CALIFORNIA PUBLIC UTILITIES COMMISSION
Utilities Division
Hydraulic Branch

GUIDE
FOR
ADJUSTING AND ESTIMATING
OPERATING REVENUES
OF
WATER UTILITIES

Standard Practice No. U-25

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TABLE OF CONTENTS

* Follows page indicated.

MEMORANDUM

This guide has been prepared by engineers of the Hydraulic Branch under Utilities Division Work Order No. S-1695. Other staff engineers, as well as outside engineers, were consulted during its preparation, particularly with respect to climatological adjustments for water usage.

CHAPTER 1

INTRODUCTION

A - PURPOSE

1. The purpose of this guide is to promote reasonable uniformity and reliability in the preparation of revenue estimates in connection with formal rate proceedings or informal investigations of earnings.

B - SCOPE

2. This guide sets forth suggested methods for adjusting and estimating the operating revenues of water utilities. Subjects covered include:

a. Procurement of data.

b. Evaluation of data and records.

c. Water use table, its terminology and application.

d. Weighting and estimates of customers and growth.

e. Flat rate schedules - simplification, application and premises surveys.

f. Corrections and adjustments to normalize for current and foreseeable events.

g. Temperature and precipitation adjustments - theory and application.

h. Computation of revenues for minimum and service charge type metered service schedules.

i. Rate spread and design.

3. In using this guide, the engineer should bear in mind that application of a number of the described adjusting and estimating methods may not be practicable for studies of small water utilities because of the unavailability of reliable recorded data. The use of the more refined methods shown in this standard practice is unwarranted in such circumstances, but the general principles set forth would still be applicable.

4. The examples presented herein do not necessarily represent actual situations, but are merely for the development of illustrative calculations. The methods outlined in the examples may be subject to improvement or deviation, as circumstances warrant.

C - GENERAL CONSIDERATIONS

5. The uniform system of accounts for water utilities provides that operating revenues be segregated by classes and types of customers. Class of customer refers to the principal use of water; e.g., commercial class relates to customers whose use depends upon residential or business activities, and industrial class represents customers using water for processing or manufacturing purposes. Type of customer refers to subdivision of water use within a class, as between metered or unmetered (flat rate) billing bases.

6. Minimum charge meter rate schedules provide for a specified minimum charge for each billing period, depending upon the size of meter. This charge permits a certain volume of water to be used without additional cost. Consumption over this volume is billed at one or more quantity rates depending on the amount of water used and the form of the rate schedule.

7. Service charge meter rate schedules provide for a specified charge each billing period depending upon the size of meter. In contrast to the minimum charge type of schedule, however, no allowance for water use is included in the service charge. An additional charge is made for all water use on a volumetric basis. This type of rate schedule is becoming more common in California, particularly for some of the larger water utilities. Such a schedule usually contains only one or two quantity, or commodity, rates.

CHAPTER 2

PROCUREMENT AND EVALUATION OF BASIC DATA

A - EXAMINATION OF TARIFF SCHEDULES

1. The first step in a revenue analysis for rate-making purposes is a critical examination and comparison of the presently effective rate schedules with the revised rate schedules proposed by the applicant. It is important to review carefully the contents of such schedules particularly with respect to pricing units and special conditions qualifying the application of such units. To a great extent, the basic data required will be determined by the type and complexity of the rate schedules.

2. When comparing the present with the proposed rate schedules, special attention should be given to tariff revisions which may require unusual treatment or the procurement of more detailed data than is customary. Examples of such revisions include:

a. Simplification of flat rate schedules by elimination or consolidation of certain rates.

b. Change from flat rate to meter rate billing.

c. Change in size or arrangement of rate blocks.

d. Change from minimum charge to service charge type meter rates.

e. Elimination of special rate zones.

B - PROCUREMENT OF DATA

3. Recorded data pertaining to revenues, metered water sales and number of customers are usually obtained from:

a. Annual reports filed with the Commission.

b. Monthly reports filed by utilities with annual operating revenues in excess of $50,000.

c. Information supplied by the utility on its own initiative or in response to staff data requests.

d. Personal study of utility records by the staff accountant and/or engineer.

4. For utilities with reliable records, especially the larger utilities, most of the required basic recorded data is either included in exhibits attached to the rate application or can be readily extracted from annual or monthly reports. The balance of the required basic data for such utilities is usually obtained through a data request. Consideration should be given to the types of records maintained by the utility under study in order that the data request be not unduly burdensome on the utility. The portion, relating to revenues, of a typical data request is included as Attachment A to this guide.

5. For utilities with inadequate records or unfamiliar with the requirements of the Commission, most of the required data will generally have to be extracted from the available records by the staff.

C - PREPARATION OF WATER USE TABLES

6. Although it is customary to require the applicant in rate increase proceedings to furnish appropriate water use tables if metered service is provided, the preparation of such tables by the staff is sometimes necessary, expecially for the smaller utilities. Definitions of fundamental terms relating to water use tables follow:

a. A water use table is a statistical distribution table of periodic water bills and total consumption in each of several consumption or sales blocks. The number of consumption blocks included in the water use table is dependent on the present and proposed rate structures and on the water consumption pattern.

b. A consumption block is the quantity of water included between particular consumption levels, usually expressed as a rounded number of 100 cubic feet or 1,000-gallon units.

c. A rate block is a grouping of consumption blocks to which a single rate, charge or price applies. This rate or price is referred to as the quantity rate. The term commodity rate is also applied to the pricing unit but generally its use is limited to the service charge type rate schedule.

7. Most water utilities record meter readings for billing to the nearest 100 cubic feet, and a few still record readings to the nearest 1,000 gallons. For example, a reading of 560 cubic feet would be billed as 600 cubic feet, while a reading of 1,400 gallons would be billed as 1,000 gallons. As meters register cumulatively, the over- and under-roundings offset one another from one meter reading period to the next. The utility's practice in recording meter readings should be ascertained at the time of analyzing or preparing water use tables.

8. Preparing a water use table is essentially a counting process. A tally is made of the number of bills falling within each consumption block, along with the related total consumption of water within the block. For example, if the billing records indicate that there were 229 monthly bills with a consumption of 1,000 cubic feet (10 Ccf consumption block) during a 12-month period, the total annual consumption represented by the 229 bills would be 2,290 hundred cubic feet. As a further example, if the billing records indicate 190 monthly bills registering a consumption of 1,900 cubic feet and 202 bills with a consumption of 2,000 cubic feet (19-20 Ccf consumption block) during a yearly period, the annual consumption for the 392 bills would be 7,650 Ccf (190 x 19 Ccf + 202 x 20 Ccf). Utilities that use a digital computer for billing purpose may submit tabulations typed by the computer in place of the conventional water use tables. As column headings are not shown and meter sizes are indicated by symbols on such sheets, this coding information must be obtained from the utility.

9. As an alternate approach, especially when the number of customers is large, the consumption varies within wide limits and the allowable working time is limited, a tally is made only of the number of bills falling in each consumption block and the related consumption within the block is calculated. For example, for the 392 bills in the 19-20 Ccf consumption block indicated above, the total consumption would be equal to the number of bills multiplied by the median consumption or 7,644 Ccf (392 x 19.5 Ccf).

10. A sample water use table for a typical water utility is included as Table 2-A. The sample water use table represents the usage distribution for 12 consecutive months for all customers of the utility. The use of a shorter or nonconsecutive period of time or a lesser number of customers is not recommended, as the accuracy of the calculated revenues would be suspect if the samples selected were too small or biased.

D - EVALUATION OF RECORDED DATA

11. As will be shown later, it is necessary to consider more than one or two years of recorded revenues. Revenues are related not only to the number of customers served but also to the revenue per customer, which varies with the quantity of water sold to each customer. An exception would be flat rate service, where revenue per customer may remain fairly constant for several months or even years. Basically, recorded customer data should be available for a sufficient number of years to establish the rate of customer growth, which rate may then be evaluated as to its applicability in the future. Likewise, for sales to metered service customers, a representative period of recorded history must be analyzed to permit development of any trend in average usage per customer or, in the absence of an indicated trend, to provide a basis for determining the average level of sales or usage per customer.

12. When working with revenue data for several past years, it is necessary to ascertain whether or not the classes and types of customers served were shown in accounting records under descriptions substantially similar to those currently in use by the utility. If a relatively large difference in number of customers or volume of sales occurs within a described class or type of customer between two successive years, for example, and the annual totals for all classes for both years are nearly equal, it is likely that the utility had effected an accounting reclassification. If it is determined that an accounting change was involved, it is then appropriate to make adjustments to prior years' customer averages and related revenue-determining elements to provide a uniform basis of analysis.

TABLE 2-A

Alpha Water Company

WATER USE TABLE

Consumption Block (100 Cu.Ft.)	Customer Billings* Number	Cumulative Number	Per Cent	Consumption 100 Cu.Ft.	Cumulative 100 Cu.Ft.	Per Cent
0	154	154	1.89%	0	0	0.00%
1	54	208	2.56	54	54	.01
2	95	303	3.72	190	244	.07
3	91	394	4.84	273	517	.14
4	109	503	6.18	436	953	.26
5	107	610	7.50	535	1,488	.40
6	145	755	9.28	870	2,358	.64
7	162	917	11.27	1,134	3,492	.94
8	150	1,067	13.12	1,200	4,692	1.27
9	122	1,189	14.62	1,098	5,790	1.56
10	229	1,418	17.43	2,290	8,080	2.18
11-12	378	1,796	22.08	4,210	12,290	3.32
13-14	361	2,157	26.52	4,869	17,159	4.63
15-16	358	2,515	30.92	5,539	22,698	6.13
17-18	336	2,851	35.05	5,881	28,579	7.72
19-20	392	3,243	39.86	7,650	36,229	9.79
21-25	726	3,969	48.79	16,615	52,844	14.27
26-30	571	4,540	55.81	15,867	68,711	18.56
31-35	402	4,942	60.75	13,241	81,952	22.14
36-40	371	5,313	65.31	14,133	96,085	25.95
41-45	318	5,631	69.22	13,487	109,572	29.60
46-50	277	5,908	72.62	13,209	122,781	33.16
51-60	526	6,434	79.09	30,885	153,666	41.51
61-75	613	7,047	86.63	44,634	198,300	53.56
76-100	623	7,670	94.28	57,894	256,194	69.20
101-150	240	7,910	97.23	30,404	286,598	77.41
151-200	44	7,954	97.78	7,981	294,579	79.57
201-300	16	7,970	97.97	4,290	298,869	80.73
301-400	14	7,984	98.14	5,351	304,220	82.17
401-500	147	8,131	99.95	63,237	367,457	99.25
501-750	3	8,134	99.99	1,800	369,257	99.74
Over 750	1	8,135	100.00	965	370,222	100.00

* To be indicated whether monthly or bimonthly.

CHAPTER 3

CUSTOMERS AND GROWTH

A - AVERAGE CUSTOMERS

1. The number of customers of a water utility is usually tallied as the total number of active service connections, excluding fire protection service.

2. Estimates regarding customers are generally related to average customers rather than end-of-year customers as is generally presented in the annual reports. For the smaller utilities, especially those with inadequate records, the average number of customers for any year is determined simply as a beginning-of-year and end-of-year arithmetical average.

3. For the larger utilities with reasonable records, a monthly average number of customers is generally used to obtain a more realistic indication of the customer distribution throughout the year. If the utility's records provide customer data as end-of-month customers, then the monthly average is calculated as one-twelfth of the total of: the 12 monthly reported figures of the present year plus one-half of the preceding December figure less one-half of the present December figure.

B - ADJUSTMENTS

4. In order to make reasonable forecasts of customer growth, past records of average customers must be placed on a comparable basis by considering the following adjustments, if appropriate.

5. The adoption of the present uniform system of accounts on January 1, 1955, resulted in the reclassification of large numbers of customers by the utilities. The records of a utility should be carefully scrutinized so that this reclassification and any other reclassification of customers can be properly adjusted and accounted for.

6. Another important adjustment to consider would be unusual changes in the number of customers. Unusual increases in customers could result from the purchase by the utility of a system or portion of a system from another water purveyor or by special subdivision development. Unusual

decreases in customers are generally related to transfer by the utility of a portion of its system to another water purveyor, or abandonment of service in a portion of the system due to freeway relocation, or area redevelopment.

7. The final adjustment would involve the changing characteristics within an area. Examples of this type of adjustment include decreasing provision for flat rate service, especially in connection with a progressive metering program in a water-short area, transformation from a rural (agricultural) area into a residential community, and conversion of residential areas into commercial or industrial centers.

C - CUSTOMER ESTIMATES

8. After adjustment of the recorded data as discussed above and as otherwise appropriate, the number of average customers, by class and type, are plotted graphically. Projection of the trend line indicated by the adjusted data by extrapolation is generally sufficient to forecast reasonable estimates of average customers for the test years. Other statistical or analytical methods may be used to extend the trend line into the future, but such refinement is rarely warranted for water utilities.

9. In certain instances and for certain classes of customers, typically commercial or residential metered service customers, the annual growth could be plotted rather than average customers, and projections into the future would be as discussed in the preceding paragraph.

D - IMPORTANT CONSIDERATIONS

10. It is important to remember that future estimates based on a projection of the trend line describe conditions on an average basis for a series of years and are not attempts to predict the actual number of customers that may prevail in any particular future year. Although it is true that reasonable estimates will appear as the trend line of future numbers of recorded average customers, it is highly improbable that the forecast will coincide exactly with actual number of customers for any particular year.

CHAPTER 4

FLAT RATE SCHEDULES AND THEIR APPLICATION

A - ANTIQUATED FLAT RATE SCHEDULES

1. The following schedule of rates is an example of a cumbersome and obsolescent flat rate schedule. Such schedules are gradually being simplified through the mutual efforts of the Commission's staff and the utilities concerned. A recommended type of flat rate schedule is presented later in this chapter.

RATES

	Per Service Connection Per Month
1. For each single-family residence of five rooms or less, exclusive of bath or toilet facilities and irrigated areas	$ 1.50
a. In addition, for each room in excess of five	.15
b. In addition, for each flush toilet, bathtub or shower	.25
c. In addition, for all irrigation or sprinkling of lawns or gardens, per 100 square feet	.03
2. For restaurants and cafes, per unit of seating capacity	.12
- minimum charge	3.00
3. For barber shops, one chair	2.00
a. In addition, for each additional chair	.75
4. For soda fountains, soft drink places, and ice cream or lunch parlors either alone or in connection with other business	2.00 to 5.00
5. For bakeries, butcher shops and retail markets	2.25
6. For ordinary stores and shops not otherwise listed, <u>according to use of water</u>*	1.00 to 4.00
7. In addition, for each toilet or bathtub in above business establishments	.35

* Underlined herein for emphasis.

2. It should be obvious that the flat rate schedule shown under paragraph 1 would be difficult to administer properly in that constant field surveillance is required and would be controversial in that certain rates are subject to negotiation and discrimination. Therefore, when utilities with such flat rate schedules come before the Commission for rate relief, the staff should make a recommendation that a simplified form of rate schedule be adopted.

B - SIMPLIFIED FLAT RATE SCHEDULES

3. It is staff policy generally to recommend that utilities be permitted to offer flat rate service only to residential customers in areas with an ample water supply and a history of such service or for competitive reasons, or in areas of minimal consumption such as resort systems. It should be kept in mind that flat rate schedules are inherently discriminatory due to variations in water use by apparently similar households. An example of a simplified flat rate schedule follows:

RATES

	Per Service Connection Per Month
For a single-family residential unit, including premises not exceeding 7,500 sq. ft. in area	$3.00
a. For each additional single-family residential unit on the same premises and served from the same service connection ..	2.00
b. For each 100 sq. ft. of premises in excess of 7,500 sq. ft.	.03

4. The schedule shown above is particularly applicable when the majority of the lots are of approximately the same size (7,500 sq. ft.) and there are few lots considerably smaller than 7,500 sq. ft. in area. It should be obvious that the design of such a schedule requires a careful analysis of the premises served.

C - PREMISES SURVEYS AND REVENUE COMPUTATIONS

5. It is apparent that any computation of revenues requires that the number of pricing units of each type be known. In order to determine such number and to verify the proper application of rates by the utility, each customer's premises must be surveyed and tallied by type. As even well-run utilities fall behind in keeping up with the installation by customers of additional equipment, especially air conditioners and changes in irrigated area, it is imperative that the premises survey be of recent date, usually the last calendar year or later fiscal period. In general, the premises survey should be obtained from the utility by data request and should be spot-checked by the staff. A complete survey by the staff should be made only under unusual circumstances.

6. Application of the schedule of rates shown in paragraph 3 requires a count of residential flat rate customers with premises not exceeding 7,500 square feet in area, of premises with more than one residential unit and the number of such units, and of the number and sizes of premises in excess of 7,500 square feet.

7. On those relatively few occasions where it is necessary for the staff engineer to make a premises survey, the first step is to obtain maps of the entire service area from the county recorder or from the utility and to ascertain locations and dimensions of the lots of flat rate service customers. The areas of the lots can be computed, measured with a planimeter or estimated by superimposing precut rectangular templates of graduated sizes. A field inspection of such lots or review of the utility's records will then provide the necessary data as to multiple residences. It is not usually necessary to count items related to nonresidential usage, such as is included in the antiquated flat rate service schedule shown in paragraph 1, since a recommendation would normally be made by the staff requiring metering of all commercial and business establishments and customers with service connections larger than one inch. Lots 25,000 sq. ft. in area and larger should usually have a service connection larger than one inch and in any event, service to customers having premises of such size should be metered.

8. The computation of revenues based on the rate schedule shown in paragraph 3 is demonstrated in the following sample calculation:

Item	Avg. No. of Units (1)	Monthly Rate (2)	Annual Revenues (3)=(1)x(2)x12
Single Dwelling	78	$3.00	$2,808
Additional Dwelling on Same Premises	17	2.00	408
Additional Area of Premises (100 sq. ft.)	324	.03	117
Total			3,333
Round and Use			3,330

9. In water systems with a comparatively wide disparity of lot sizes, the flat rate service schedule can be designed with rates set in steps dependent on lot sizes. A sample calculation for such a schedule is set forth in the following tabulation:

Item	Avg. No. of Units (1)	Monthly Rate (2)	Annual Revenues (3)=(1)x(2)x12
6,000 sq. ft. or less	933	$3.05	$ 34,150
6,001 sq. ft. to 10,000 sq. ft.	4,790	4.05	232,790
10,001 sq. ft. to 16,000 sq. ft.	1,100	5.00	66,000
16,001 sq. ft. to 25,000 sq. ft.	400	6.35	30,480
Additional Dwelling on Same Premises	14	2.50	420
Total			363,840

D - OTHER UNMETERED SERVICE

10. Other unmetered service revenues are generally derived from private fire protection service, public fire hydrant service, rents and other miscellaneous service.

11. In common with other types of flat rate service, revenues for fire protection service can be determined as the product of the average number of pricing units and the annual rate per pricing unit. However, very little refinement in making such estimates is generally warranted as revenues from fire protection service usually constitute only a small portion of the total revenues. A sample computation for estimating both private fire protection service and public fire hydrant revenues is set forth in the following tabulation:

Fire Protection Revenues
Present Rates

Line	Item	Source	1967 Adj.	1968 Est.	1969 Est.
	Private Fire Protection				
(10)	Avg. No. of Customers		24	25	26
(12)	Avg. Revenue/Cust./Yr. ($213 ÷ 24) x 12 =		$106.50	$106.50	$106.50
(14)	Revenue from Pr. Fire Protection	Line (10)x(12)	2,556	2,662	2,769
	Round and Use		2,560	2,660	2,770
	Public Fire Hydrants				
	To date, $434.50/Mo. for 404 hydrants				
(20)	Avg. Revenues/Hydr./Yr. ($434.50 ÷ 404) x 12 =		$12.90	$12.90	$12.90
(22)	Avg. No. of Hydrants		388	404	420
(24)	Revenue from Hydrants	Line (20)x(22)	$5,005	$5,212	$5,418
	Round and Use		5,010	5,210	5,420

12. - Revenues from rents and other miscellaneous flat rate service are generally based on the average revenues of a past representative period, usually 3 to 5 years. As with fire protection service, revenues from these items are comparatively small and very little refinement in making such estimates can be justified.

CHAPTER 5

NORMALIZATION OF METERED SALES

A - CLIMATOLOGICAL ADJUSTMENT

1. Sales to metered service customers are customarily adjusted for rate-making purposes in order that estimates of usage predicated for the test years reasonably reflect normal conditions. Sales to commercial (residential and business) and public authority customers are adjusted to normalize the effects of unpredictable climatological fluctuations, while sales to industrial and other customers are adjusted to eliminate other unusual abnormalities.

2. The preferred method of determining average annual metered consumption is to divide total yearly sales by weighted average customers. Past experience has indicated a persistent upward trend in average commercial usage ranging from 1 to 4 Ccf per customer per year in most areas. The reasons for this trend include constantly improving living standards, larger home sites, and urbanization of suburban areas, including the construction of multi-unit residences or apartments which has the effect of increasing average meter size.

3. Climatic conditions which may affect the consumption of water by commercial customers include temperature, rainfall, evaporation, fog, dust, wind, humidity and clouds. However, except for rainfall and temperature data, very little other climatological information is available or adaptable and it is therefore impractical to analyze the effects of other climatological conditions on consumption. There are a few weather stations which record evaporation data; so for these areas, the effect of net evaporation (evaporation less rainfall) on sales may be considered.

4. Annual factors that may be used when considering the effect of temperature on consumption include: average temperature, average maximum temperature and degree-days 90°F or over. The actual factor selected for a particular study will depend on the data available and the area being studied. For most applications involving water utilities, the use of average temperature will facilitate the study and provide reasonable results. In the southern and desert areas in California, however, where the temperature is consistently high in summer, degree-days 90°F or over may be more significant than average temperature. Degree-days here represent the total of the number of degrees on each day that the maximum daily temperature exceeds 89 degrees.

5 - NORMALIZATION OF METERED SALES

5. Total rainfall, total rainfall adjusted for excess rainfall in any month, number of days of rain, and weighted number of days of rain are factors that may be used to analyze the effect of rainfall on consumption. However, the use of factors that rigorously adjust for rainfall frequency is rarely warranted nor are they readily available, and reasonable correlation can usually be obtained using total rainfall adjusted for some maximum rainfall in any month. A maximum effective rainfall of 4 inches per month is a good empirical figure to use in California.

6. Because meters are read periodically, usually monthly or bimonthly, there is a disparity between the time of actual consumption and the time that the consumption is recorded. This disparity must be adjusted for and the times correlated to get meaningful normalized results from the climatological data. For example, take the case of a utility which reads meters throughout a monthly cycle and which bills monthly by billing rounds. In this case, the time of recording the consumption lags the time representing the midpoint of actual consumption by approximately one-half month.

7. A sample calculation for shifting average annual temperature by one-half month to coincide with consumption is shown below:

Year	Avg. Temp. Annual (1)	Avg. Temp. December (2)	Prior Dec. Less Current Dec. (3)	Adjustment (4)=(3) ÷ 24	Adjusted Avg. Annual Temp. (5)=(1) + (4)
1958		49.0	-	-	-
1959	60.8	43.9	5.1	0.2	61.0
1960	61.4	44.0	(.1)	-	61.4
1961	58.5	46.3	(2.3)	(.1)	58.4
			(Red Figure)		

8. The following tabulation shows a typical calculation for placing total rainfall adjusted for a maximum rainfall of four inches per month in proper time correlation with consumption for a utility with monthly billing and continuous meter reading:

Year	Recorded Rainfall (1)	Rainfall Adjusted to Monthly Maximum of 4": Annual (2)	December (3)	Prior Dec. Less Current Dec. (4)	Adjustment (5)=(4) ÷ 2	Adjusted Annual Rainfall (6)=(2) + (5)
1960	-	-	0.42	-	-	-
1961	24.12	16.32	4.00	(3.58)	(1.79)	14.53
1962	22.72	18.64	4.00	-	-	18.64
1963	11.12	10.48	1.64	2.36	1.18	11.66
				(Red Figure)		

9. In the two examples above, the climatological data were shifted rather than the consumption data. This might appear to be the less logical approach; however, it achieves the necessary time correlation between consumption data and climatological conditions with considerably more accuracy than shifting the consumption, as the effect of certain weather conditions, rainfall particularly, can be carried through to subsequent months.

10. The formula used in the preceding two tabulations for continuous meter reading and monthly billing can be stated as 1/2 Prior December plus January through November of Current Year plus 1/2 Current December. For bimonthly billing and reading of meters throughout the two months, the corresponding formula for placing consumption and climatological conditions in phase is 1/4 Prior November plus 3/4 Prior December plus January through October of Current Year plus 3/4 Current November plus 1/4 Current December.

11. The methods that have been used to normalize consumption for the effects of temperature and precipitation are: the graphical method, month-by-month method, and the Mamson method. These are discussed below:

The Graphical Method

12. The Graphical Method is a rapid and effective means for normalizing sales when at least eight years of reliable data are available. This method assumes that consumption is a dependent variable and a function of time, temperature and precipitation (independent variables) and that by successive graphic approximations, the multiple correlation of consumption with the independent variables can be determined. The graphical method is also referred to as the "Bean Method" or "Modified Bean Method". A more detailed discussion of this method is presented in "Methods of Correlation and Regression Analysis" by Mordecai Ezekiel and Karl A. Fox, published in 1959 by John Wiley & Sons, Inc.

Bean experimented with this method to attempt to predict crop yields based on water & other factors.

13. The following tabulation contains the data used in the example of the use of the graphical method which follows. It is assumed that the climatological data have been correlated in time with consumption and that rainfall, including its long term mean, has been adjusted to reflect a maximum monthly rainfall of 4 inches. The U.S. Weather Bureau published long-term (30-year) mean temperature and rainfall data are normally used. The weather bureau establishes new norms each decade, the next 30-year period to be 1941-1970.

Year	Annual Avg. Sales Ccf.	Adjusted Avg. Temp.	Adjusted Rainfall
X_2	X_1	X_3	X_4
1956	115	59.0	11.6
1957	109	59.0	15.6
1958	119	60.6	18.8
1959	136	61.6	13.4
1960	139	61.0	12.6
1961	141	60.2	11.0
1962	125	59.3	10.4
1963	119	59.5	22.2
United States Weather Bureau Long Term Mean (1931-1960)		59.7	13.8

14. In the first step of the graphical method, average annual consumption (X_1) is plotted against time (X_2) as shown on Chart 5A2. Points with similar weather characteristics are connected with light, dashed lines as shown on Chart 5A1 to determine the general shape and location of first approximate regression Line F_1. Although, in an actual study this would all be done on one chart, the additional chart (5A1) has been prepared to avoid excessive clutter and to present details clearly. Line F, should be conservatively sloped, as a first approximation.

15. The second step is to prepare the scales on Chart 5B2: deviations in average consumption versus average temperature. It should be noted that the year corresponding with the average adjusted temperature is identified. The third step is to transfer the vertical deviations from regression line F_1 on Chart 5A2 as vertical deviations from the zero ordinate on Chart 5B2. For example, for the year 1960, the vertical deviation A from line F_1 on Chart 5A2 is transferred to

Chart 5B2 by plotting it from zero ordinate at an average temperature of 61.0° F. Points with similar rainfall characteristics are connected with light, dashed lines as shown on Chart 5B1 in order to determine the shape and location of regression line T_1. Although T_1 appears to have the same shape as F_1, this is coincidental as it is a separate plot. As outlined in the previous paragraph, in actual practice only one chart would be used for this step and T_1 generally should be conservatively sloped, as a first approximation.

16. The vertical deviations from the regression line T_1 on Chart 5B2 are transferred to Chart 5C1 and scaled from zero ordinate versus precipitation for the corresponding years. For example, for the year 1963, the vertical deviation B from line T_1 on Chart 5B2 is transferred to Chart 5C1 and plotted from zero ordinate at a rainfall of 22.2 inches. The preliminary step of connecting points with like climatological conditions is no longer needed as the points have presumably been adjusted, even if not finally, for variations in time and temperature. After the points have been transferred, a regression line P_1 is plotted. It can be seen that the year 1962 does not fall into the pattern and should be given little weight and that a curve fits these particular points better than a straight line.

17. The next step is to transfer the vertical deviations from line P_1 on Chart 5C1 to Chart 5A2 by plotting vertical deviations from line F_1. In order to avoid clutter, the latter chart has been reproduced as Chart 5A3 and the points of this second plot are designated on Chart 5A3 by small squares. For example, for the year 1960, the vertical deviation C has been transferred from Chart 5C1 to Chart 5A3. The second approximate line of best fit, regression line F_2 is then drawn. In like manner, vertical deviations from line F_2 are transferred to Chart 5B2 (reproduced as Chart 5B3 for clarity) from line T_1 and the location of revised regression line T_2 is determined. Similarly, deviations from T_2 are transferred to Chart 5C1 (shown as Chart 5C2) and regression line P_2 is drawn.

18. Finally, the vertical deviations from line P_2 are transferred back to Chart 5A3. This step is not shown on the accompanying charts as these points varied only slightly from the second plot points, so that the analysis can be considered complete. In an actual study, it may be necessary to transfer the points between charts several more times before satisfactory multiple correlation is obtained. Such correlation can be

considered to be effected when the points converge to a definite line, curve or pattern on all three charts and further transfers do not increase this convergence. Usually at least two trials are required to obtain reasonable and verified correlation. The use of straight lines is best whenever the data do not clearly and conclusively define curves.

19. The final regression lines F_2, T_2, and P_2 represent respectively the effects of time, temperature and rainfall on consumption and can be used to project future normal consumption estimates. A sample calculation of consumption estimates for test years 1964 and 1965 for a normal average temperature of 59.7° F and adjusted rainfall of 13.8 inches is shown in the following tabulation:

Item	Source	1964 Est.	1965 Est.
Consumption Trend	Chart 5A3	134.0	135.5
Temperature Adj.	G on Chart 5B3	(3.3)	(3.3)
Rainfall Adj.	Chart 5C2	.7	.7
Adjusted Consumption		131.4	132.9
USE		131	133
	(Red Figure)		

20. The graphical adjustments described in Paragraph 19 can be avoided, and at the same time a normal consumption regression line covering the past years can be developed. After placing temperature (X_3) and rainfall (X_4) data and their respective lines or curves on Charts 5B2 and 5C1, also locate the intersection of the long-term means and each zero ordinate. Line T_1, then could be relocated by a parallel movement, without altering the results of the method, until it passes through the point of intersection of the long-term mean and zero ordinate. In a like manner, Line P_1 is relocated. (This points up a good reason to use a straight line for first regression lines.) When the results from these adjustments are carried back to the original consumption Line F_1, a so-called normal line is developed directly, without need of the further temperature and rainfall adjustments described in Paragraph 19.

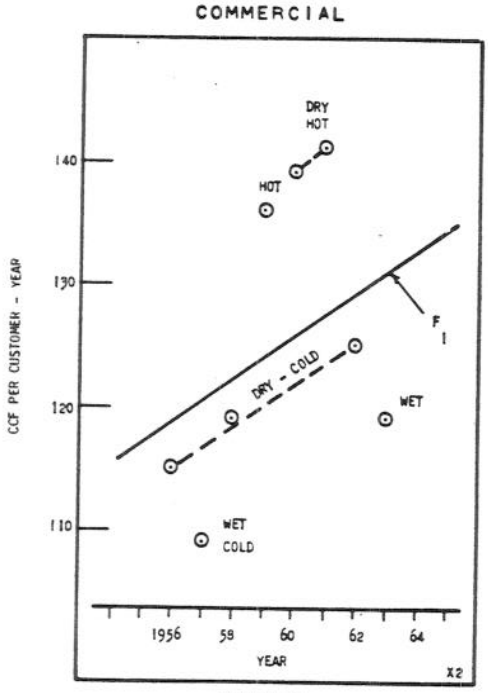


CHART 5 A1

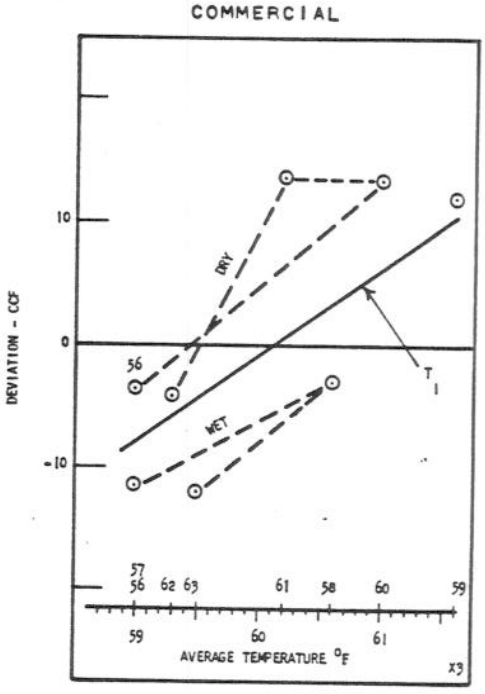


CHART 5 B1

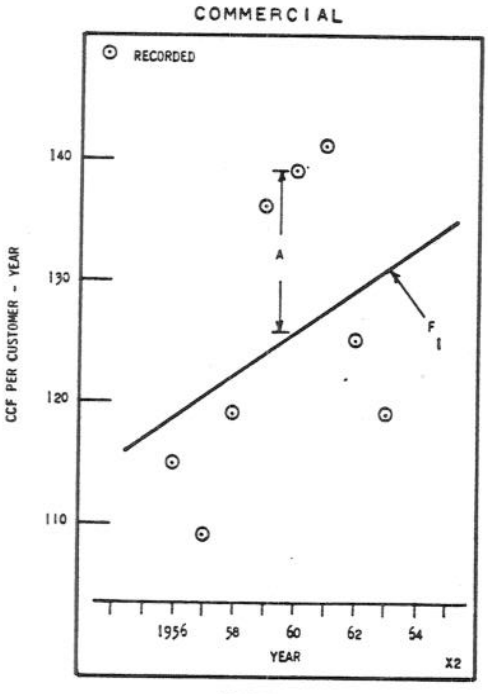


CHART 5 A2

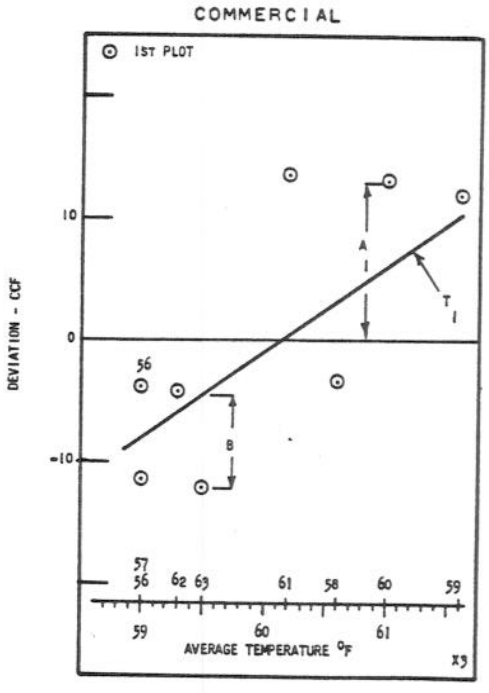
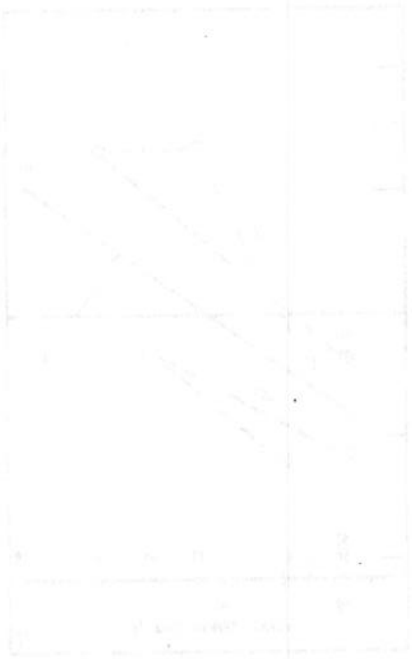


CHART 5 B2



COMMERCIAL

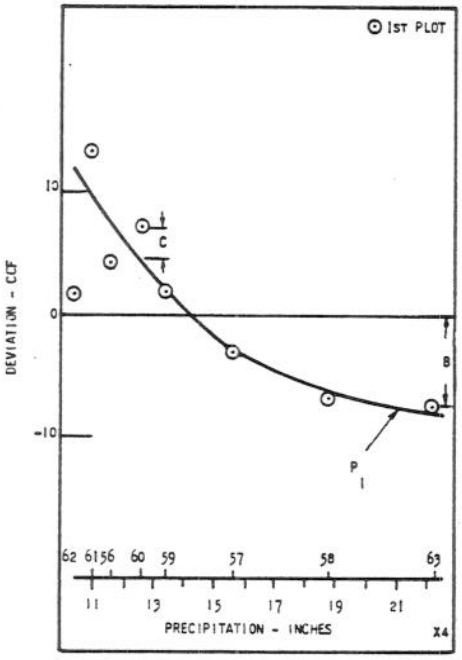


CHART 5 C1

COMMERCIAL

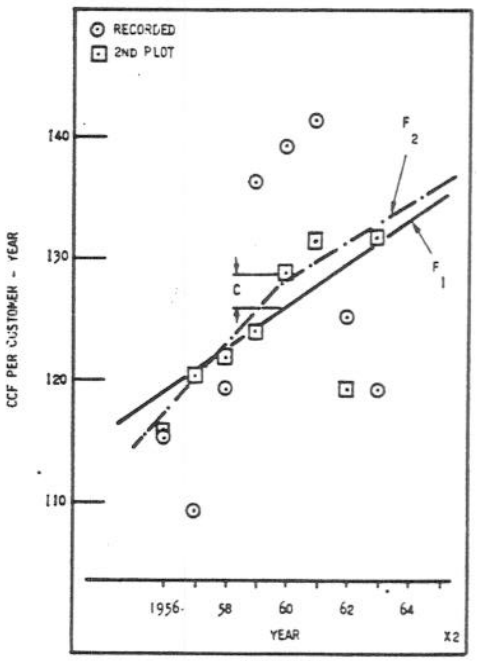


CHART 5 A3

COMMERCIAL

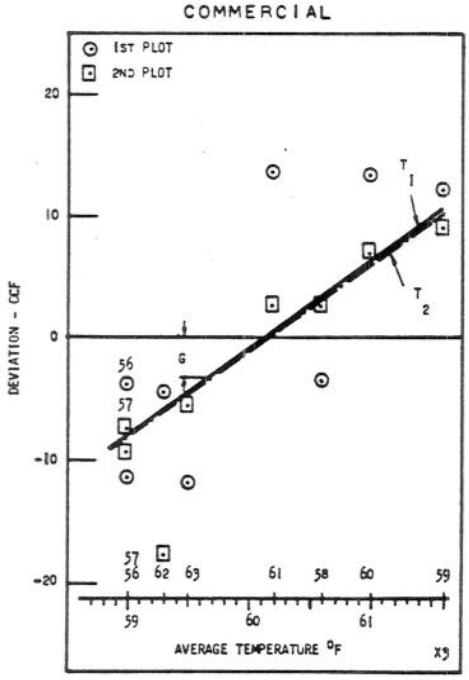


CHART 5 B3

COMMERCIAL

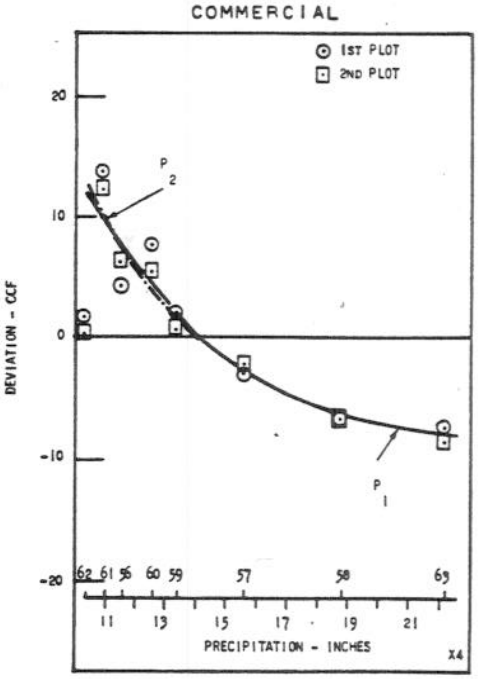
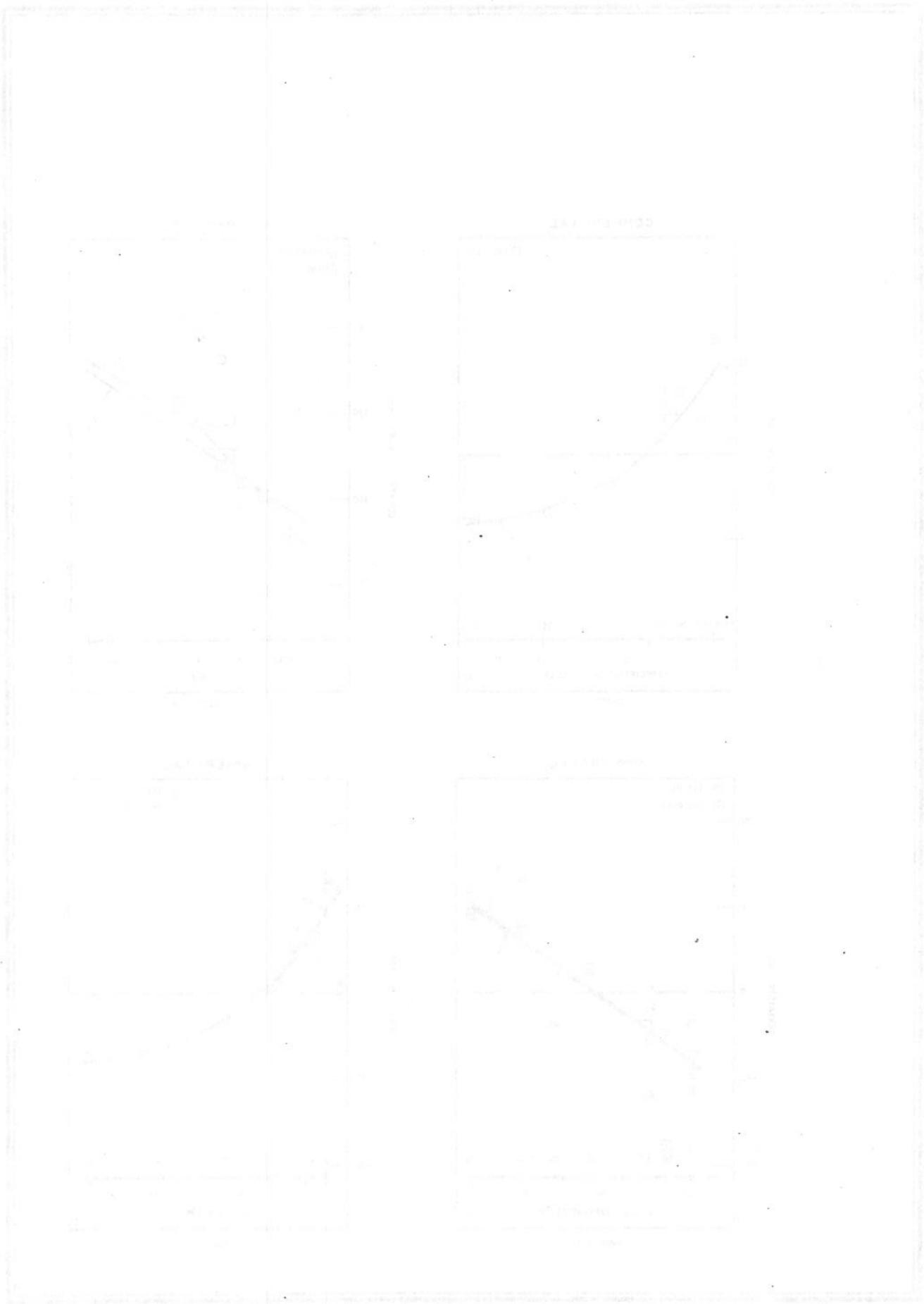


CHART 5 C2



21. Two other techniques that should prove helpful are: (a) make horizontal scales longer than vertical scales; and (b) do a second separate study, reversing the order of temperature and rainfall regression charting, to confirm the first study. Any small difference in the answers may then be averaged.

Month-by-Month Method

22. This method can be used when monthly data are available for a period of three or four years. In this method, the consumption for each month of the year is normalized on a judgment basis after reviewing temperature and rainfall data with recorded consumption data and comparing the climatological data with the long-term means.

23. The data to be used in a sample study of this method are presented in Table 5-A. It should be noted that the calculations shown in the table include the placing of climatological conditions in proper time correlation with consumption for continuous monthly billing.

24. The data from Table 5-A are then plotted as shown on Chart 5D for the respective years, with Column N reserved for long-term mean climatological conditions and estimated normal consumption. After careful study of the climatological effects, including a review of daily data when unusual climatological conditions prevailed, and consideration of any historical upward trend in water consumption, the monthly consumption is estimated on a judgment basis and entered under the Column N for each month.

TABLE 5-A

SALES, TEMPERATURE & PRECIPITATION DATA

Month	Ccf Cust. - Mo.	Long Term Mean Temp.	One Half of (Current + Prior Month) Temp. Average	Departure	Degree Days 90° and Over	Long Term Mean Precip.	Total Precip.	Departure
	(1)	(2)	(3)	(4)=(3)-(2)	(5)	(6)	(7)	(8)=(7)-(6)
1961								
January	-	52.3	55.6	3.3	-	2.05	.42	-1.63
February	-	52.2	57.4	5.2	-	2.13	.32	-1.81
March	-	54.7	57.2	2.5	-	2.02	.26	-1.76
April	-	58.4	59.8	1.4	18	1.36	.26	-1.10
May	-	62.6	63.0	.4	20	.60	.02	- .58
June	-	67.2	68.4	1.2	56	.13	.01	- .12
July	-	72.8	75.2	2.4	119	.05	.00	- .05
August	49	75.7	77.4	1.7	138	.11	.06	- .05
September	40	74.4	74.8	.4	115	.12	.06	- .06
October	37	69.5	69.1	- .4	82	.31	.00	- .31
November	27	61.9	61.8	- .1	40	.68	.36	- .32
December	10	55.7	55.4	- .3	-	1.48	1.13	- .35
1962								
January	20	52.3	54.5	2.2	-	2.05	1.60	- .45
February	13	52.2	53.6	1.4	-	2.13	2.84	.71
March	10	54.7	52.5	-2.2	-	2.02	2.48	.46
April	28	58.4	58.8	.4	13	1.36	.47	- .89
May	-	62.6	64.1	1.5	16	.60	.22	- .38
June	31	67.2	66.3	- .9	35	.13	.24	.11
July	35	72.8	71.4	-1.4	80	.05	.02	- .03
August	52	75.7	75.2	- .5	156	.11	.00	- .11
September	40	74.4	75.0	.6	170	.12	.00	- .12
October	33	69.5	69.4	- .1	72	.31	.00	- .31
November	25	61.9	62.0	.1	12	.68	.01	- .67
December	25	55.7	56.1	.4	2	1.48	.04	-1.44
1963								
January	43	52.3	52.2	- .1	-	2.05	.12	-1.93
February	17	52.2	55.6	3.4	-	2.13	1.29	- .84
March	16	54.7	57.8	3.1	-	2.02	1.84	- .18
April	19	58.4	56.1	-2.3	-	1.36	1.36	-
May	30	62.6	60.6	-2.0	-	.60	.72	.12
June	33	67.2	66.5	- .7	4	.13	.04	- .09
July	51	72.8	72.2	- .6	62	.05	.04	- .01
August	55	75.7	75.8	.1	126	.11	.06	- .05
September	46	74.4	76.4	2.0	182	.12	2.01	1.89
October	25	69.5	72.0	2.5	114	.31	2.12	1.81
November	17	61.9	62.8	.9	-	.68	1.02	.34
December	17	55.7	56.1	.4	-	1.48	.86	- .62
1964								
January	26	52.3	52.8	.5	-	2.05	.60	-1.45
February	16	52.2	52.6	.4	-	2.13	.72	-1.41
March	19	54.7	54.6	- .1	-	2.02	.64	-1.38
April	19	58.4	57.4	-1.0	9	1.36	.90	- .46
May	26	62.6	61.2	-1.4	10	.60	.40	- .20
June	-	67.2	65.6	-1.6	24	.13	.03	- .10
July	-	72.8	72.6	- .2	119	.05	.00	- .05
August	49	75.7	76.6	.9	159	.11	.00	- .11
September	41	74.4	73.7	- .7	100	.12	.10	- .02
October	41	69.5	70.8	1.3	86	.31	.16	- .15
November	20	61.9			49	.68	.06	- .62
December	45	55.7			-	1.48	.00	- 1.48

25. The monthly consumption estimates from Chart 5D are plotted as shown on Chart 5E. This curve represents the normalized monthly consumption. It is difficult to make an allowance for the historical upward trend in consumption with this method, so an upward trend of 1% or 2% may be used based on studies of larger utilities in the area.

Mamson Method

26. In this method, climatological effects for March, April, May, September, October, and November only are considered, hence the name, derived from the initial letters of those months.

27. The data to be used in the sample analysis of this method are set forth in the following tabulation. In the example, water production, which is in proper time correlation with climatological conditions, has been adjusted for the unaccounted-for-water factor and to exclude large customers.

Year	Precip. Inches (1)	Avg. Mo. Temp Degr. F (2)	Ccf. Prod. Per Cust. Mo. (3)	% Water Loss (4)	Ccf. Sales Per Cust. Mo. (5) (3) x 100-(4) / 100	Ccf. Prod. Adj. to 8.2% Water Loss (6) (5) x 100 / 100-8.2	Deviation From LTM Prec.	Deviation From LTM Temp.
1955	4.1	64.6	27.08	7.4	25.08	27.3	-2.6	-1.0
1956	3.6	65.8	30.51	12.6	26.66	29.0	-3.1	+ .2
1957	6.0	63.8	24.41	6.0	22.94	25.0	- .7	-1.8
1958	9.7	67.2	29.62	8.3	27.16	29.6	+3.0	+1.6
1959	.5	66.6	31.96	8.2	29.34	32.0	-6.2	+1.0
1960	5.2	66.8	30.68	8.5	28.07	30.6	-1.5	+1.2
Long Term Mean	6.7	65.6						

28. Deviations from the long term mean of temperature and precipitation are plotted versus adjusted production as shown on Chart 5-F. Approximate regression lines are drawn for the temperature and precipitation points. By trial and error these lines are adjusted until they intersect at 0 abscissa, or normal temperature and precipitation. The ordinate at the point of intersection is the desired adjusted production for the Mamson months. The production for the other months is estimated by averaging water use over a representative past period.

Other Methods

29. One alternate method is to group the six months of January, February, March and October, November and December into a winter period and the months of April through September into the summer period. Then an analysis similar to the Graphical Method may be employed for each period separately.

30. When monthly data are available for more than four years, the Month by Month method may be modified by plotting the data for each month, similar to the Mamson Method as shown on Chart 5-F, although for certain winter and summer months only a precipitation line or a temperature line, respectively, may have any significance.

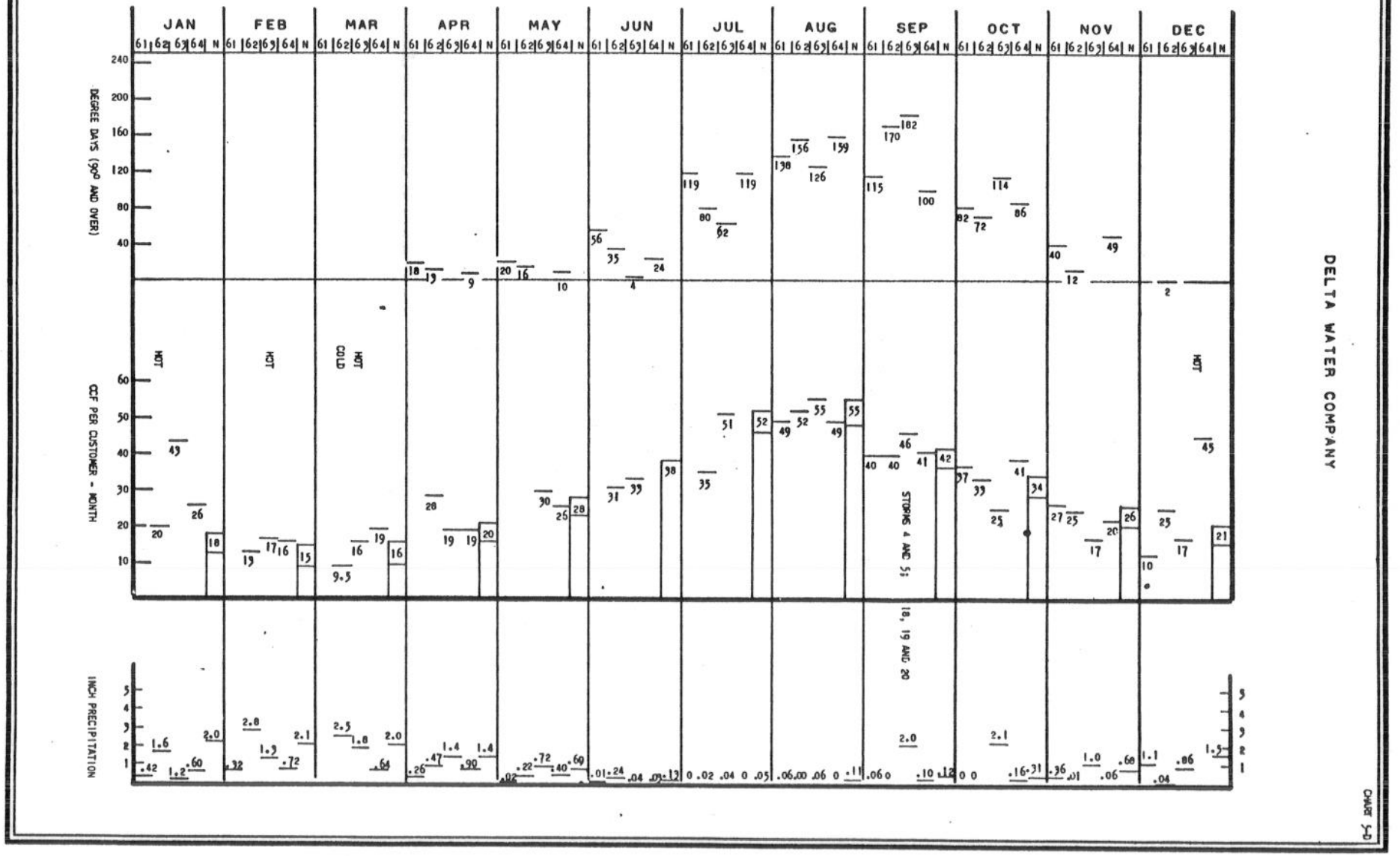
31. Another method consists of drawing recorded monthly consumption curves in different colors each similar to Chart 5E on one sheet of graph paper and then drawing a judgment curve through points estimated to reflect normal conditions. This method is not shown herein.

B - OTHER ADJUSTMENTS

32. In addition to climatological factors, the following considerations may distort future consumption estimates and therefore require adjustment:

a. Recording errors
b. Changes in recording methods
c. Customer reclassification
d. Changes in method of operation of larger customers, usually industrial users.

33. Industrial consumption is generally independent of climatic fluctuations. Estimates for large industrial customers are usually analyzed separately to avoid distortion of the basic data and obscuring of trends. Estimates for the consumption of smaller industrial customers are usually based on a graphical analysis of average usage or total usage or a combination of both.


DELTA WATER COMPANY
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
61 62 63 64 N
DEGREE DAYS (90° AND OVER)
CCF PER CUSTOMER - MONTH
INCH PRECIPITATION
HOT
COLD
STORMS 4 AND 5;
18, 19 AND 20
CHART 5-D

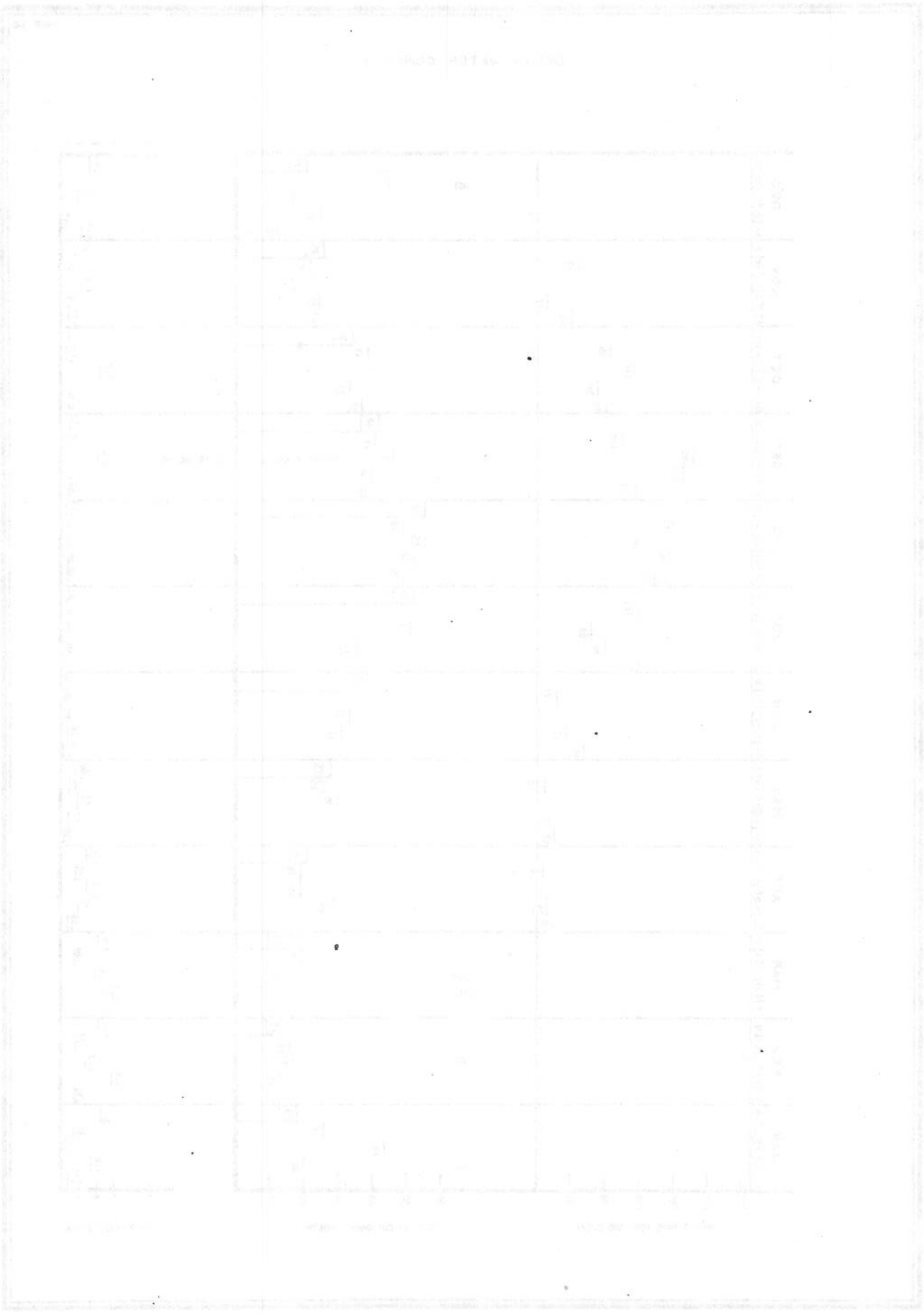
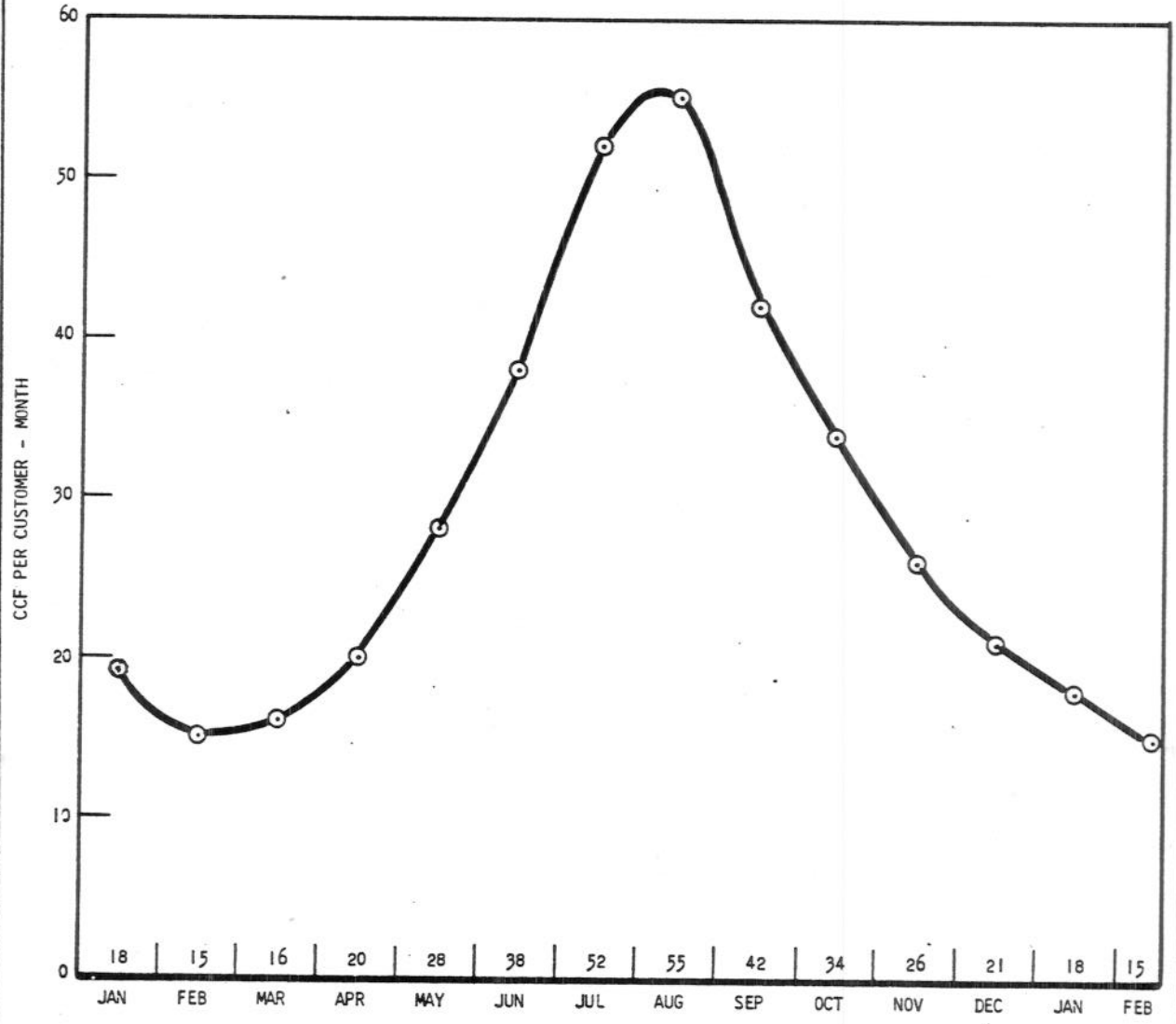
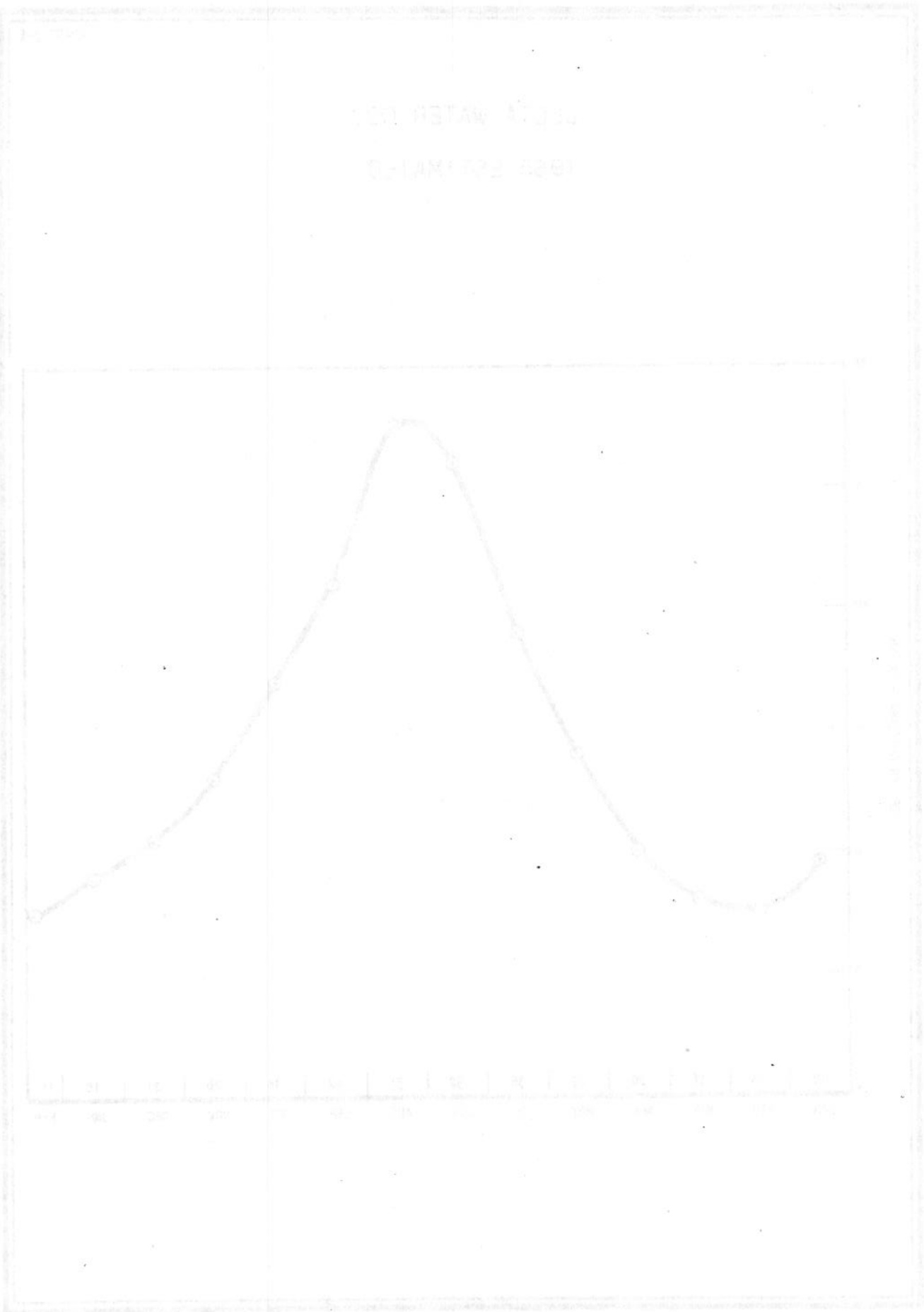


CHART 5-E

DELTA WATER CO.

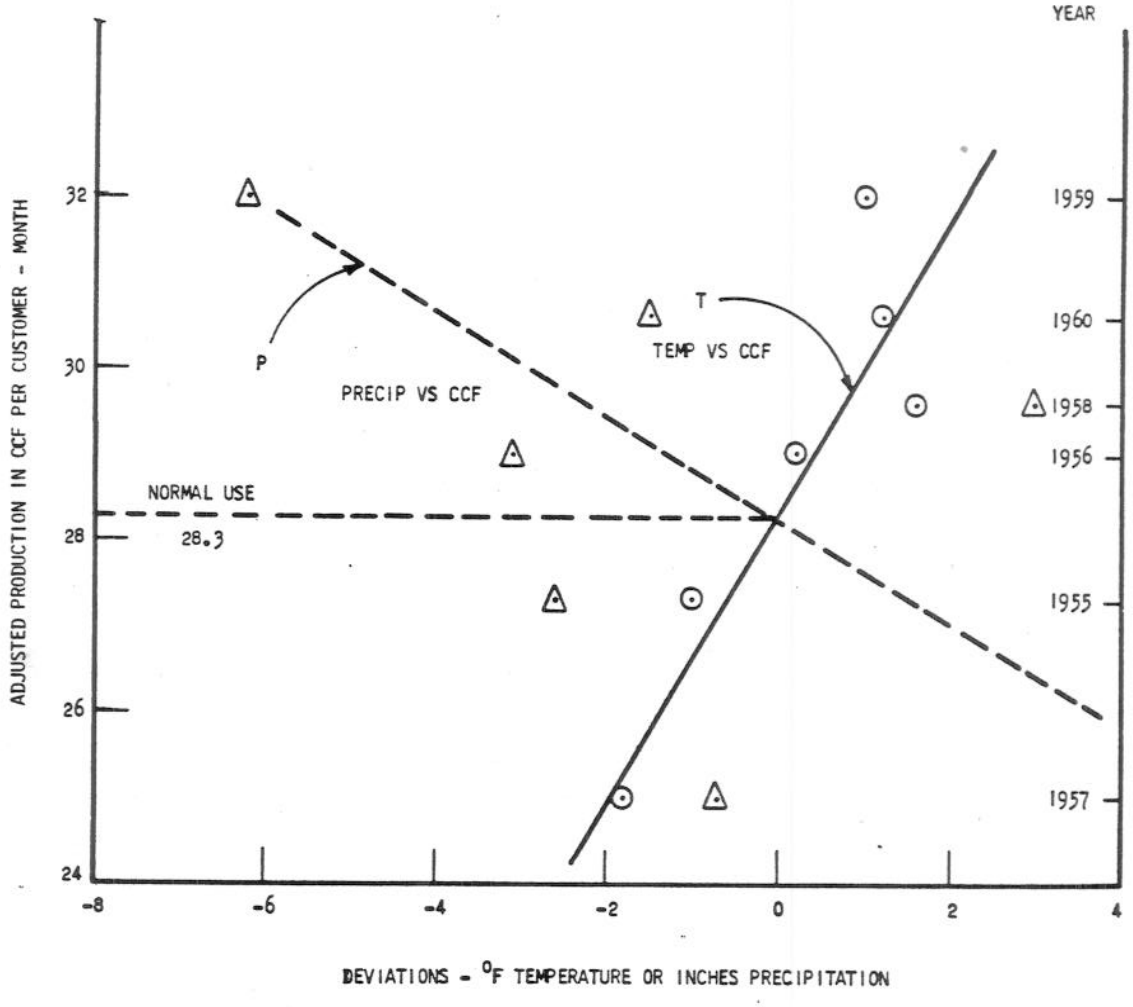
1965 ESTIMATED





TEMPERATURE AND PRECIPITATION ADJUSTMENT

MAR - APR - MAY - SEP - OCT - NOV



5 - NORMALIZATION OF METERED SALES

34. Sales to public authority customers usually are affected by variations in climatological conditions and to a large degree correspond to the pattern established for the commercial customers. In most cases, estimates of normal average sales of public authority customers are related to average commercial sales on a judgment basis, rather than by making a detailed climatological analysis. In other cases the same procedure described in the preceding paragraph for industrial customers may be used.

CHAPTER 6

ESTIMATING METERED SERVICE REVENUES

A - MINIMUM CHARGE TYPE RATE SCHEDULES

Water Use Table

1. Sample revenue calculations in this section are based on the water use table shown in Table 2-A, and the following assumed present and proposed monthly minimum charge type rate schedules.

	Present Rates	Proposed Rates
Quantity Rates:		
First 600 cubic feet or less	$ 1.90	$ 2.50
Next 2,400 cubic feet, per 100 cubic feet	.25	.30
Next 17,000 cubic feet, per 100 cubic feet	.20	.25
Over 20,000 cubic feet, per 100 cubic feet	.15	.20
Minimum Charge:		
For 5/8 x 3/4-inch meter	1.90	2.50
For 3/4-inch meter	2.75	3.50
For 1-inch meter	4.50	5.50
For 1½-inch meter	9.00	11.00
For 2-inch meter	13.00	16.00
For 3-inch meter	24.00	28.00

2. As mentioned in Chapter 2 the selection of consumption blocking in the water use table is based on the rate blocking of the rate schedules. In this case and in a majority of the applications, a closer spacing in the first blocks of the water use table and a wider spacing toward the terminal (tail) block is indicated. To expedite calculation of revenues based on the above rate schedules, the water use table is condensed into four consumption blocks as shown in the first three columns of the following tabulation. The total consumption in column (3) is then spread over the remaining four columns to fix the actual consumption in the proper rate block for pricing purposes.

6 - ESTIMATED METERED SERVICE REVENUES

Rate Block Ccf	Customer Billings	Total Consumption Ccf	Consumption in Block - Ccf 0-6	7-30	31-200	Over 200
(1)	(2)	(3)	(4)	(5)	(6)	(7)
0-6	755	2,358	2,358			
			6xCol.(2)			
7-30	3,785	66,353	22,710	43,643		
				24xCol.(2)		
31-200	3,414	225,868	20,484	81,936	123,448	
					170xCol.(2)	
Over 200	181	75,643	1,086	4,344	30,770	39,443
Total	8,135	370,222	46,638	129,923	154,218	39,443

3. In spreading the total consumption in column (3), first, the figure below the step line in each rate block is calculated as the product of the customer billings in that rate block and the consumption range in the block as shown in the inserted instructions under columns (4) through (6). Then, the figure above the step line, which is the remainder of the consumption in the rate block, is determined as the difference between the total consumption in column (3) and the intervening calculated consumptions in the same rate block.

4. Tentative revenues at present rates and at proposed rates may now be calculated as demonstrated in the following tabulation:

Item	No. of Units	Present Rates	Present Revenues	Proposed Rates	Proposed Revenues
	(1)	(2)	(3)=(1)x(2)	(4)	(5)=(1)x(4)
Minimum Charge (Rate Blocks)	8,135	$1.90	$15,456	$2.50	$ 20,338
7-30 Ccf	129,923	.25	32,481	.30	38,977
31-200 Ccf	154,218	.20	30,844	.25	38,554
Over 200 Ccf	39,443	.15	5,916	.20	7,889
Total	-	-	84,697	-	105,758

5. In general, the revenues at present rates, as determined above, differ from latest known, or representative, recorded revenues due to: partial billings, billing errors, refunds for prior discrepancies, customers with large meters using less than the volume of water included in the minimum charge, and the period covered by the water use table not coinciding with the latest known annual recorded revenues. The ratio of the recorded revenues (assumed to be $83,528) to the computed revenues at present rates ($84,697 from the above tabulation) is equal to 0.986 and can be termed the revenue adjustment factor.

6. To estimate the revenues generated by the company's proposed rates, the ratio of revenues at proposed rates ($105,758) to revenues at present rates ($84,697) is developed. In this case, it is equal to 1.249 and is called the rate increase factor.

7. In order to account for projected changes in the number of customers, the ratios of estimated average customers for the test years to the average customers for the latest recorded period are developed as the growth factors. For example:

	Test Year #1		Test Year #2	
Recorded Avg.Cust.	Estimated: Avg.Cust.	Growth Factor	Estimated: Avg.Cust.	Growth Factor
(1)	(2)	(3)=(2)÷(1)	(4)	(5)=(4)÷(1)
680	740	1.088	790	1.162

8. Finally, in order to adjust consumption for normal climatological conditions and to account for the projected trends in use of water, the ratios of estimated average consumption for the test years to the average consumption per customer derived from the water use table (370,222 Ccf ÷ 678 customers = 546 Ccf) are developed as the usage factors.

For example:

	Test Year #1		Test Year #2	
Recorded Avg.Cons.	Estimated: Avg.Cons.	Usage Factor	Estimated: Avg.Cons.	Usage Factor
(1)	(2)	(3)=(2)÷(1)	(4)	(5)=(4)÷(1)
546	610	1.117	630	1.154

9. If the usage factor is close to 1.0 (unlike the present examples) or additional refinement does not appear warranted, revenues at present and proposed rates may now be calculated as shown in the tabulation in Paragraph 13, except that the usage factors developed in the preceding paragraph would be substituted there for the adjusted usage factors actually used in the tabulation in Paragraph 13.

10. When the usage factor does not approach unity, it should be adjusted to reflect changing water use table characteristics resulting from projected changes in average consumption. To develop a revised condensed water use table, assume proportional increases in each consumption block and determine the portion of the consumption in each rate block which "passes through" the rate block boundary to the next adjacent rate block. In making this adjustment, the following procedure can be used as illustrated in Table 6-A.

a. Consumption blocks which are likely to pass through the rate block boundary are analyzed and entered either in column (2) or column (4).

b. Number of billings and related consumption passing through are determined.

c. Increased consumption is computed by applying the usage factor to the original consumption.

d. Billings and consumption are redistributed to produce a revised condensed table.

TABLE 6-A

Alpha Water Company

REDISTRIBUTED CONDENSED WATER USE TABLE

Test Year No. 2

Analysis and Computation of Billings and Consumption Passing Through

No. of Billings from Table 2-A: (1)	Original Cons. Block (2)	No. of Single Ccf Levels Each Cons. Block (3)	Increased Ccf (2) x 1.154 Usage Factor (4)	Billings Passing Through (5)	Back Up for Col. (5) (6)	Consumption Passing Through (7)
145	5 6	1	5.770 6.924	134 =	145x (6.924-6)	134 x 7 = 938
571	7 25 26	1	8.078 28.850 30.004			
	27 Avg. 30 28.5	4	31.158	457 =	571x 4/5	28.5 x 1.154 x 457 = 15,030
44	151 173.31	23	174.25 200.			
	174 Avg. 200 187	27	200.796 230.8	24 =	44x 27/50	187 x 1.154 x 24 = 5,179

Increased and Redistributed Billings and Ccf

Rate Block	Original Billings (11)	Original Consumption Ccf (12)	Increased Consumption Ccf (12)x1.154 (13)	Passing Through Billings (14)	Passing Through Ccf (15)	Redistributed Billings (11)+(14) (16)	Redistributed Ccf (13)+(15) (17)
0-6	755	2,358	2,721	(134)	(938)	621	1,783
7-30	3,785	66,353	76,571	134 (457)	938 (15,030)	3,462	62,479
31-200	3,414	225,868	260,652	457 (24)	15,030 (5,179)	3,847	270,503
201 and Over	181	75,643	87,292	24	5,179	205	92,471
Total	8,135	370,222	427,236	-	-	8,135	427,236

(Red Figure)

11. In order to obtain the increased average usage of 6.924 Ccf shown in Column (4) of Table 6-A for the 6 Ccf consumption block (an example of a portion of a single block passing through), some of the 145 billings will remain in the 6 Ccf block and the remainder will pass through the rate block boundary to the 7 Ccf block. The formula shown in Column (6) for calculating the number of billings passing through can readily be derived by simplifying the following equation:

$$6\ (145 - x) + 7x = (6)\ (1.154)\ (145)$$

Where a consumption block comprises several discrete Ccf levels (such as the 26-30 block or the 151-200 block), the lowest Ccf level in the block passing through is determined as shown in Column (2). Assuming that the billings are uniformaly distributed throughout the consumption block, the number of billings passing through is based on the ratio of the number of Ccf levels passing through to the total number of Ccf levels in the consumption block as shown in Column (6). The related average consumption passing through is then equivalent to the average of the Ccf levels passing through multiplied by the usage factor as shown in Column (7). The lower section of Table 6-A sets forth a method of redistributing the bills and increased consumption, resulting in a redistributed condensed water use table.

12. By pricing out this condensed table, following the methods described in paragraphs 3 and 4, adjusted revenues of $95,904 are derived. These revenues, when related to the tentative revenues of $84,697 at present rates developed in paragraph 4, result in an adjusted usage factor of 1.132 for test year No. 2. Similarly, an adjusted usage factor of 1.101 may be derived for test year No. 1, using a table similar to Table 6-A, not reproduced herein, based on the unadjusted usage factor of 1.117 developed in paragraph 8.

6 - ESTIMATING METERED SERVICE REVENUES

13. The following tabulation sets forth a sample calculation at present and proposed rates for the two test years using the data developed in the preceding paragraphs and tabulations:

Line	Item	Test Year No. 1	Test Year No. 2	Source
1	Revenues at Present Rates (from Condensed Water Use Table)	$ 84,697	$ 84,697	Para. 4
2	Revenue Adjustment Factor	0.986	0.986	Para. 5
3	Revenues at Present Rates, Adjusted to Recorded Revenues	$ 83,511	$ 83,511	Line (1)x(2)
4	Growth Factor	1.088	1.162	Para. 7
5	Revenues at Present Rates, Adjusted for Growth	$ 90,860	$ 97,040	Line (3)x(4)
6	Adjusted Usage Factor	1.101	1.132	Para. 12
7	Normalized Revenues at Present Rates	$100,037	$109,849	Line (5)x(6)
8	Rate Increase Factor	1.249	1.249	Para. 6
9	Revenues at Proposed Rates	$124,946	$137,201	Line (7)x(8)

14. The principles described above apply to bimonthly billing also, except that the size of the rate block, the minimum allowance and the minimum charge would be doubled.

15. As an alternate procedure, revenues can be calculated by determining the average number of customers and total consumption for the test years; spreading the results, based on a water use table, either original or redistributed; and pricing out the revenues at present and proposed rates directly. This is shown in Chapter 7.

B - SERVICE CHARGE TYPE RATE SCHEDULES

16. Sample revenue calculations in this section are based on the following present and proposed monthly service charge type rate schedules:

	Present Rates	Proposed Rates
Quantity Rate:		
For all water delivered, per 100 cu.ft. ..	$0.16	$ 0.20
Service Charge:		
For 5/8 x 3/4-inch meter	2.00	2.45
For 3/4-inch meter	2.20	2.60
For 1-inch meter	2.40	3.60
For 1½-inch meter	4.00	5.00
For 2-inch meter	5.80	6.50
For 3-inch meter	10.60	12.00

17. In determining the revenues that will accrue from the service charge portion of the schedule, it is convenient to use the average monthly service charge for each class of customers.

18. The development of the trend in average monthly service changes at proposed rates is shown in the following tabulation:

		June 30, 1960		June 30, 1963	
Meter Size	Rates	No. of Meters	Monthly Revenues	No. of Meters	Monthly Revenues
(1)	(2)	(3)	(4)=(2)x(3)	(5)	(6)=(2)x(5)
5/8 x 3/4	$ 2.45	5,602	$13,725	5,268	$12,907
3/4	2.60	-	-	-	-
1	3.60	1,760	6,336	1,887	6,793
1½	5.15	250	1,288	285	1,468
2	6.60	55	363	668	4,409
3	12.25	49	600	27	331
		7,716	22,312	8,135	25,908

Avg. Service Charge $\frac{\$22,312}{7,716} = \$2.892$ $\frac{\$25,908}{8,135} = \$3.185$

19. Assuming a straight-line projection, monthly average service charges of $3.283 and $3.381 for the test years 1964 and 1965 can be easily developed.

20. Using the trended service charges developed above, the revenues at proposed rates are developed as shown below:

Line	Item	1964 Estimated	1965 Estimated	Source
1	Average Number of Customers	8,850	9,452	
2	Average Service Charge	$ 3.283	$ 3.381	Para. 19
3	Annual Service Charge Rev.	348,700	383,500	Line (1)x(2)x12
4	Annual Consumption - Ccf	5,399,200	5,957,400	
5	Quantity Rate	$ 0.20	$ 0.20	
6	Annual Quantity Rate Revenues	1,079,800	1,191,500	Line (4)x(5)
7	Total Annual Revenues	1,428,500	1,575,000	Line (3)+(6)

21. For a service charge type rate schedule with two block quantity rates, the percentage of water in each block to be used in computing the quantity rate revenues can be readily obtained if a water use table is available. However, without a water use table, it is necessary to set up and solve an equation in order to determine the percentage of water in each block.

22. Assuming recorded quantity rate revenues of $747,250 and a corresponding recorded consumption of 4,442,700 Ccf and with the following rate schedule:

Quantity Rates	Per Meter Per Month
First 5,000 cu.ft., per 100 cu.ft.	$0.19
Over 5,000 cu.ft., per 100 cu.ft.	.13

an equation may be readily developed. Assume that x % are in the first block, then (100 - x)% will be in the tail block. Therefore,

$$\frac{0.19\ (x)\ (4,442,700)}{100} + \frac{0.13\ (100-x)\ (4,442,700)}{100} = 747,250$$

$$0.19\ (x)\ (4,442,700) + 0.13\ (100-x)\ (4,442,700) = 74,725,000$$

$$0.19\ x + 0.13\ (100-x) = \frac{74,725,000}{4,442,700}$$

Solving for x gives 63.6% of the consumption in the initial block.

23. If enough data are obtainable, the engineer should compute the percentages in the blocks for three of four 12-month periods and use the average determined therefrom. Trending of these percentages is not recommended as they tend to fluctuate in practice.

CHAPTER 7

RATE SPREAD

A - GENERAL

1. It is a requirement that the utility applying for a rate increase must state the present and proposed rates in its formal application. If the examiner's decision draft authorizes only part of the requested increase or finds that new types of rate schedules are necessary, it is the responsibility of the assigned engineer to determine rates that will produce the authorized increase in revenues and to prepare an appropriate rate appendix to the decision draft, setting forth the rate schedules that should be authorized. The computation is carried out by a trial and error method until satisfactory results have been obtained.

2. In the event new rates are being established, an examination of rates in effect for adjacent utilities may be helpful in determining the rates to be used. When the rates in two or more schedules are to be increased, such as those applicable to metered, flat rate and fire protection service, the engineer should use his judgment as to the increase for each type of service. If a cost of service study is available, it will serve as a guide for rate spread and design.

3. It is the usual practice to develop rate schedules that will generate slightly higher calculated revenues than those stated in the decision draft as being authorized. The rate schedules should be carefully prepared as errors discovered subsequent to the issuance of a decision can be corrected only by the issuance of an amended decision.

4. Generally, the increased rates authorized by the decision are not at a level above the rates proposed in the application. However, there are instances where certain portions of the proposed rates may be unrealistically low in relation to the basic rates. For example, the proposed monthly minimum charges for meters larger than the 5/8 x 3/4-inch size used for residential and other small users may be inconsistent with the proposed charges for the 5/8 x 3/4-inch meter. In such cases, the staff should make an appropriate recommendation in its report on results of operation and such recommendation may be adopted in the decision draft.

If this occurs, the staff may then include in the rate spread the effects of the adopted recommendation, even though this may result in some authorized rates being higher than those requested by the applicant.

5. If the rate schedules as proposed by the applicant are not compatible, e.g., the meter minimum charge for residential service is equal to, or greater than, the basic flat rate charge for essentially the same service, the staff should make a recommendation in its report that, if any rate increases are authorized, the rate schedules for comparable service should be consistent. Assuming that such a recommendation has been adopted in the decision draft, the engineer must then follow this up when making his rate spread. A basic premise is that the customers in any one class should receive bills for metered service, for example, that will be slightly higher than for flat rate service, in order to compensate the utility for the additional costs of providing metered service. The meter minimum charge or service charge, therefore, should be somewhat less than the comparable basic flat rate charge, and the quantity rates for metered service should be fixed at levels which will result in monthly charges for average usage that will be reasonably compatible with the flat rate charges.

6. The same procedures may be followed when the staff, in its results of operation report, recommends certain increases and/or changes in tariff schedules, and includes appropriate appendixes setting forth the rate schedules that will yield the recommended revenue increase. This form of staff report has been widely used in recent years in connection with a procedure approved by the Commission on August 1, 1961, and a revised procedure approved on October 13, 1964 relating to the processing of rate increase applications for small water utilities. The procedure contemplates the handling of such applications on an ex parte basis, if possible, and is set forth in Subject Reference D-46 (641016).

B - FLAT RATES

7. A typical rate spread for flat rates is shown in Table 7-A. The example used herein is based on the same data as shown in Paragraph 9 of Chapter 4. Actually "Trial I" might have been adopted except that the

full requested increase would have been granted for customers with large size lots. Of course, the engineer may find it convenient to check revenues at present and proposed rates concurrently as shown further in Table 7-B for metered service.

C - METER RATES

Minimum Charge

8. As the first step in spreading rates, the engineer should obtain from his work papers and/or compute, for the test year adopted in the decision draft, the following information:

a. Total average services.
b. Total consumption.
c. Distribution of the total consumption according to a redistributed condensed water use table.

9. If a new rate block structure is desirable, then an appropriate condensed water use table can be prepared as described in Chapter 6, Paragraph 2. Then the percentage increase in revenue authorized is computed and applied to the present rates. It is also advisable to divide the authorized revenue by the revenue adjustment factor to compute revenue based on the water use table directly.

$$\frac{\text{Authorized Revenue}}{\text{Revenue Adjustment Factor}} = \frac{\$130,000}{0.986} = \$131,845$$

10. Table 7-B illustrates the rate spread for minimum charge type schedules; the computation of units on Line 1 is not shown. If the same rate schedule covers different types of customers, it is advisable to combine the units to simplify the rate spread. The computation of minimum charges for larger meters as shown is done on the basis of factors and additional charges developed in "A Guide to the Preparation of Rate Schedules for Water Utilities*". For illustrative purposes, charges for meters larger in size than 3 inches have also been developed, although not required for this rate schedule.

* May 19, 1967.

TABLE 7-A
Sheet 1 of 2

Beta Water Company

FLAT RATE SPREAD

Item	Avg. No. of Units (1)	Avg. No. of Customer Months (2)= (1) x 12	Round and Use from Col.(2) (3)	Present Monthly Rate (4)	Revenues (5)
Checking					
6,000 sq. ft. or less	933	11,196	11,200	$ 3.05	$ 34,160
6,001 sq. ft. to 10,000 sq. ft.	4,790	57,480	57,500	4.05	232,875
10,001 sq. ft. to 16,000 sq. ft.	1,100	13,200	13,200	5.00	66,000
16,001 sq. ft. to 25,000 sq. ft.	400	4,800	4,800	6.35	30,480
Additional Dwelling	14	168	140	2.50	350
					363,865
Flat Rate Revenue per Staff Report (Present Rates)					363,840
Flat rate Revenue Authorized by Decision Draft					385,000

Tentative Rates

Ratio Increase = $\frac{\$385,000}{363,865} = 1.058$

	Present Monthly Rate (4)	1.058x(4) (7)
Lot Size		
6,000 sq. ft. or less	$ 3.05	$ 3.23
6,001 sq. ft. to 10,000 sq. ft.	4.05	4.28
10,001 sq. ft. to 16,000 sq. ft.	5.00	5.29
16,001 sq. ft. to 25,000 sq. ft.	6.35	6.72
Additional Dwelling	2.50	2.64

TABLE 7-A
Sheet 2 of 2

Beta Water Company

FLAT RATE SPREAD

Line	Item	Lot Size in Sq. Ft. 6,000 or less (11)	6,001 to 10,000 (12)	10,001 to 16,000 (13)	16,001 to 25,000 (14)	Addit'l Dwelling (15)	Total (16)=Sum (11)to(15)
(1)	Customer-Months	11,200	57,500	13,200	4,800	140	86,840
(3)	Proposed Monthly Rate	$ 3.90	$ 4.50	$ 5.30	$ 6.70	$2.80	-
(5)	Annual Revenue (Prop. Rates) Line (1)x(3)	43,680	258,750	69,960	32,160	392	$ 404,942
	Annual Revenue Per Staff Report (Proposed Rates)						404,900
	Trial I						
(11)	Monthly Rate	3.20	4.30	5.30	6.70	2.60	-
(13)	Annual Revenue Line(1)x(11)	35,840	247,250	69,960	32,160	360	385,570
	Trial II						
(18)	Monthly Rate	3.30	4.30	5.20	6.60	2.60	-
(20)	Annual Revenue Line(1)x(18)	36,960	247,250	68,640	31,680	360	384,890
	Trial III						
(24)	Monthly Rate	3.35	4.30	5.20	6.60	2.60	-
(26)	Annual Revenue Line(1)x(24)	37,520	247,250	68,640	31,680	360	385,450

Trial III Adopted

TABLE 7-B

Alpha Water Company

MINIMUM CHARGE - RATE SPREAD

Line	Item	Billings	Ccf in Block 7-30	31-200	201 & Over	Total	Source
		(1)	(2)	(3)	(4)	(5) Sum of (1)to(4)	(6)
1	No. of Units	9,452	161,460	220,710	59,810		
3	Present Rates	$ 1.90	$ 0.25	$ 0.20	$ 0.15	$ -	
4	Prlim.-Revenue	17,959	40,365	44,142	8,972	111,438	Line(1)x(3)
5	Re.Adj.Factor					.986	Ch. 6 Para. 5
6	Revenue					$109,878	Line(5)x(6)
8	Proposed Rates	2.50	.30	.25	.20		
9	Prlim.-Revenue	23,630	48,438	55,178	11,962	139,208	Line(1)x(8)
10	Re.Adj.Factor					.986	
11	Revenue					$137,259	Line(9)x(10)
13	Trial I Rates	2.25	.29	.24	.18	-	
14	Prlim.-Revenue	21,267	46,823	52,970	10,766	131,826	Line(1)x(13)
16	Trial II Rates	2.25	.30	.24	.18	-	
17	Prlim.-Revenue	21,267	48,438	52,970	10,766	133,441	Line(1)x(16)
19	Trial III Rates	2.25	.29	.24	.19	-	
20	Prlim.-Revenue	21,267	46,823	52,970	11,364	132,424	Line (1)x(19)
21	Re.Adj.Factor					.986	
22	Adopt Revenue					$130,570	Line(20)x(21)

Nominal Meter Size	Rated Capacity G.P.M.	Factor	Monthly Quantity Cu. Ft.	Additional Cost at Quantity Rates	Charges for Depr., Return, Maint., etc.	Total Computed Charge	Recommended Charge
(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Source	AWWA	(12)÷20	(13) x 600			(15)+(16)	
5/8 x 3/4	20	1	600	$ 2.25	$ -	$ 2.25	$ 2.25
3/4	30	1.5	900	3.12	0.10	3.22	3.25
1	50	2.5	1,500	4.86	.35	5.21	5.25
1½	100	5.0	3,000	9.21	1.00	10.21	10.25
2	160	8.0	4,800	13.53	1.50	15.03	15.00
3	300	15.0	9,000	23.61	3.50	27.11	28.00
4	500	25.0	15,000	38.01	6.00	44.01	45.00
6	1,000	50.0	30,000	69.01	15.00	84.01	85.00
8	1,600	80.0	48,000	103.01	25.00	128.01	130.00

Service Charge

11. In spreading rates for a service charge type schedule, the same principles apply as were used previously, with the exception that different standards apply to the relationship of service charges for different sized meters. The suggested ratios used in Table 7-C of this chapter have been prepared by a major utility and are based on the costs of a meter, a meter box, a 30-foot service line, and some 60 feet of adequately-sized main. As a preliminary step, it is advisable to combine all the different classifications of customers, such as commercial, industrial, public authority, and others, together to facilitate computations and also to design for a 5/8 x 3/4-inch meter service charge using equivalent meter factors to allow for larger meters in use. Table 7-C sets forth the rate spread and the suggested equivalent meter factors.

TABLE 7-C

Beta Water Company

SERVICE CHARGE - RATE SPREAD

Line	Item	Service (1)	Quantity (2)	Total (3)=(1)+(2)	Source
1	Avg.No. of Customers	9,452			
2	Equivalent Meter Factor	1.384			
3	Equivalent Cust.-Month	156,979			Line (1)x(2) x 12
5	No. of Units or Ccf	156,979	5,957,400		
7	Proposed Rate	$ 2.45	$ 0.20	$ -	
8	Proposed Revenue	384,600	1,191,480	1,576,080	Line (5)x(7)
10	Trial I Rate	2.30	.19		
11	Trial I Revenue	361,050	1,131,910	1,492,960	Line (5)x(10)
13	Trial II Rate	2.35	.19		
14	Trial II Revenue	368,900	1,131,910	1,500,810	Line (5)x(13)

Service Charges

Meter Size (11)	Equivalent Meter Factor (12)	Authorized Rate (13) = 2.35 x (12)	Round & USE (14)
5/8x3/4-inch	1.0	$ 2.35	$ 2.35
3/4-inch	1.1	2.58	2.60
1-inch	1.5	3.52	3.60
1½-inch	2.0	4.70	4.70
2-inch	2.7	6.34	6.40
3-inch	5.0	11.75	12.00
4-inch	6.8		
6-inch	11.3	Not Requested	
8-inch	16.8		
10-inch	20.8		

ATTACHMENT A

ALPHA WATER COMPANY

Data Request

Item No.	Description
H-1	Number of active service connections, by months, for the last five calendar years and for the available months of the current year, shown separately for each class and type of service.
H-2	Number, size and type of municipal, district, and private fire hydrants, by months, for the last three calendar years and for the available months of the current year.
H-3	Revenues by class and type of service, and related water consumption for metered service, by months, for the same period of time designated in H-1.
H-4	Water use tables for metered service for the last calendar year. Separate water use tables should be prepared for each class of service. For customers whose use is exceptionally large or subject to wide fluctuations, their monthly revenues and consumption should be shown separately for the period indicated in H-1.
H-5	For flat rate service, a tabulation by months of the number of customers listed for each separate charge, comprising an analysis of total flat rate revenues for the last calendar year.
H-6	Describe the present schedule of reading meters and any substantial changes in the schedule over the last 10 years.