yarn (3)	140,000 lb per ton viscose yarn (3)
	FOOD INDUSTRY	
Bread	500 to 1000 gal per ton bread (4)	600 to 1000 lb per ton bread (4)
Brewing		
Beer	470 gal per bbl beer (5)	
Whiskey	80 gal per gal whiskey (5)	
Canning		
Apricots	8000 gal per 100 cases No 2 cans (5)	
Asparagus	7000 gal per 100 cases No 2 cans (1, 5)	
Beans		
Green	3500 gal per 100 cases No 2 cans (1, 5)	
Lima	25,000 gal per 100 cases No 2 cans (1, 5)	
Pork and beans	3500 gal per 100 cases No 2 cans (1)	
Beets	2500 gal per 100 cases No 2 cans (5)	
Corn	2500 gal per 100 cases No 2 cans (5)	
Cream or whole	4000 gal per 100 cases No 2 cans (1)	
Peas	3000 gal per 100 cases No 2 cans (1)	
Sauerkraut	300 gal per 100 cases No 2 cans (1, 5)	
Spinach	16,000 gal per 100 cases No 2 cans (1, 5)	
Succotash	12,500 gal per 100 cases No 2 cans (5)	
Tomatoes		
Products	7000 gal per 100 cases No 2 cans (1)	
Whole	750 gal per 100 cases No 2 cans (1)	
Corn refining	333 gal per ton corn (1)	
Edible gelatin	13,200 to 20,000 gal per ton gelatin (4)	
Edible oil	22 gal per gal oil (3)	
Meat packing		
Packing house	55,000 gal per 100 hog units (1, 5)	
Poultrt	4400 gal per ton live weight (1)	
Slaugh er house	16,000 gal per 100 hog units (1, 5)	
Stockyards	160 gal per acre (5)	
Milk and milk products		
Butter	5000 gal per ton butter (1)	
Cheese	4000 gal per ton cheese (1, 5)	
Dairies	3 gal per qt milk (2)	
Receiving and bottling	450 gal per 100 gal milk (1, 5)	
Creamery	220 gal per ton raw (5)	
estaurants	0 5 to 4 0 gal per meal (2, 5)	
Rugar		
S Beet	2160 gal per ton refined sugar (3)	
	20,000 to 25,000 gal per ton sugar (1)	
	2600 to 3200 gal per ton beets (1)	
Refined cane	1000 gal per ton sugar (2)	
	Condensing 4800 to 8400 gal per ton (3)	3500 lb per ton refined sugar (3)
	Pure water 1400 gal per ton refined sugar	
Vegetable dehydration		
Beets	37,400 gal per ton product (1)	
Cabbage	15,000 gal per ton product (1)	
Carrots	31,600 gal per ton product (1)	
Potatoes	11,200 to 25,000 gal per ton product (1)	
Rutabagas	30,400 gal per ton product (1)	
Sweet potatoes	18,000 gal per ton product (1)	
	TEXTILE INDUSTRY	
Cotton		
Bleaching	25 to 38 gal per yd (2)	
Dyeing	1000 to 2000 gal per 100 lh goods (1)	
Finishing	10 to 15 gal per yd (2)	
Processing	3800 gal per 100 lb goods (1)	
Knit goods, bleaching	16,000 gal per ton goods (2)	
Linen	200,000 gal per ton goods (1)	
Rayon		
Cuprammonium yarn	160,000 gal per ton yarn (1)	
Dissolving pulp	190,000 gal per ton pulp (1)	
Viscose yarn	200,000 gal per ton yarn (1)	
Silk, hosiery dyeing	6000 to 8000 gal per ton goods (2)	
Wool		
Scouring	2000 to 15,000 gal per 100 lb raw wool (1)	
Scouring and bleaching	40,000 gal per ton goods (2)	
	MISCELLANEOUS INDUSTRIES	
Air conditioning	6000 to 15,000 gal per person per season (1)	
Aluminum	1,920,000 gal per ton aluminum (2)	
Buildings, office	27 to 45 gal per day per capita (2, 5)	
Cement, portland	750 gal per ton cement (2, 3)	
Cement rock, beneficiation	720 gal per ton raw rock (3)	

	Water	Steam
Coal		
By-product coke	1430 to 2860 gal per ton coke (3)	570 to 860 lb per ton coke (3)
Carbonizing	3500 gal per ton coal carbonized (1)	
Washing	125 gal per ton coal (1)	
Electricity	80 gal per kw electricity (2, 5)	
	120,000 gal per ton coal burned (1)	
Hospitals	135 to 350 gal per day per bed (2, 5)	
Hotels	300 to 525 gal per day per guest room (2, 5)	
Laundries		
Commercial	8600 to 11,400 gal per ton "work" (2, 5)	
Institutional	6000 gal per ton "work" (2, 5)	
Leather tannery	375 gal per ton vegetable tan (3)	
	600 gal per ton chrome tan (3)	
	6000 to 16,000 gal per ton leather (2)	
	16,000 gal per ton hides (1)	
Petroleum		
Airplane engine (to test)	125,000 gal per airplane engine (2)	
Gasoline	7 to 10 gal per gal gasoline (2)	
Gasoline, aviation	25 gal per gal aviation gasoline (2)	
Gasoline, natural	20 gal per gal gasoline (3) and 2000 cu ft stripped gas at 150 lb pressure	6 lb per gal gasoline (3) and 2000 cu ft stripped gas at 150 lb pressure
Gasoline, polymerization	34 gal per gal polymer gasoline (3)	2.7 lb per gal polymer gasoline (3)
Oil, Fischer-Tropsch synthesis	150,000 gal per 100 bbl oil (7)	
Oil fields	18,000 gal per 100 bbl crude oil (1)	
Oil refinery	77,000 gal per 100 bbl crude oil (1)	
Pulp and paper mills	50,000 to 150,000 gal per ton pulp (2)	
De-inking paper	38,000 gal per ton paper (1)	
Paper board	14,000 gal per ton paper board (1)	
Soda pulp		13,000 lb per ton dried soda pulp (3)
Strawboard	26,000 gal per ton strawboard (1)	
Sulfate pulp (Kraft)		10,000 lb per ton dried sulfate pulp (3)
Sulfate pulp bleaching	60,224 gal to bleach 1 ton (3) dry pulp of 80 to 85 G.E. brightness	3120 lb to bleach 1 ton (3) dry pulp of 80 to 85 G.E. brightness
Sulfate pulp		5000 to 7000 lb per ton dried pulp (3)
Rock wool	4000 to 5000 gal per ton rock wool (1, 3)	3000 lb per ton rock wool (3)
Rubber (auto tire)		120 lb per auto tire (3)
Steel plant	20,000 to 35,000 gal per ton steel (1)	
Fabricated steel	42,000 gal per ton steel (2)	
Ingot steel	18,000 gal per ton steel (2)	
Pig iron	4000 gal per ton pig iron (1)	
Sulfur mining	3000 gal per ton sulfur (1)	

REFERENCES

(1) G. E. Symons, "Treatment of Industrial Wastes," *Water and Sewage*, Vol, 82, No. 11, November, 1944, p. 44.
(2) *Journal*, Am. Water Works Assn., Vol. 37, No. 9, September, 1945, p. 4.
(3) Chemical and Metallurgical Engineering Flow Sheets, 4th Ed. (1944).
(4) Food Industries Flow Sheets of the Food Producing Industry, 2nd Ed. (1947).
(5) H. E. Jordan, "Industrial Requirements for Water," *The Johnson National Drillers' Journal*, July–August, 1948, p. 7.
(6) W. L. Faith, "Plant Location in Agricultural Process Industries," *Chemical Engineering Progress*, Vol. 45, May, 1949, p. 313.
(7) W. C. Schroeder, "Comparison of Major Processes for Synthetic Liquid Fuels," *Chemical Industries*, Vol. 62, No. 4 p. 577 (1948).
(8) S. T. Powell and L. G. von Lossberg, "Relation of Water Supply to Chemical Plant Location," *Chemical Engineering Progress*, Vol. 45, May, 1949, pp 289–300.