TEXAS GULF COAST INDUSTRIAL WATER SURVEY

CIRCULAR NO. 63-02

TEXAS WATER COMMISSION
APRIL 1963

TEXAS WATER COMMISSION

Joe D. Carter, Chairman
O. F. Dent, Commissioner
H. A. Beckwith, Commissioner

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Data obtained and compiled by the Water Supply and Conservation Committee of the Houston Chamber of Commerce

Final report prepared
by
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Texas Water Commission

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PREFACE

This report presents data on the quantity, quality, and cost of water used by industries in the Texas Gulf Coast industrial complex. The data were gathered by a 1961 survey of Gulf Coast industries. This survey was conducted by means of a questionnaire which was prepared and distributed by the Water Supply and Conservation Committee of the Houston Chamber of Commerce at the request of the Texas Water Commission (formerly the Board of Water Engineers). The purpose of the survey was to ascertain the present and future water-use requirements in this area for industries having a total daily use greater than 100,000 gallons per day.

In his letter transmitting the questionnaire to the industries, Mr. P. H. Robinson, President of the Houston Chamber, stated, "The availability of an abundant supply of industrial water is recognized as a major factor in the continued industrial growth of our entire Gulf Coast area." In emphasizing the importance of an abundant supply, the considerations of water quality and cost were not neglected. Although water may be available in large quantities, poor quality or the cost factor may render it undesirable for some uses. Therefore, information on quality and cost of industrial water is of great significance both to agencies such as the Texas Water Commission and to organizations such as the Houston Chamber of Commerce in planning for and assisting in future industrial development.

When the completed questionnaire had been returned to the Chamber and the data had been compiled, the results were transmitted in tabular form to the Texas Water Commission for its review. Additional tabulations and illustrations were prepared by the Commission along with a draft of this report. The report was reviewed by the Water Supply and Conservation Committee of the Houston Chamber of Commerce prior to its publication.

ACKNOWLEDGEMENTS

The Texas Water Commission gratefully acknowledges the efforts of the following organizations and individuals having a part in making this publication possible:

Water Supply and Conservation Committee of the Houston Chamber of Commerce (Frank H. Newnam, Chairman)

Industrial Water Division of the Water Supply and Conservation Committee (H. M. Shilstone, Jr. and C. R. Marks, Cochairmen)

Charles D. Curran, Industrial Water Division member, for preparation of the questionnaire

R. F. Gray for the compilation of the original data from returned questionnaires

The Houston Chamber of Commerce joins the Texas Water Commission in expressing special appreciation to the industries who assisted in the survey by completing the detailed questionnaire.

TABLE OF CONTENTS

TABLES

TABLE OF CONTENTS (Cont'd.)

ILLUSTRATIONS

Figures

TEXAS GULF COAST

INDUSTRIAL WATER SURVEY

INTRODUCTION

The questionnaire shown on the following page was sent to 282 coastal industries located in an area which lies between Orange and Corpus Christi and includes the counties either on the coast or adjacent to the coastal counties. Completed questionnaires were returned by 122 of the firms queried, an indication of a use rate less than 100,000 gallons per day was made by 94, a statement that no reply would be returned was made by 3, and no reply of any kind was received from 63.

The questionnaire itself consisted of two pages of questions designed to provide an indication of present and future water requirements for industries in the Orange to Corpus Christi reach of the Gulf Coast together with desirable information concerning the chemical quality and cost of water. This information was sought according to type of water use. Data were gathered on potable, process, cooling, and recirculated cooling water. Questions asked in this survey sought to determine: the quantity used of each type of water, methods of handling and disposing of cooling and waste water, sources of present supply, cost of each type of water, quality desired, quantity of water used per unit of product, and estimated percentage increase in water use in the next 10 years. Several questions also were asked concerning the importance of water quality to the industries.

A copy of the industry classification sheet which was sent along with the questionnaire is also shown on the following page. Using this sheet, it was possible for an industry to send an anonymous reply. The only place that the name of the industry appeared on a reply was on that portion of the classification sheet below the dotted line. This portion was returned in an envelope apart from the questionnaire. For industries using less than 100,000 gallons per day and those not replying for any other reason, the return of the lower portion of the classification sheet was the only response.

In general, the questionnaires were answered completely, although some were only partially answered or contained conflicting statements. The information resulting from the survey can be considered as a good <u>indicator</u> of present and future uses but cannot be interpreted to completely represent the water-use characteristics of the Gulf Coast industries.

The data extracted from the questionnaires are presented in the tables and graphs appearing later in the report. The results are arranged in such a manner as to present the industries' sources of supply, quantity used, cost, quality requirements, and anticipated future needs.

INDUSTRIAL WATER USE QUESTIONNAIRE

HOUSTON CHAMBER OF COMMERCE

1. TYPE OF INDUSTRY_____(See Attached Schedule)

2. NUMBER OF EMPLOYEES: Under 25( ); 25-100( ); 100-500( ); Over 500( ).

3. APPROXIMATE AVERAGE WATER USAGE IN GALLONS PER DAY

Type of Water	Under 10,000	10,000-50,000	50,000-100,000	100,000-250,000	250,000-500,000	Over 500 M (Give Amount)	Est. % Incr. In 10 yrs.
Potable & Sanitary							
Process							
Cooling, Make-up							
Cooling, Recirculated							
Other							

4. IF COOLING WATER IS USED PLEASE CHECK FOLLOWING:

A. Cooling water is: (1) Returned to tidewater after one use_____

(2) Returned to a stream after one use_____

(3) Recirculated through cooling tower_____

(4) Recirculated through lake or pond_____

(5) Other_____Describe_____

B. Is any waste water treated: Yes____No____Details attached_____

5. SOURCE OR SOURCES OF PRESENT SUPPLY:

		QUANTITY						QUALITY OF SUPPLY		
		Present Requirement			Est. 1970 Requirement					
Source	Percent of Total	Supply Ample	Doubtful	Inadequate	Supply Ample	Doubtful	Inadequate	Excellent	Satisfactory	Poor
Private Surface Supply										
Private Wells										
Public Potable										
Public Raw										
Brackish										

6. COST: If not confidential give average unit cost for each type of water:

Type	Potable or Sant.	Process	Cooling	Other
Cost ¢/1000 Gal.				
or Cost $/Ac.Ft.				

7. QUALITY:

a. Would better quality water induce expansion of your industry? Yes____No____

b. Would your industry pay substantially higher prices for better quality water? Yes__No__ If so, specify relationship.

c. What are highest acceptable values (in PPM) of the following:

	Potable	Process	Cooling
Chlorides			
Sulphates			
Carbonates			
Total dissolved solids			
Total hardness as $CaCO_3$			
Other			

d. To what extent could you use salt, or brackish water if it should become necessary? % of Total_____Purpose_____
Attached remarks if desired.

8. LOCATION OF PLANT: How important is ample supply of good quality water to location or expansion of your type of plant;
Minimum importance( ); Fairly important( ); Of prime importance( ).

9. QUANTITY OF WATER PER UNIT OF PRODUCT: If available give estimate of quantity of water per unit of product in one or more units such as suggested below:

Type	Gallons/Ton	Gallons/$ of Output	Gallons/Btu of Fuel Used	Other Measure Unit	Other Measure Amt/Unit
Process					
Cooling					
Other					

INDUSTRIAL WATER USE SURVEY
CLASSIFICATION OF INDUSTRIES

List by letter and number in answer to question 1 (or give alternate description.) If plant represents more than one type use numerals 1,2 and 3 to indicate order of importance.

A. Products relative to Agriculture, Forestry, Fisheries

B. Mining:

13 Oil and Gas
14 Sulfur
15 Other

C. Construction

D. Manufacturing Industries

20 Food and Beverages and Tobacco
22 Apparel and Textiles
24 Lumber, Wood and Furniture
26 Paper and Pulp
28 Chemicals & Drugs (Other than oil and gas products)
(This classification includes fertilizers, insecticides and others)
29 Oil and Gas Products other than Plastics
29A Plastics
31 Leather and Leather Products
32 Stone, Clay and Glass Products
33 Metal, Machinery and Transportation Products
38 Professional and Scientific Instruments
39 Miscellaneous (Specify)

E. Heat, Light and Power

Please detach and return

TO: Water Supply and Conservation Committee
Houston Chamber of Commerce

In respect to the Industrial Water Use Questionnaire, we

( ) - Have or will respond.

( ) - Will not respond because our water intake is less than 100,000 g/d.

( ) - Will not respond for other reasons.

_____
Company Name

SOURCES OF WATER SUPPLY

The number of firms using water from each of the six sources of supply listed on the questionnaire is shown in Table 1, categorized according to the amount of daily use. Probably the most important information presented in this table is the division between the plants using ground water and those using surface water. As shown in Figure 1, the majority of the plants using private supplies used ground water. The predominant use of ground water would be more obvious if it were possible to reflect whether the public supplies indicated were ground water or surface water, since many cities in this area use ground water. It should be noted that 52 of the 122 plants participating in the survey reported more than one source of supply.

CLASSIFICATION BY TYPE OF WATER USE

Table 2 presents data on the type of water use. It is arranged to show the number and percentage of plants reporting for each type of use in each of several rate ranges of daily use. Not all of the 122 firms responding to the questionnaire indicated use in all of the classes of use. Potable, process, and cooling water uses were indicated by 95, 96, and 89 industries respectively. As might have been expected, the table shows that potable water use is predominantly in the lower rate ranges of daily use whereas process and cooling water uses are predominantly in the upper rate ranges.

WATER USE BY TYPE OF INDUSTRY

Table 3 presents the quantity of water used according to the type of industry. The total daily intake values given in column three include potable, process, cooling make-up, and single-use cooling water quantities. Four increasing ranges of daily use are shown in succeeding columns. For each type of industry, the number and percentage of plants within each range reporting use are shown together with the quantity of water used by these plants. Several types of industries--notably (1)food, beverages, and tobacco, (2)chemicals and drugs, (3)oil and gas products, (4)plastics, and (5)metal products--provided a sufficient number of replies to give a good indication of the total daily water use for their respective types of industry in the survey area. Figure 2 shows the percentage of these plants reporting use in the ranges indicated.

It should be particularly noted that extreme care is essential in any interpretative use of the data presented on industrial water use. An obvious example of why such extreme care is necessary is revealed by close examination of Table 3, which indicates that 39 percent of the total reported daily intake of industrial water is attributable to use by the one reporting plant in the heat, light, and power industry classification.

QUANTITIES OF COOLING WATER USE

A summary of the amounts of cooling water use reported, according to the type of cooling use, is shown in Table 4. The summary is presented in two parts, with the upper portion showing quantities of water demand and the lower part indicating quantities of recirculated cooling water.

It is interesting to note that the total cooling water demand of 2,002 mgd (million gallons per day) constitutes 86 percent of the total daily intake of 2,328 mgd. Fresh-water supplies for all other industrial uses, such as potable and process, total only 326 mgd.

The single use of cooling water by 19 plants is reflected in the table. Returned questionnaires showed that 28 plants resort to cooling by single use of either brackish or fresh water; incomplete replies necessitated elimination of the quantities used by 9 of these plants from the tabulation. Recirculation through cooling towers was reported by 89 plants, and 14 plants indicated cooling pond use. The combination of single-use cooling and cooling tower operation was reported by 15 plants. Four of the responding industries indicated recirculation through cooling ponds alone, and 10 reported combining pond use with tower operation.

COOLING WATER USE BY TYPE OF INDUSTRY

Table 5 gives a breakdown of the quantities of cooling make-up water used and single-use and recirculated cooling water pumped. The amounts of cooling make-up water used are presented in rate ranges of daily use and the amounts of cooling water pumped are presented according to whether fresh or brackish single-use cooling water or recirculated cooling water was used. The number of plants and quantity used are shown for each type of industry.

WATER COST

Data are presented in Table 6 on the cost of the types of water used as indicated in the survey. The number of plants having costs in the given ranges are indicated in column three. For each range in cost, a range in rate of use is shown in column four. Therefore, these figures give an indication of the daily cost of water for the reporting industries.

Figure 3 depicts graphically the percentage of plants experiencing costs in the ranges shown. As would be expected, it shows a very high percentage of plants reporting that cooling water is in the lowest cost range. A more even distribution of percentages of plants reporting, ranging from 19 to 28 percent, is shown across the four cost ranges for potable water. The distribution of costs for process water is shown to fall between that for cooling and potable water.

HIGHEST ACCEPTABLE CONCENTRATIONS OF CHEMICAL CONSTITUENTS

The highest acceptable concentrations of chemical constituents for the water of all reporting plants are shown in Table 7 for the constituents on which data were sought. The number of plants desiring a particular concentration, the daily use of these plants, and the percentage of the total daily use are presented for each of several concentration ranges by type of water.

It is notable that exceptionally rigorous quality requirements were not indicated as necessary for most of the process and cooling water used. For more than 90 percent of the process water used, a chloride concentration equal to or greater than 100 ppm (parts per million) was acceptable. A chloride concentration equal to or greater than 200 ppm was acceptable to more than 90 percent of the plants for use as cooling water.

As shown in the table, only a small percentage of plants specifically reported use of potable water meeting the drinking-water standards recommended by the U. S. Public Health Service or Texas State Department of Health. In actuality, an investigation of the replies indicated that quality requirements for potable water generally did lie within the ranges specified as acceptable in these drinking-water standards.

Figures 4 through 7 show graphically the number of plants which can use water having concentrations of chemical constituents in specific ranges. A separate graph is included for each type of water use. The graphs are arranged so as to present the desirable concentrations for each type of industry that provided sufficient data.

EFFECT OF WATER QUALITY ON PLANNING FUTURE OPERATIONS

Table 8 presents answers given to the survey questions concerning the importance of water quality. It is arranged so that the number of plants and amount of their use are indicated according to the type of industry. It is interesting to note that, although most of the firms stated that an ample supply of good water is of prime importance, they indicated that they would not pay a higher price for water of improved quality and that improved quality would not affect their plans for plant expansion. This probably is indicative that an industry either has adapted its processes to the water available or has located in an area in which water of the quality desired is available.

ESTIMATED INCREASE IN WATER REQUIREMENTS

In Table 9, the reported present use of water and estimated increase in water requirements are presented for each reporting industry. The table is divided into parts so that the present use, the estimated 10-year percentage increase in use, and the increase in quantity of use in the next 10 years can be found by type of water use for each industry reporting an estimated increase. The total present use is given in the second column of the table, and the total estimated 10-year increase in use is listed in the last column. The total

present use includes potable, process, cooling, recirculated cooling, and single-use cooling water. Quantities of single-use cooling water pumped are not included in the breakdown of water use by types (columns four through eighteen in the table). No amount of use is included in the table if an estimated increase in use was not indicated for that type of water. Therefore, the sum of the individual uses listed in the table will not always equal the total present use shown in column three.

Only 52 of the 122 respondents answered the part of the questionnaire concerning increased use. However, these plants have a daily intake equal to 70 percent of the total daily intake of all reporting industries. The total of the estimated increases in water requirements of these plants is 48.8 percent of their total present daily intake.

QUANTITY OF WATER PER UNIT OF PRODUCT

The quantity of water used per unit of product is given in Table 10. The figures presented in the table are the ones given in answer to question nine of the questionnaire. There were 60 plants of the 122 participating in the survey which answered this part of the questionnaire. By looking through the figures given, it can be seen that no correlation exists between the amount of water used and the products produced. Because there is a wide variation in quantities used per unit of product, and because it is difficult to compare the quantities when different products are represented, this table's usefulness probably is limited to presenting to interested parties as much of the data received in this survey as it is possible to present.

COMMENTS AND SUGGESTIONS FOR FUTURE STUDY

The data shown in the tables and figures of this report are presented in the hope that they will be helpful to Gulf Coast water users and those planning new water supplies.

Experience with this survey prompts the suggestion, for future surveys, including several items on which it would have been helpful to have data. The identity of the respondents, particularly the larger water users, should be obtained on a confidential basis if possible for further follow-up and clarification of replies. More information needs to be gathered concerning the significance of water quality in industry planning operations, in an effort to resolve the apparent contradictory character of responses in this survey stating that water of good quality was of prime importance and at the same time stating that the industries would not pay a higher price for water of better quality. Information is needed on the types and uses of water-saving methods, such as cooling ponds or towers and partial treatment, and the relative costs of utilizing these methods.

Table 1.--Sources of water supply

Quantity drawn (gallons per day)	Number of plants drawing from indicated source					
	Private surface supply	Private wells	Public potable supply	Public raw water supply	Brackish, stream, or ocean	Other sources
Amount unstated	--	--	1	--	2	--
Less than 10,000	--	2	5	--	--	--
10,000 to 50,000	2	3	15	2	--	--
50,000 to 100,000	--	5	11	4	1	--
100,000 to 250,000	1	19	5	1	--	--
250,000 to 1 million	2	26	7	4	1	1
1 million to 10 million	6	23	4	10	5	--
More than 10 million	3	--	--	7	8	--
Total	14	78	48	28	17	1

Total replies: 122

Plants using more than one source of supply: 52

Table 2.--Classification by type of water use

Quantity diverted to use (gallons per day)	Potable and sanitary			Process			Cooling, make-up		
	Plants reporting	Per-cent	Cumulative percent	Plants reporting	Per-cent	Cumulative percent	Plants reporting	Per-cent	Cumulative percent
Less than 10,000	36	38	38	9	9	9	15	17	17
10,000 to 100,000	30	32	70	28	29	38	21	23	40
100,000 to 500,000	22	23	93	19	20	58	23	26	66
More than 500,000	7	7	100	40	42	100	30	34	100
Total	95	--	--	96	--	--	89	--	--

Quantity diverted to use (gallons per day)	Cooling, recirculated			Other use			Unclassified
	Plants reporting	Per-cent	Cumulative percent	Plants reporting	Per-cent	Cumulative percent	Plants reporting
Less than 10,000	3	3	3	2	7	7	--
10,000 to 100,000	8	9	12	6	21	28	--
100,000 to 500,000	12	14	26	6	22	50	1
More than 500,000	66	74	100	14	50	100	--
Total	89	--	--	28	--	--	1

Number of plants participating in survey: 122

Table 9.--Estimated increase in water requirements
(thousand gallons per day)

Industry	Total replies	Total present use	Potable and sanitary water			Process water			Cooling make-up water			Cooling recirculation			Other uses			All uses
			Present use	Est. 10-yr. percent incr.	Total est. increase	Present use	Est. 10-yr. percent incr.	Total est. increase	Present use	Est. 10-yr. percent incr.	Total est. increase	Present recirculation	Est. 10-yr. percent incr.	Total est. increase	Present use	Est. 10-yr. percent incr.	Total est. increase	Total est. increase
Oil and gas production	2	2,420	--	--	--	--	--	--	--	--	--	2,300	280	6,500	--	--	--	6,500
		10,260	--	--	--	--	--	--	--	--	--	10,000	10	1,000	--	--	--	1,000
Subtotals		12,680	--	--	--	--	--	--	--	--	--	12,300	--	7,500	--	--	--	7,500
Food and beverage mfg.	5	350	100	10	10	100	10	10	100	10	10	--	--	--	50	10	5	35
		250	250	10 to 15	40	--	--	--	--	--	--	--	--	--	--	--	--	40
		13,710	--	--	--	1,150	35	400	260	35	90	12,300	35	4,300	--	--	--	4,790
		3,748	850	50	425	--	--	--	--	--	--	--	--	--	--	--	--	425
		1,920 1/	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Subtotals		19,978	1,200	--	475	1,250	--	410	360	--	100	12,300	--	4,300	50	--	5	5,290
Paper and pulp mfg.	1	61,800	50	10	5	31,000	25	8,000	--	--	--	--	--	--	--	--	--	8,005
Subtotals		61,800	50	--	5	31,000	--	8,000	--	--	--	--	--	--	--	--	--	8,005
Chemicals and drugs (except oil and gas products)	15	7,820	20	15	3	4,200	10	420	--	--	--	3,600	100	3,600	--	--	--	4,023
		3,260	--	--	--	--	--	--	--	--	--	1,750	100	1,750	--	--	--	1,750
		410	10	50	5	--	--	--	--	--	--	--	--	--	--	--	--	5
		2,990	950	164	1,560	--	--	--	--	--	--	--	--	--	--	--	--	1,560
		99,750	360	50	180	3,020	50	1,510	1,370	50	685	95,000	50	47,500	--	--	--	49,875
		200	50	800	400	--	--	--	--	--	--	--	--	--	--	--	--	400
		378,300	800	25	200	9,500	10	950	8,000	25	2,000	360,000	10	36,000	--	--	--	339,150
		148,600	--	--	--	3,000	20	600	6,400	15	960	22,000	25	5,500	116,500 2/	20	23,300	30,360
		820	--	--	--	750	10	75	--	--	--	--	--	--	--	--	--	75
		1,530	--	--	--	--	--	--	--	--	--	1,500	70	1,050	--	--	--	1,050
		3,050	50	10	5	750	20	150	250	20	50	2,000	20	400	--	--	--	605
		2,577	7	25	5	735	25	185	110	25	30	1,725	25	430	--	--	--	650
		550	50	250	125	250	500	1,250	--	--	--	--	--	--	--	--	--	1,375
		370	10	50	.5	--	--	--	10	100	10	250	100	250	--	--	--	265
		1,800	10	100	10	1,250	100	1,250	40	100	40	500	100	500	--	--	--	1,800
Subtotals		652,027	2,317	--	2,498	23,455	--	6,390	16,180	--	3,775	488,325	--	96,980	116,500	--	23,300	132,943
Oil and gas refining (except plastics)	18	684,000	1,000	10	100	7,000	35	2,450	26,000	35	9,100	650,000	35	227,500	--	--	--	239,150
		586,830	200	10	20	5,760	75	4,320	10,870	75	8,150	565,000	75	423,750	--	--	--	436,240
		144,760	50	1,000	500	10	1,000	100	700	500	3,500	--	--	--	--	--	--	4,100
		169,950	250	100	250	1,100	100	1,100	3,600	80	2,880	165,000	80	132,000	--	--	--	136,230
		6,816	--	--	--	--	--	--	200	150	300	6,616	100	6,620	--	--	--	6,920
		750	--	--	--	240	20	50	--	--	--	500	20	100	--	--	--	150
		1,036,150	--	--	--	--	--	--	14,000	10	1,400	970,000	10	970,000	--	-50 3/	--	98,400
		310,530	80	50	40	3,150	50	1,575	6,500	45	2,925	300,000	50	150,000	--	--	--	154,540
		179,390	290	35	100	8,200	35	2,870	2,900	35	1,015	168,000	35	58,800	--	--	--	62,785
		59,472	130	10	15	504	30	150	1,238	30	370	57,600	30	17,280	--	--	--	17,815
		214,870	--	--	--	5,000	20	1,000	--	--	--	--	--	--	--	--	--	1,000
		573,615	--	--	--	7,565	25	1,890	9,000	30	2,700	500,000	30	150,000	57,000 4/	-25	-14,250	140,340
		58,370	--	--	--	720	25	180	2,880	25	720	54,720	25	13,680	--	--	--	14,580
		52,060	10	10	5	250	25	65	800	2	20	--	--	--	--	--	--	90
		354,310	--	--	--	1,920	30	580	7,410	30	2,220	342,000	30	102,600	2,480	30	750	106,150
		44,756	30	70	20	26	100	30	1,300	100	1,300	43,200	100	43,200	200	50	100	44,650
		42,830	730	26	190	500	26	130	1,100	26	290	40,000	26	10,400	--	--	--	11,010
		4,850	100	200	200	250	100	250	500	100	500	4,000	100	4,000	--	--	--	4,950
Subtotals		4,524,309	2,770	--	1,440	42,195	--	16,740	88,998	--	37,390	3,966,636	--	1,436,930	59,680	--	-13,400	1,479,100
Plastics	6	499,140	250	10	25	109,590	10	109,960	500	10	50	100,800	10	10,100	--	--	--	120,135
		26,750	--	--	--	1,500	10	150	--	--	--	25,000	10	2,500	--	--	--	2,650
		46,446	--	--	--	1,210	25	300	216	50	110	45,000	50	22,500	--	--	--	22,910
		48,940	--	--	--	2,000	50	1,000	--	--	--	--	--	--	--	--	--	1,000
		207,500	500	50	250	2,000	25	500	5,000	25	1,250	200,000	25	50,000	--	--	--	52,000
		147,580	500	20	100	5,000	20	1,000	2,000	30	600	140,000	30	42,000	--	--	--	43,700
Subtotals		976,356	1,250	--	375	121,300	--	113,910	7,716	--	2,010	510,800	--	127,100	--	--	--	243,395
Mfg. metal products	3	57,000	1,000	20	200	--	--	--	6,000	20	1,200	50,000	20	100,000	--	--	--	101,400
		22,400	100	15	15	250	20	50	50	20	10	22,000	20	4,400	--	--	--	4,475
		38,300	750	30	225	100	15	15	500	10	50	36,700	2	735	--	--	--	1,025
Subtotals		117,700	1,850	--	440	350	--	65	6,550	--	1,260	108,700	--	105,135	--	--	--	106,900
Miscellaneous	1	9,650	250	50	125	1,175	40	470	250	40	100	8,000	30	2,400	--	--	--	3,095
Subtotals		9,650	250	--	125	1,175	--	470	250	--	100	8,000	--	2,400	--	--	--	3,095
Lighting and power	1	2,313,722	137	26	40	755	29	220	3,830	12	460	1,411,000	160	2,248,000	--	--	--	2,258,720
Subtotals		2,313,722	137	--	40	755	--	220	3,830	--	460	1,411,000	--	2,248,000	--	--	--	2,258,720
Totals	52	8,688,222	9,824	--	5,398	221,480	--	146,205	123,884	--	45,095	6,518,061	--	4,038,345	176,230	--	9,905	4,244,948

1/ Ice manufacture. Decline in market expected.
2/ Brackish water for cooling once through.
3/ Reduction in brackish water for cooling once through.
4/ Reduction in cooling water once through (Fresh or brackish not stated).

Table 3.--Water use by type of industry, in thousand gallons per day

Type of Industry	Number of plants surveyed	Total intake	Less than 10 per plant			10 to 100 per plant			100 to 500 per plant			More than 500 per plant		
			No. of plants	Percent of plants	Combined intake	No. of plants	Percent of plants	Combined intake	No. of plants	Percent of plants	Combined intake	No. of plants	Percent of plants	Combined intake
MINING														
Oil and gas production	4	1,283	--	--	--	--	--	--	3	75	673	1	25	610
Sulphur production	3	9,910	--	--	--	--	--	--	--	--	--	3	100	9,910
Other	1	250	--	--	--	--	--	--	1	100	250	--		--
MANUFACTURING INDUSTRIES														
Food, beverages, and tobacco	17	6,850	1	6	6	3	18	275	6	35	1,099	7	41	5,470
Paper and pulp	2	32,600	--	--	--	--	--	--	--	--	--	2	100	32,600
Chemicals and drugs (except oil and gas products)	29	220,037	2	7	20	3	10	90	6	21	1,160	18	62	218,767
Oil and gas products (except plastics)	37	714,312	2	5	12	5	14	275	7	19	1,521	23	62	712,504
Plastics	10	422,505	--	--	--	--	--	--	3	30	689	7	70	421,816
Stone, glass, and ceramic products	1	1,750	--	--	--	--	--	--	--	--	--	1	100	1,750
Metal products	8	10,603	--	--	--	2	25	143	3	37	660	3	38	9,800
Miscellaneous	9	3,397	2	22	20	3	33	182	1	11	190	3	34	3,005
HEAT, LIGHT, AND POWER	1	904,722	--	--	--	--	--	--	--	--	--	1	100	904,722
Total	122	2,328,219	7	--	58	16	--	965	30	--	6,242	69	--	2,320,954

Table 4.--Quantities of cooling water use

Cooling water pumped	Amount, in million gallons per day
COOLING WATER DEMAND	
Brackish water	
Single use (11 plants).....	1,375
Total.....	 1,375
Fresh water	
Single use (8 plants).....	457
Cooling make-up.....	170
Total.....	 627
Total cooling water demand.....	 2,002
RECIRCULATED WATER	
Total.....	 8,422
Grand total cooling water pumpage....	 10,424

Table 5.--Cooling water use by type of industry,
in thousand gallons per day

Type of industry	Total no. of plants [1]	Cooling make-up water									
		Less than 10 per plant		10 to 100 per plant		100 to 500 per plant		More than 500 per plant		Total	
		No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake
Oil and gas production	4	--	--	1	100	3	1,020	--	--	4	1,120
Sulphur mining	3	--	--	1	100	--	--	--	--	1	100
Other mining operation	1	--	--	--	--	--	--	--	--	--	--
Food, beverages, and tobacco	17	4	40	3	140	1	400	--	--	8	580
Paper and pulp	2	--	--	--	--	--	--	1	750	1	750
Chemicals and drugs (except oil and gas products)	29	6	60	7	510	6	1,610	6	23,000	25	25,180
Oil and gas products (except plastics)	37	4	40	3	200	3	1,200	19	120,400	29	121,840
Plastics	10	--	--	1	50	6	2,150	2	7,000	9	9,200
Stone, brick, and ceramics	1	--	--	--	--	1	500	--	--	1	500
Metal products	8	--	--	4	170	2	750	1	6,000	7	6,920
Miscellaneous	9	1	10	1	100	1	250	--	--	3	360
Heat, light, and power	1	--	--	--	--	--	--	1	3,800	1	3,800
Total	122	15	150	21	1,370	23	7,880	30	160,950	89	170,350

Type of industry	Cooling water pumped							
	Single Use				Recirculated [2]		Total	
	Fresh		Brackish					
	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake
Oil and gas production	--	--	--	--	4	12,800	4	12,800
Sulphur mining	--	--	--	--	1	50	1	50
Other mining operation	--	--	--	--	--	--	--	--
Food, beverages, and tobacco	--	--	--	--	8	21,510	8	21,510
Paper and pulp	--	--	--	--	1	30,000	1	30,000
Chemicals and drugs (except oil and gas products)	1	21,000	2	126,500	22	665,940	25 [3]	813,440
Oil and gas products (except plastics)	5	435,920	4	59,700	29	5,560,810	32 [4]	6,056,430
Plastics	--	--	3	288,180	9	594,990	10 [5]	883,170
Stone, brick, and ceramics	--	--	--	--	1	2,700	1	2,700
Metal products	1	250	1	600	7	114,250	7	115,100
Miscellaneous	1	30	--	--	3	8,040	3	8,070
Heat, light, and power	--	--	1	900,000	1	1,411,000	1	2,311,000
Total	8	457,200	11	1,374,980	86	8,422,090	93	10,254,270

[1] Plants reporting a usage, quantities not reported in all uses.
[2] 4 plants circulate through cooling ponds alone; 10 plants utilize cooling ponds together with towers.
[3] 3 plants employ single use alone.
[4] 3 plants employ single use alone.
[5] 1 plant employs single use alone.

Table 6.--Water cost

Type of water	Cost-range category (cents per thousand gallons)	No. of plants	Range in use (thousand gallons per day)	Range in cost (cents per thousand gallons)
Potable	Less than 5	12	5.3 to 1,000	1.6 to 5.0
	5 to 10	11	6.0 to 250	5.3 to 10.0
	10 to 20	12	30.0 to 1,500	12.0 to 20.0
	More than 20	8	10.0 to 850	21.0 to 33
	No data	79	--	--
Process	Less than 5	15	50.0 to 5,000	0.4 to 5.0
	5 to 10	10	10.0 to 31,000	5.3 to 10.0
	10 to 20	10	10.0 to 5,000	11.7 to 17.1
	More than 20	6	17.0 to 2,000	21.0 to 42
	No data	81	--	--
Cooling	Less than 5	23	15.0 to 26,000	0.1 to 5.0
	5 to 10	6	22.0 to 9,000	5.5 to 10.0
	10 to 20	5	50.0 to 250	11.0 to 20.0
	More than 20	1	18.0	21.0
	No data	87	--	--
Other purposes	Less than 5	7	2,480 to 12,000	0.9 to 5.0
	5 to 10	1	--	5.6
	10 to 20	3	500 to 860	12.9 to 20.0
	More than 20	1	525	49 1/
	No data	110	--	--

1/ Processed boiler water

Plants participating in survey: 122

Table 7.--Highest acceptable concentrations of chemical constituents
(Water quantities in thousand gallons per day)

Chemical constituents	Potable supply			Process supply			Cooling make-up (including once-through)		
	No. of plants	Combined intake	Percent of total intake	No. of plants	Combined intake	Percent of total intake	No. of plants	Combined intake	Percent of total intake
CHLORIDE									
U.S.P.H. or State Dept. Health Std.*	5	25.92	1.3	1	0.19	Nil	2	0.30	Nil
More than 200 ppm	23	1,252.78	62.6	10	187.00	9.3	18	1,066.22	53.3
200 ppm or less	6	415.09	20.8	9	1,557.04	77.8	8	37.83	1.9
100 ppm or less	14	63.86	3.2	24	126.54	6.3	13	69.01	3.5
10 ppm or less	0	--	--	1	0.29	Nil	0	--	--
0 ppm only	0	--	--	0	--	--	0	--	--
Total	48	1,757.65	87.9	45	1,865.07	93.3	41	1,173.36	58.7
Not replying	19	243.10	12.1	22	135.67	6.7	26	--	41.3
SULPHATE									
U.S.P.H. or State Dept. Health Std.*	5	25.92	1.3	1	0.19	Nil	2	0.30	Nil
More than 200 ppm	16	636.85	31.8	8	424.52	21.2	12	971.02	48.5
200 ppm or less	4	990.68	49.5	1	66.15	3.3	2	73.65	3.7
100 ppm or less	10	42.99	2.1	17	1,217.93	60.9	11	75.74	3.8
10 ppm or less	8	26.92	1.3	9	27.94	1.4	7	20.12	1.0
0 ppm only	2	20.84	1.0	1	0.29	Nil	2	1.97	0.1
Total	45	1,744.20	87.2	47	1,737.02	86.8	36	1,142.80	57.1
Not replying	22	256.54	17.8	20	263.22	13.2	31	857.94	42.9
CARBONATE									
U.S.P.H. or State Dept. Health Std.*	5	25.92	1.3	1	0.19	Nil	2	0.30	Nil
More than 200 ppm	11	1,398.42	69.9	11	1,613.88	80.7	11	95.93	4.8
200 ppm or less	8	52.46	2.6	7	44.30	2.2	9	983.06	49.2
100 ppm or less	9	50.56	2.5	10	41.87	2.1	7	49.94	2.5
10 ppm or less	4	28.72	1.5	4	22.67	1.1	3	8.17	0.4
0 ppm only	3	3.94	0.2	5	14.65	0.7	4	4.59	0.2
Total	40	1,560.02	78.0	38	1,737.56	86.9	36	1,141.99	57.1
Not replying	27	440.72	22.0	29	263.18	13.1	31	858.75	42.9
DISSOLVED SOLID									
U.S.P.H. or State Dept. Health Std.*	5	25.92	1.3	1	0.19	Nil	2	0.30	Nil
More than 800 ppm	16	518.54	25.9	12	464.10	23.2	18	998.24	49.9
800 ppm or less	15	1,017.82	50.9	13	1,044.52	52.2	11	125.02	6.3
400 ppm or less	7	36.80	1.8	12	42.06	2.1	7	38.77	1.9
200 ppm or less	3	7.22	0.4	5	18.01	0.9	3	5.88	0.3
Total	46	1,606.30	80.3	43	1,568.88	78.4	41	1,168.21	58.4
Not replying	21	394.44	19.7	24	431.86	21.6	26	832.53	41.6
TOTAL HARDNESS									
U.S.P.H. or State Dept. Health Std.*	5	25.92	1.3	1	0.19	Nil	2	0.30	Nil
More than 200 ppm	4	973.85	48.7	7	94.72	4.7	10	126.08	6.3
200 ppm or less	10	36.70	1.8	5	909.54	45.5	9	17.46	0.9
100 ppm or less	20	98.45	4.9	22	121.15	6.1	13	984.05	49.2
10 ppm or less	2	4.91	0.3	6	37.72	1.9	4	13.91	0.7
0 ppm only	--	--	--	3	12.57	0.6	0	--	--
Total	41	1,139.83	57.0	44	1,175.89	58.8	38	1,141.80	57.1
Not replying	26	861.91	43.0	23	824.85	41.2	29	858.94	42.9

* Drinking-water standards recommended by the U. S. Public Health Service of the Texas State Department of Health.

Total response to specific question on quality, 55 percent, 67 replying out of 122 questionnaires returned.

Total daily use of water by 122 plants (all sources including wells), 2,328 million gallons per day.

Total daily use of water by 67 plants replying to questionnaire, 2,001 million gallons per day (86 percent).

Table 8.--Effect of water quality on planning future operations
(Water quantities in million gallons per day)

Type of industry	No. of plants	Total industry intake	Would improved quality affect plans for plant expansion?						Would the industry pay a higher price for improved quality?					
			Yes		No		No reply		Yes		No		No reply	
			No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake
Oil and gas products	4	1.283	--	--	3	1.163	1	0.120	--	--	2	0.903	2	0.380
Sulphur products	3	9.910	--	--	3	9.910	--	--	--	--	3	9.910	--	--
Other mining operation	1	.250	--	--	1	.250	--	--	--	--	1	.250	--	--
Food, beverages, and tobacco	17	6.850	1	0.868	15	5.872	1	.110	--	--	16	6.750	1	.100
Paper and pulp	2	32.600	--	--	2	32.600	--	--	--	--	2	32.600	--	--
Chemicals and Drugs (other than oil and gas products)	29	220.037	1	.550	24	198.097	4	21.390	1	0.210	23	211.397	5	8.430
Oil and gas refining (other than plastics)	37	714.312	--	--	35	712.506	2	18.06	--	--	35	712.506	2	1.806
Plastics	10	422.505	--	--	9	422.355	1	.150	--	--	10	422.505	--	--
Stone, clay and glass products	1	1.750	--	--	--	--	1	1.750	--	--	--	--	1	1.750
Metal products (base and fabrication)	8	10.603	--	--	8	10.603	--	--	--	--	8	10.603	--	--
Miscellaneous (unclassified)	9	3.397	1	--	7	3.337	1	.060	--	--	7	32.37	2	.160
Heat, light and power	1	904.722	--	--	1	904.722	--	--	--	--	1	904.722	--	--
Total	122	2,328.219	3	1.418	108	2,301.415	11	25.386	1	0.210	108	2,315.383	13	12.626

Type of industry	Could salt or brackish water be used (limited extent) if necessary?						How important is ample supply of good water to location or expansion of plant?							
	Yes		No		No reply		Minimum importance		Fairly important		Prime importance		No reply	
	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake	No. of plants	Combined intake
Oil and gas products	1	0.260	2	0.903	1	0.120	--	--	2	0.413	2	0.870	--	--
Sulphur products	--	--	3	9.910	--	--	--	--	--	--	3	9.910	--	--
Other mining operation	--	--	--	--	1	.250	--	--	--	--	1	.250	--	--
Food, beverages, and tobacco	1	.250	15	6.490	1	.110	3	0.106	--	--	12	5.844	2	0.900
Paper and pulp	--	--	2	32.600	--	--	--	--	--	--	2	32.600	--	--
Chemicals and drugs (other than oil and gas products)	10	183.592	16	28.845	3	7.600	2	.040	10	41.685	14	177.762	3	.550
Oil and gas refining (other than plastics)	11	270.469	22	364.953	4	78.890	1	.025	11	108.062	24	606.225	--	--
Plastics	2	401.200	7	21.155	1	.150	--	--	4	9.859	5	411.210	1	1.436
Stone, clay and glass products	--	--	--	--	1	1.750	--	--	--	--	--	--	--	1.750
Metal products (base and fabrication)	1	7.000	7	3.603	--	--	3	.303	2	2.000	2	8.200	1	.100
Miscellaneous (unclassified)	3	.772	4	2.555	2	.070	1	.010	2	2.445	4	.872	2	.070
Heat, light and power	1	904.722	--	--	--	--	--	--	--	--	1	904.722	--	--
Total	30	1,768.265	78	471.014	14	88.940	10	0.484	31	164.464	70	2,158.465	11	4.806

Table 10.--Quantity of water used per unit of product
(gallons per ton)

Industry	Total replies	Process	Make-up	Cooling recirculation	Once-thru	Boiler-fed	Other	Data in units other than gallons per ton
Oil and gas production	1	--	--	1,150	--	--	--	
Sulphur production	3	5,000	--	--	--	--	--	
		2,500	--	--	--	--	--	2,500 Btu/gal. = 0.0004 gal./Btu of fuel.
		8,000	--	--	--	--	--	
Salt from brine	1	--	--	--	--	--	800	
Food processing								
(vegetable oils)	7	5,000	--	--	--	--	--	36 gal./case of 24 cans.
canned vegetable		1,500	--	--	--	--	--	6.5 gal./dollar, or 0.0022 gal./Btu of fuel.
		1,150	--	--	--	--	1,200	
		4,800	--	1,200	--	--	20	
		740	--	15,000	--	--	--	
Ice manufacturing		290	20	--	--	--	--	
Ice manufacturing		225	--	4,400	--	--	--	
Paper and pulp mfg.	2	35,000	--	--	--	--	--	
		4,375	--	--	--	--	--	
Chemicals and drugs	11	5,000	--	--	--	--	--	
		5,620	--	6,580	--	--	--	
		5,000 to 25,000	--	5,000 to 25,000	--	--	--	
		2,400	--	1,400	--	--	9	
		1,000	--	2,100	--	--	1,000	
		2,700	--	240,000	--	--	--	Process 1.33 gal./lb.; cooling 1,000 gal./gal.
		500	--	--	--	--	--	
		--	--	65,000	--	--	--	
		16,000	--	2,500	--	--	350	
		160	--	350	--	--	--	
		11	--	293	--	600	--	
Oil and gas refining	22	1,600	10.6	470	--	--	--	
		33	--	--	--	1.5	--	
		--	--	7,150	--	--	--	
		1.4	--	37	--	--	--	
		--	--	--	--	--	--	Cooling recirculated 25 gal./dollar.
		57	400	--	1,230	185	--	
		100 1/	--	--	--	--	--	
Oil refining		97	--	3,900	--	--	--	
		600	--	--	--	--	--	
		700	--	--	--	--	--	
		100	--	240	--	--	--	
		170	--	500	--	--	300	
		350	--	500	--	--	--	
		--	--	--	--	--	5,360 1/	
		--	--	--	--	--	740 1/	
		100	--	570	--	--	--	
		500	--	400	--	130	--	0.000177 gal./Btu fuel.
		100	--	235	--	--	15	
		--	--	--	--	--	1,700 1/	
		--	--	--	--	--	300 1/	
		--	--	--	--	--	225 1/	
		700	--	2,300	--	--	--	
Plastics ind.	6	136,000	--	125,000	--	--	--	
		--	--	250,000	--	--	--	
Synthetic rubber		3.3	--	410	--	--	0.64	
		3,000	--	66,000	--	--	--	
		2,800	--	230,000	--	--	--	
		--	--	--	--	--	--	Process 8^{-6} gal./Btu; cooling 8^{-5} gal./Btu.
Metal products	4	--	--	2,300	--	--	16,000	
		--	--	--	--	--	--	Process 0.77 gal./cu. ft. gas fuel; cooling 0.76 gal./cu. ft.; other 0.30 gal./cu. ft.
		--	--	--	--	--	--	Process 50 gal./unit product; cooling 312 gal./unit; other 858 gal./unit.
		--	--	--	--	--	--	Total 1.0 gal./dollar.
Miscellaneous ind.								
(carbon black-ink)	2	3,600	--	--	--	--	--	
Synthetic rubber prod.		9,000	1,100	--	--	--	1,100	
Electrical power	1	--	--	--	--	--	--	Steam 0.02 gal./kwhr; cooling make-up 0.142 gal./kwhr; recirculation cooling 52.5 gal./kwhr.

1/ All uses
Total response to questionnaire: 60 replies from a total of 122 questionnaires (49 percent)

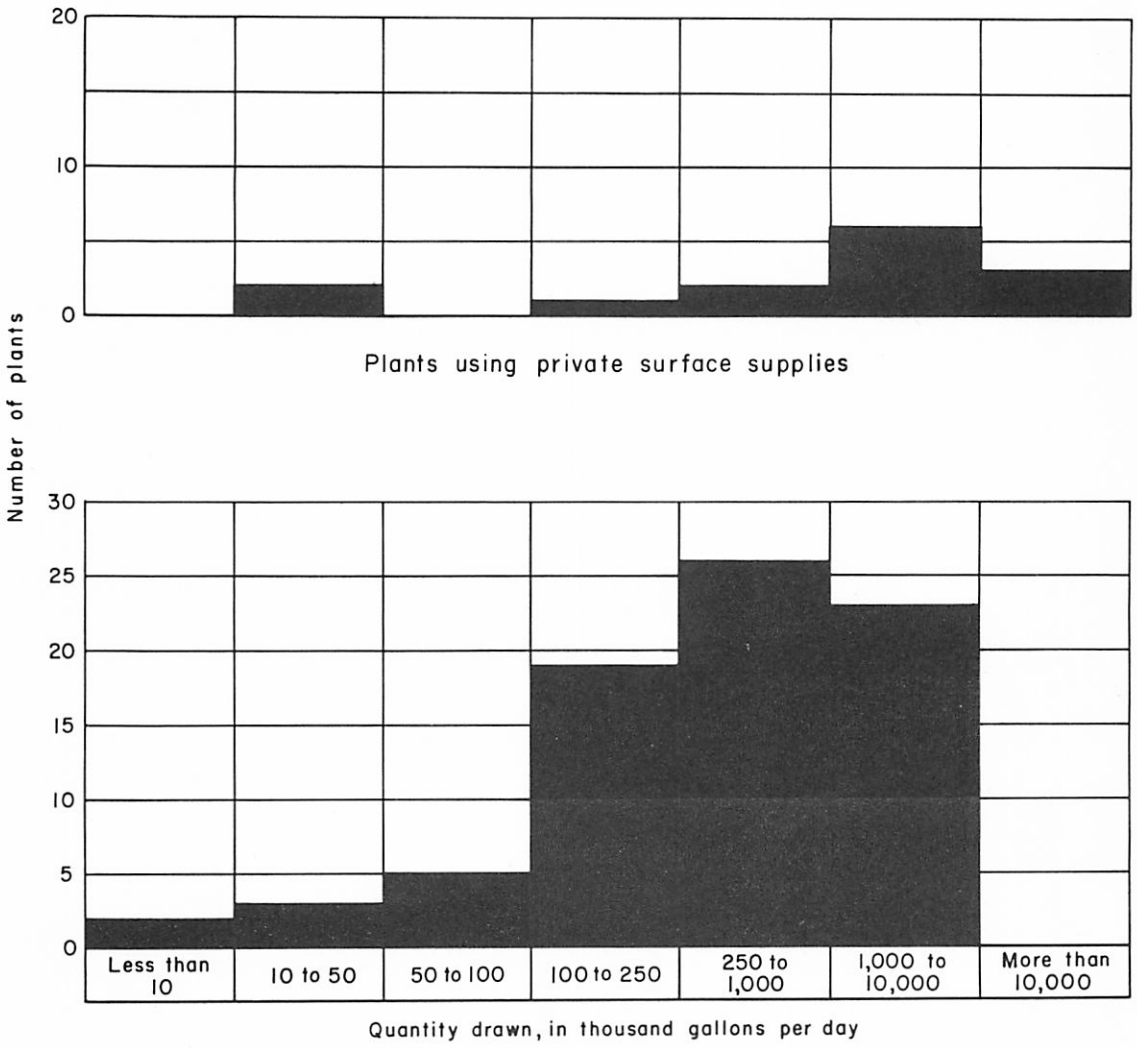

Figure I

Comparison of plants using private surface supplies and private wells

123

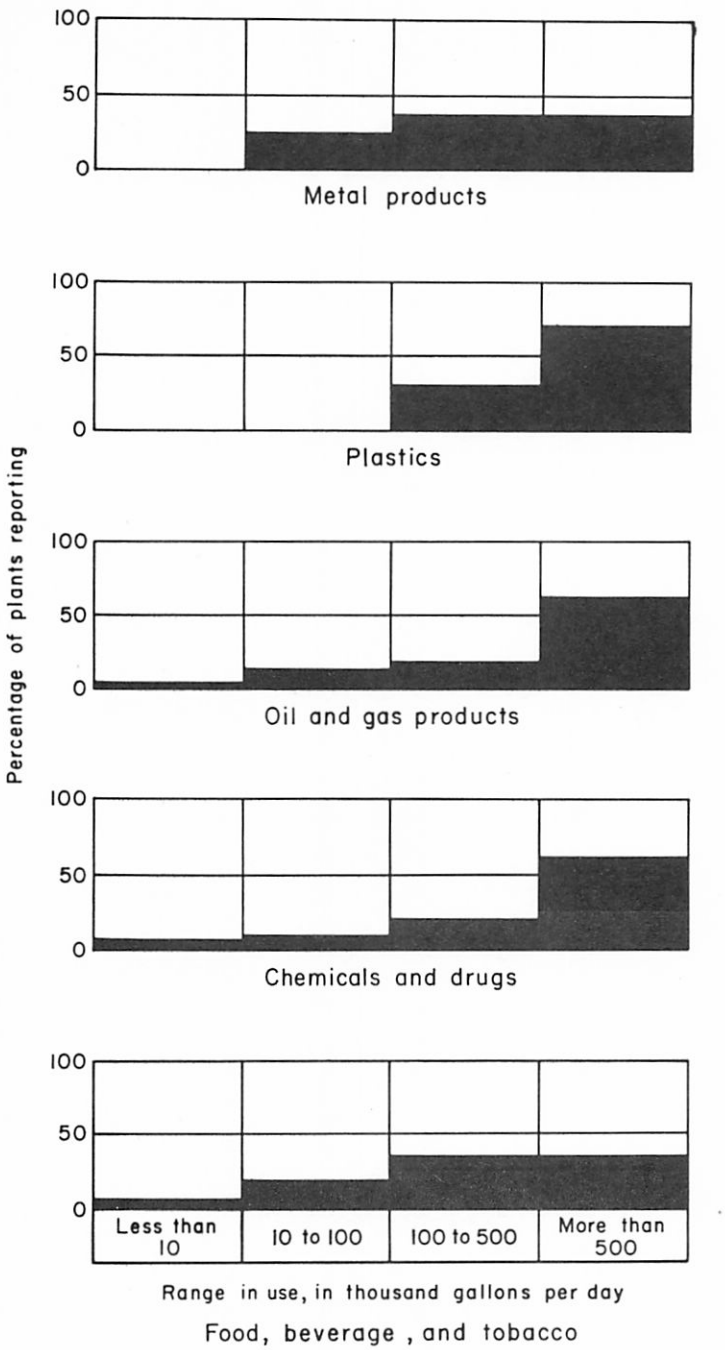

Figure 2

Water use by type of industry

123

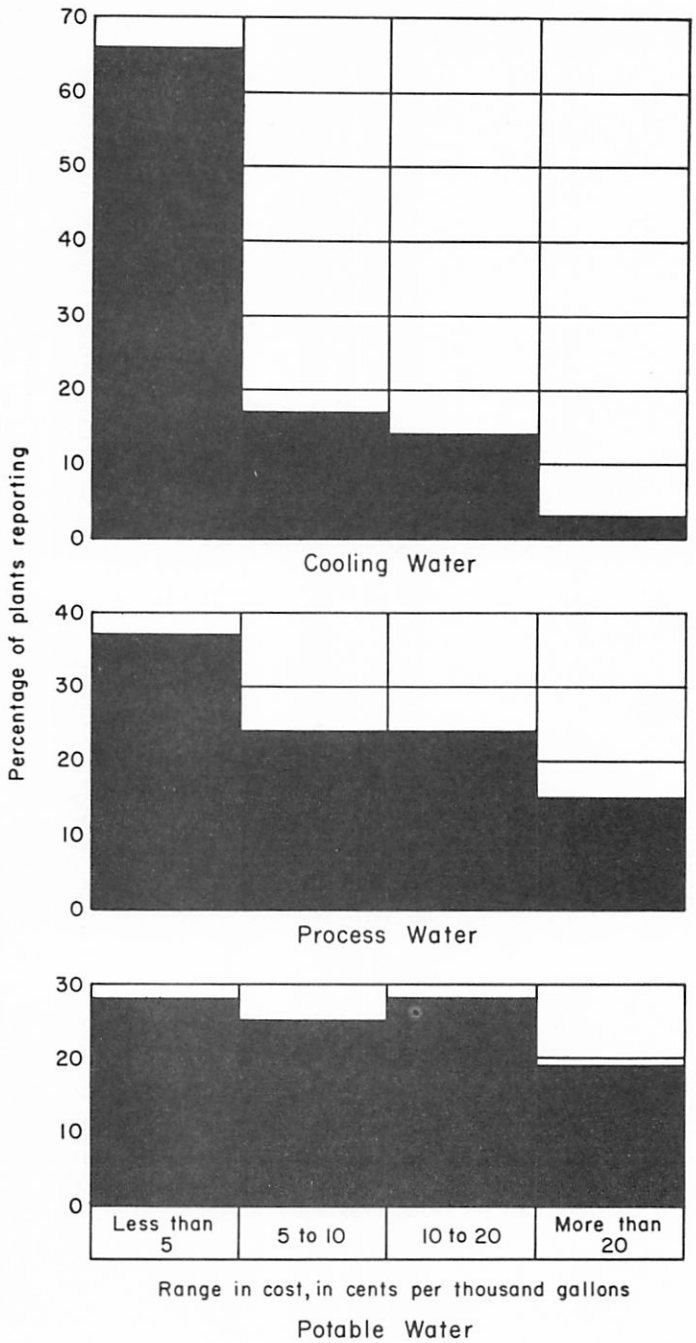

Figure 3

Water cost

123

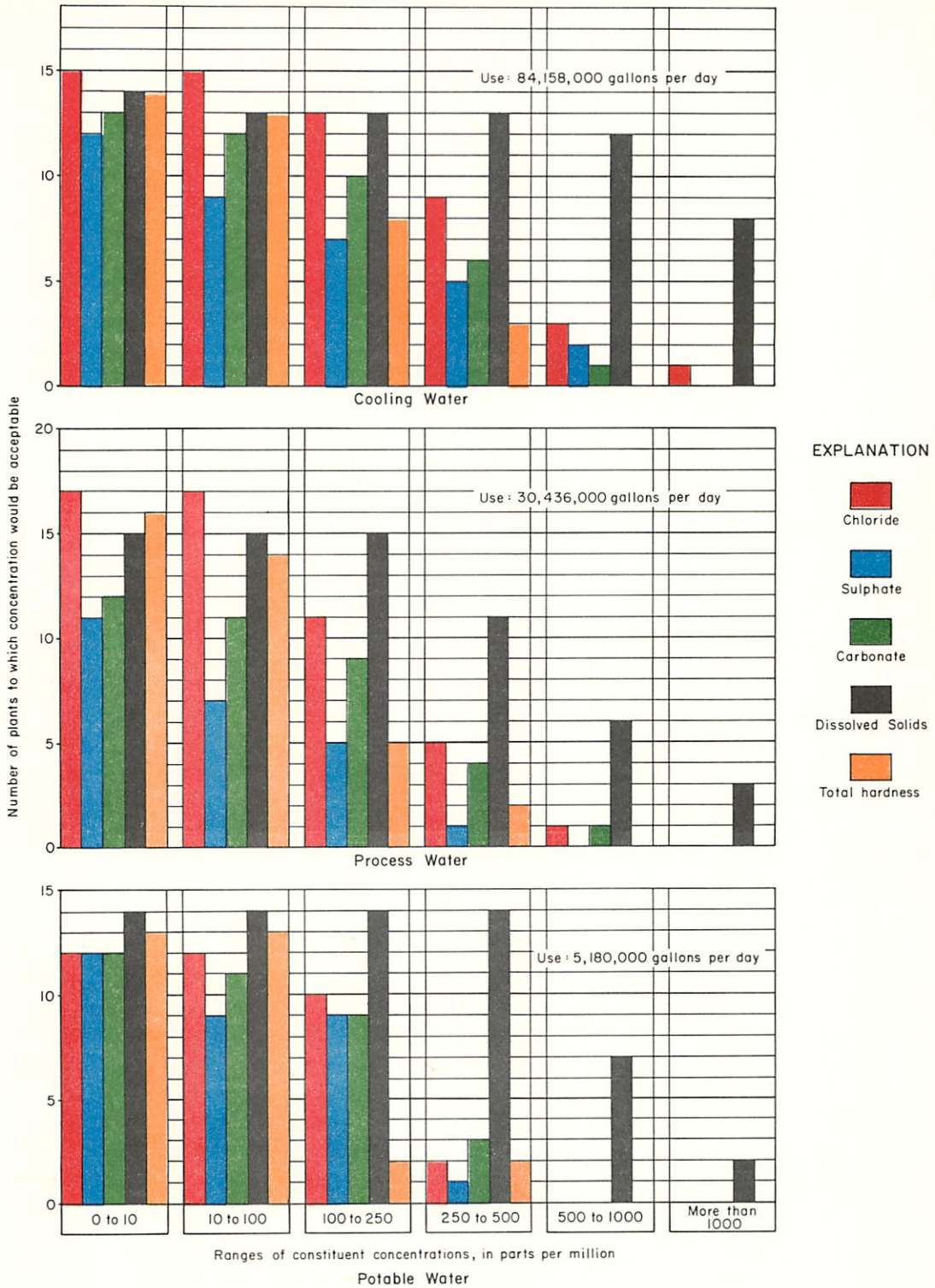

Figure 4

Desirable concentrations of chemical constituents
(Industry: Oil and gas products other than plastics)

123

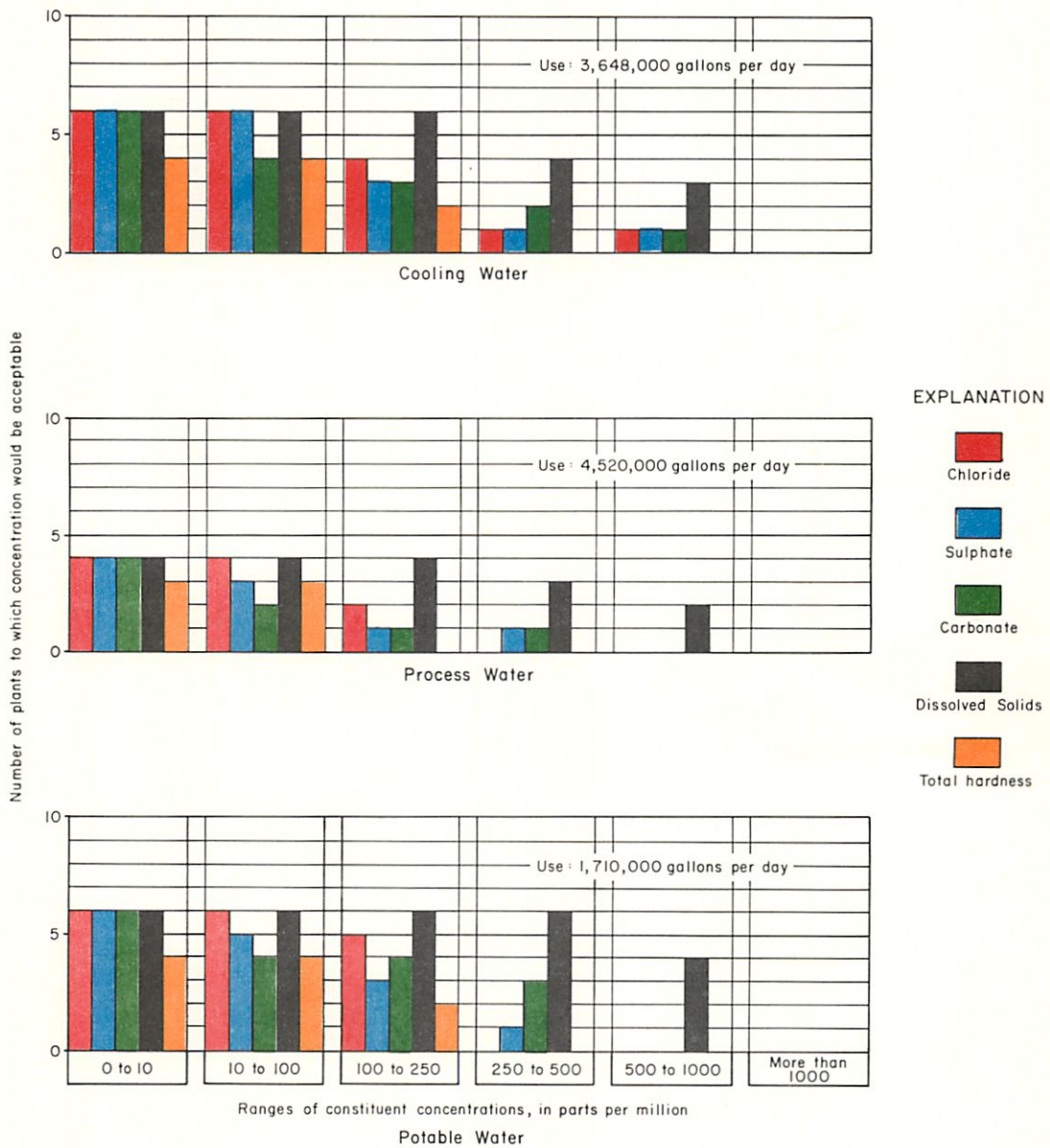

Figure 5

Desirable concentrations of chemical constituents
(Industry: Manufacturing -- plastics)

123

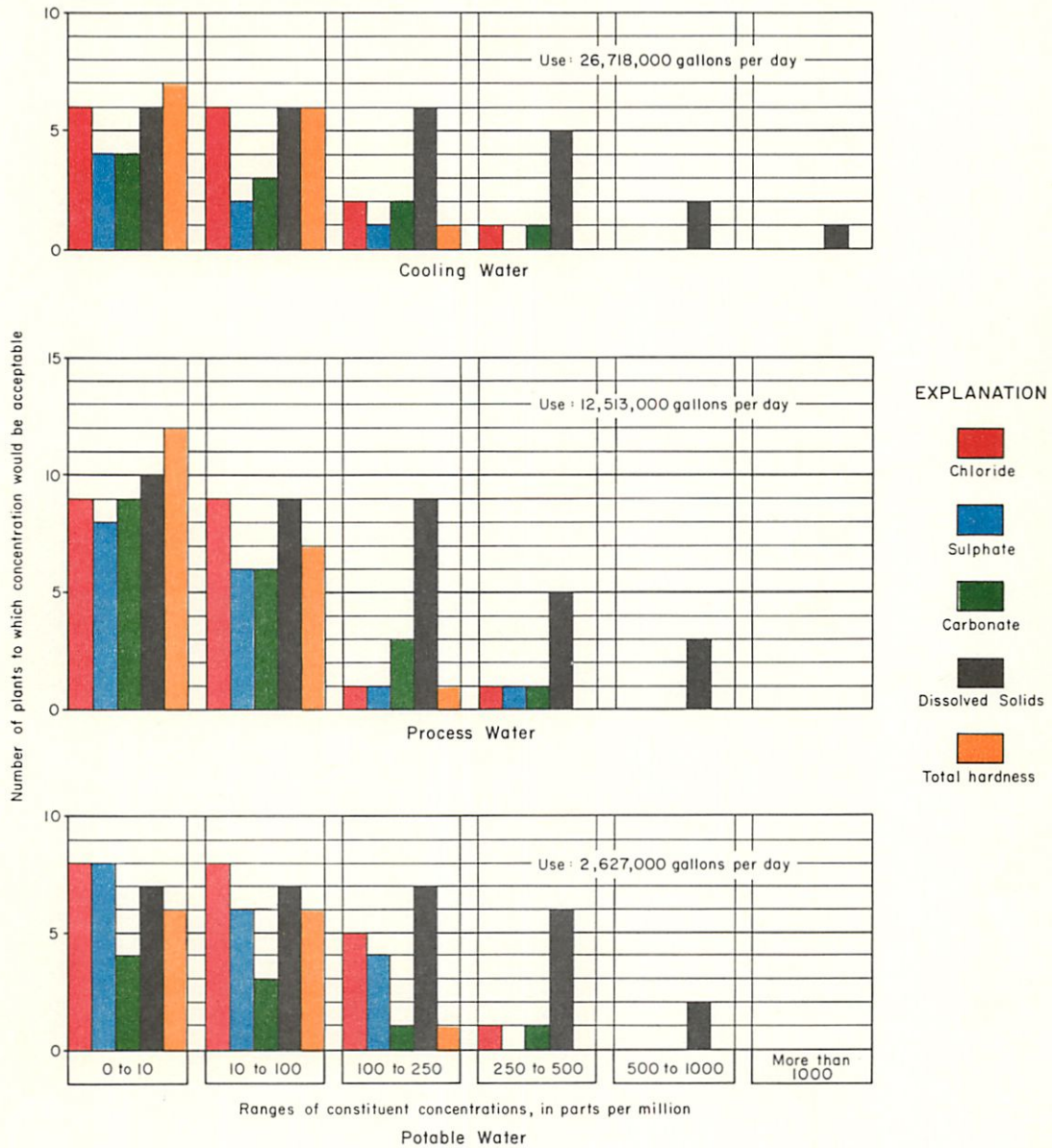

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Figure 6

Desirable concentrations of chemical constituents
(Industry: Manufacturing--chemicals and drugs)

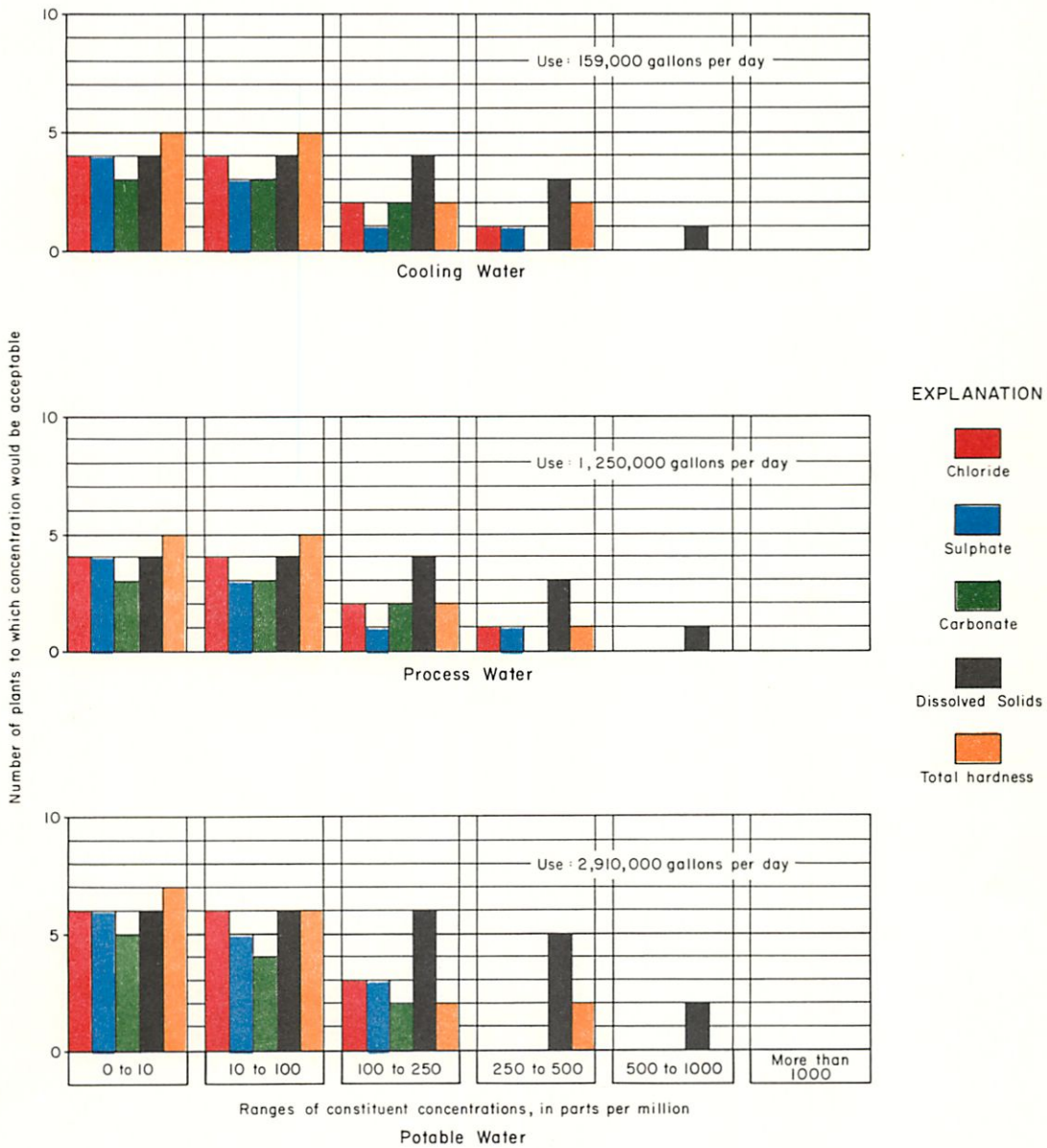

Figure 7

Desirable concentrations of chemical constituents
(Industry: Manufacturing-- food, beverages, and tobacco)

123