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ESTIMATING OUTPUT AND OPERATING EXPENSES OF

MUNICIPALLY-OWNED PUBLIC UTILITIES IN

BROOKINGS, SOUTH DAKOTA,

1959 TO 1970

BY

RODNEY DELOS PETERSON

ESTIMATING OUTPUT AND OPERATING EXPENSES OF
MUNICIPALLY-OWNED PUBLIC UTILITIES IN
BROOKINGS, SOUTH DAKOTA,
1959 to 1970

This thesis is approved as a creditable, independent investigation by a candidate for the degree, Master of Science, and acceptable as meeting the thesis requirements for this degree; but without implying that the conclusions reached by the candidate are necessarily the conclusions of the major department.

Thesis Adviser

Head of the Major Department

ii

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This thesis is dedicated to the author's mother—she has made all things possible!

<div align="right">R. D. P.</div>

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Rapid population increases during times of prosperity tend to encourage, and often necessitate, expansion of community residential areas. Increases in new construction are necessarily followed by an increase in demand for public utilities. Such a situation currently exists in Brookings, South Dakota. However, before evaluation of this phenomenon, the environmental factors which are unique in this particular instance should be analyzed and their implications considered in relation to future community planning.

When a small community has a large educational institution of higher learning within its physical framework, it seems logical that the community would look upon that institution as a major determinant of its population. In order to obtain a foundation for this study, it was necessary to review the economic climate that supported the problem. This led to the information that was used as background material for this study.

The total population of Brookings, South Dakota, may be considered largely a function of college enrollments at South Dakota State College. Assuming this, college enrollments would affect the number of employees at South Dakota State College and also the population that results from business activity in the commercial sector.

College enrollments at South Dakota State College are expected to increase sharply by 1970 "because college-age population will increase

at an increasing rate . . . to 1970."[1] This is due to several factors. The primary reason is that an increase in the birth rate during the 1940's has caused more college age youth to exist. Other factors that influence the expected enrollment increase are: (1) a greater percentage of youth attend and graduate from high school,[2] (2) a larger percentage of high school graduates are attending college,[3] and (3) a trend has been established indicating that an increasing percentage of South Dakota youth attend South Dakota State College; in fact, "its enrollment increased 156 percent from 1951-1952 to 1958-1959."[4]

Assuming that college enrollments would increase, it then seems logical to conclude that the number of personnel at South Dakota State College would increase if enrollments are to be matched to the present student/employee ratio. The student/employee ratio was approximately 4.86 to 1 in 1958.[5]

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[1]Charles Benrud and Travis W. Manning, "A Report on Long-Range Salary Trends and Requirements for Acquiring and Maintaining an Adequate Faculty at South Dakota State College," Report Number 1, p. 4, Committee on Economic Status of the Faculty, South Dakota State College Chapter, American Association of University Professors, January, 1959.

[2]National Education Association, Research Bulletin, Volume 37, Number 1, p. 3, Research Division of the National Education Association, February, 1959.

[3]Frank A. Beu, William E. Lipsey, and Louis M. Scheier, Introduction to Education, pp. 328-329, Interstate Printers and Publishers: Danville, Illinois, 1956.

[4]Benrud and Manning, op. cit., p. 9.

[5]In calculating the number of employees, the Extension Division was omitted. Graduate Assistants were not included as faculty, but as students. The ratio was obtained by dividing the number of students (3,788), by the number of employees (780), as of the 1958 fall quarter enrollment.

3

College enrollments would cause the commercial sector to expand
if capitalistic expectation for profits drew a host of entrepreneurs
toward Brookings; thus the volume of business would grow larger in re-
sponse to added consumer demand for additional goods and services.

In this study, an attempt was made to estimate the amount of
operating expenses that may be required to maintain the municipally-
owned public utilities in Brookings, South Dakota, from 1959 to 1970.
The basic assumption of this study was that the anticipated increase in
enrollments at South Dakota State College would cause the population of
Brookings to grow to a considerable degree and at a very rapid rate.
From this followed the purpose and the major objectives.

Nature of the Problem

When the residential housing sector of a city expands, it normally
does not expand within the city proper. Rather, most of the building of
new homes seems to take place on the perimeter of the city and continues
outward toward the rural districts. This means that most of the residen-
tial lots will have to be developed from tracts of raw land, which would
then cause the city to increase in total area as well as by population.

The Urban Land Institute has done much work in relation to commu-
nity planning and residential development. In Technical Bulletin 27, the
institute pointed out that a lack of planning may cause many complications

and problems.[6] Particularly, as a city grows in total area, the problem of providing public utilities services may become acute due to the inadequacies of existing facilities to satisfy the increased demand for consumption. Even if extensions were added to existing facilities, in some cases increased demand might be so great that the resulting service would be inadequate. This means that new facilities from the source of utility to the points of consumption, i.e., to the newly developed residential areas, may have to be built if consumer demand for service is to be supplied.

It is possible that Brookings may experience this problem of inadequate public utilities facilities in the future. However, by becoming aware of the nature of a future expected increase in college enrollments, and hence, a similar expected increase in total population, Brookings can cope with the problem of providing a large amount of funds for expansion and investment in its municipally-owned public utilities.

Municipal authorities and city-planners recognize that an expected population increase will affect expansion in the residential sector and the corresponding increase in output and operating expenses of municipally-owned public utilities. However, no calculated predictions and synthesization of overall estimates has been developed. Research such as this may be of great importance to residents of the city and county of Brookings in the roles of consumers and taxpayers; to business

[6]Urban Land Institute, "Utilities and Facilities for New Residential Development," Technical Bulletin 27, pp. 5-12, Washington, D. C., December, 1955.

5

enterprises such as the construction industry; and finally to municipal authorities and city-planners for use as a guide for future decisions in relation to city development.

Purpose and Objectives

In order to show what the effect of an expansion in municipally-owned public utilities would mean to Brookings in the form of tax and/or consumption rate increases or bonded indebtedness, it was necessary to estimate the amount of future output of public utilities and the resulting amount of future operating expenses.

The purpose of this study was to predict yearly, total operating expenses in municipally-owned public utilities for Brookings, South Dakota, for the period 1959 to 1970. In order to achieve this purpose, three major objectives had to be attained. They were to predict:

(1) The future college enrollments at South Dakota State College.

(2) The total yearly future population for Brookings.

(3) The increased amount of output in municipally-owned public utilities that will result from the anticipated population increase.

It was realized that as the city of Brookings grew by area and population, the increases in new homes built would be a supporting cause of the increased expansion of public utilities. It was, therefore, a minor purpose of this study to estimate the volume of residential construction that may take place during the 1959 to 1970 period.

Limitations of the Study

In reaching the conclusions of this study, it was not intended to present a theory of urban development and city-planning, nor to develop a scheme for strict zoning of geographical expansion by direction and area. Rather, an attempt was made to bring to the attention of those concerned the nature of the problem that could occur during a period of rapid acceleration of population, and to show the relationship between population increases and resulting increases in consumption of public utilities.

It was not the purpose of this study to present a detailed analysis of the type and nature of materials needed for construction of residential housing and municipally-owned utilities, nor to make a cost analysis of each public utility department. The study was designed to present final gross estimates of probable operating expenses. While it seemed plausible that in order to calculate operating expenses it would be necessary to estimate construction costs and needed materials, however, in light of the methodology used, this was not attempted. To reiterate, this study lent itself to basic superficial direction as to what operating expenses might be, assuming the basic premises to be correct.

Procedure

Previously most community planning and urban development programs have not shown estimates of output and cost of future public utilities. Many of these studies were usually related to zoning or geographical

expansion. Such research carried on in some of the larger cities in the United States has been cited in a publication edited by the Chamber of Commerce of the United States. Some of these projects were city improvement programs designed for the clearance of slum areas or for the improvement of parking facilities. For example, the Dayton, Ohio, Chamber of Commerce had a list of 90 items in its 1955 program of work; among these items were development of downtown parking areas and pilot studies for housing rehabilitation.[7] Similar studies showed plans to perfect the city in order to draw business or other economic activity. This type of research was accomplished when the Worcester, Massachusetts, Chamber of Commerce had a program in existence from 1945 to 1955 for the purpose of attracting large industries. That program consisted of industrial development and a promotion of Worcester as a distribution center.[8]

The present study was partially developed from a similar study completed by Norma Koch.[9] In her thesis, the dollar volume of trade in Brookings for the 1958 to 1970 period was forecast. From that study, much basic data were obtained with which to support this research.

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[7]Chamber of Commerce of the United States, Urban Development Guidebook, p. 69, Construction and Civic Development Department: Washington 6, D. C.

[8]Ibid., p. 87.

[9]Norma Ruth Koch, Estimating Commercial Expansion in Brookings Resulting from the Anticipated Increases in South Dakota State College Enrollments, Thesis for Master of Science Degree, Department of Economics, South Dakota State College: Brookings, South Dakota, June, 1958.

Before estimates of future output and operating expenses of utilities were attempted, it was necessary to synthesize other basic data so that relationships could be shown. Previous college enrollments for the 1950 to 1958 period were first secured, then estimations of future enrollments at South Dakota State College for the 1959 to 1970 period were obtained. After this was accomplished, the yearly population for the 1950 to 1970 period was estimated. As the 1950 census was the only official figure available, the population for the remaining years had to be estimated.

With both college enrollments and total population figures estimated for the 1950 to 1970 period, the next phase of the study was achieved. This consisted of estimating the probable number of housing units that would be needed for the 1959 to 1970 period. After this had been completed, the last phase of the study, the actual predicting of output and operating expenses for the municipally-owned public utilities, was completed. This was done by establishing relationships between the population and output and operating expenses for each of the public utilities. Future population estimates were then applied to the relationships; this resulted in actual predictions of output and operating expenses for each of the municipally-owned public utilities for the 1959 to 1970 period.

CHAPTER II

PRELIMINARY CONSIDERATIONS

The limitations and assumptions of this study were not made with the belief that the future would remain unchanged. Rather, they were made because it seemed necessary to isolate the problem in order to make the study less complicated and more meaningful.

Definition of Terms

In order to avoid confusion and to facilitate comprehension, it was first necessary to consider the meaning of terminology used in the study. The definitions of terms used lend themselves to the special case, i.e., this particular study.

Base Period

The period of time from 1950 to 1958 from which relationships were established was considered the base period.

Estimations

These were the predictions or forecasts of future phenomena that resulted from statistical and mathematical methodology used in this study. It should be emphasized that it was not the purpose of this study to present actual or exact predictions, but to show what the future might be, in the light of past occurrences.

College Enrollment

College enrollment included both full-time and special students registered in the initial enrollment at the beginning of the fall quarter for each academic year.[10]

Population of Brookings

All people residing within the city limits of Brookings, South Dakota, were considered as the "total population of Brookings." This term then included all college students and their families that made temporary or permanent residence in Brookings at the beginning of the fall quarter of each academic year. The effect of students, college personnel, and employees of the Brookings community that commute from surrounding towns, areas, or settlements was held constant relative to college enrollments and the future population of Brookings.

Dwellings

The use of this term had reference to the number of housing units in the city of Brookings. It included both single and multiple units, i.e., duplex, triplex, etc. The effect of remodeling, repairing, houses moved into the city, trailer homes, apartment buildings, or college-built family-units, was held constant for this part of the study, i.e., the population of Brookings and the number of houses in the city.

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[10]To illustrate, the college enrollment for 1958 is cited in Table I as 3,788. This means that at the beginning of the fall quarter of the 1958-1959 academic year, the total enrollment was 3,788.

Municipally-Owned Public Utilities

The concept of "municipally-owned public utilities" had reference to telephone, electric and water-sewer facilities. Fire, hospital, park and recreational, police, school, and street facilities were considered as public services; no attempt at future estimations was made in regard to these.

Output

"Output" was used in an all-inclusive sense. It had reference to yearly totals, which were: (1) the number of telephones in use in Brookings, (2) the number of kilowatt hours of electric power, either manufactured or purchased, that were made available for distribution to consumers located in Brookings, and (3) the amount of water pumped by Brookings for municipal, commercial, and residential consumption. The term "output" was chosen because the term "consumption" would not be an overall concept that would include what the city must provide. Consumption would be total output minus leakage or waste.[11]

Operating Expenses

This term had reference to total amount of spending needed to maintain each of the municipally-owned public utilities. It was used as synonymous with "operating costs." It included: (1) administrative costs, (2) bad debts loss, (3) depreciation, (4) fuel, (5) insurance,

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[11]For example, there is approximately a nine percent loss on electric output. This would mean that in order to consume 91 kilowatt hours, 100 kilowatt hours would have to be produced.

(6) maintenance of plant and equipment, (7) operating labor, (8) salaries and wages, (9) supplies and equipment, and (10) miscellaneous expenses.

Assumptions

Four factors will obviously affect the level of college enrollments. They are: (1) the appropriations of the state legislature, (2) the level of farm incomes, (3) the relationship of the Regents of Education with the administration and faculty, and (4) the attitude of the administration toward the students.

If the appropriations of the state legislature were cut considerably, South Dakota State College would not be able to allow an increasing number of students to enroll because facilities would not be adequate. Should the level of farm incomes fall drastically, the number of students might decrease because those in the agricultural sector might not be able to afford the burden of college expenditures for their young people. In case the Regents of Education should limit or restrict the curriculum, or propose a different policy in hiring personnel, enrollments might decrease because students would not be serviced properly. If the administration were to adopt a more stringent policy of rigid scholastic standards or changed their policy to a more rigorous curriculum, student attitudes and decisions toward attendance might change. However, for purposes of this study, each of the above four factors were held constant relative to the base period.

Much of this study relied on the acceptance of previous work done in relation to college enrollments and population prediction methods.

It was assumed that these were reliable.

In order to estimate the future amount of residential housing units that will be necessary to support the expected population increase, it was necessary to assume that the small communities surrounding Brookings would have no effect on decisions to build or live in Brookings.

In reference to the entire study, the amount of per capita income, consumer tastes and spending patterns, purchasing power of the dollar, family size, and the amount of manufacturing carried on in Brookings were also held constant.

Future College Enrollments

At the onset of this study, it was assumed that the total population of Brookings was a function of the increase in college enrollments. This assumption then made it necessary to obtain accurate predictions of future enrollments at State College.

At least two studies had previously been made concerning this type of prediction. The earliest of these was the thesis written by Koch in which the 1970 college enrollment at South Dakota State College was estimated at 7,900.[12] However, a later study developed by the Brookings Chapter of the American Association of University Professors forecast the 1970 college enrollment at over 9,700.[13] The later study used a

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[12]Koch, op. cit., p. 17.

[13]Benrud and Manning, op. cit., p. 28.

type of arrangement in establishing statistical relationships very
similar to that of this study. It was desired that a consistent
method be employed throughout the study as much as possible; therefore,
these later predictions were regarded as being an acceptable estimate
of future enrollments at South Dakota State College. College enrollment
estimates are listed in Table I.

Predicting the Population of Brookings

In order to develop this study, knowledge of yearly population
totals for the city of Brookings for the period 1950 through 1970 was
required. The last official census was conducted by the United States
Bureau of Census in 1950; for that year, the population of Brookings
was reported at being 7,764.[14] This was the only official calculation
available for use in this study. This meant that the total population
for the remaining years, 1951 to 1970, had to be estimated. The 1954
population seemed accurately calculated by Koch as being 8,830;[15] this
was accepted as being a reasonable estimate.

There then remained two periods for which estimations had to be
made, 1951 to 1953, and 1955 to 1970. The 1951 to 1953 population was
estimated by interpolation. Since there were four population changes

[14]United States Bureau of Census, A Report of the Seventeenth
Decennial Census of the United States, Census of Population, Volume One,
Number of Inhabitants, United States Government Printing Office:
Washington, D. C., 1952.

[15]Koch, op. cit., p. 25.

between 1950 and 1954, the difference between the 1950 census and the 1954 estimate by Koch was divided by the number of changes, i.e., four, and the resulting dividend added to each previous value.[16] The population of Brookings for the 1950 to 1954 period was thus estimated.

Remaining was an estimation of the total population for the 1955 to 1970 period. Some difficulty was encountered concerning methodology. The Bureau of Census, when conducting population estimates between the decennial census, multiply the average size of family, i.e., 3.4, by the total number of houses built since the last decennial census.[17] This method was not used because of the nature of the Brookings population, i.e., the city is small relative to the college. It was feared that the large enrollments would have a disturbing effect on the results of this method.

Another method is the use of a multiplier. The "Omaha Improvement Plan", which was a series of programs and projects completed in Omaha, Nebraska, in 1957, for purposes of industrial and residential development, used this method in order to predict the increase in total population that would result from the addition of new factory workers. That study relied upon a multiplier of 2.96 in order to arrive at a reasonable

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[16] 8,830 - 7,764 = 1,066; 1,066 ÷ 4 = 266.5; 7,764 + 266 = the 1951 population, etc.

[17] Ernest G. Booth, United States Department of Commerce, Field Services, Minneapolis, Minnesota, personal correspondence, March 19, 1959.

estimate of the increase in total population.[18] A similar multiplier was also used in the thesis by Koch, which estimated that "each additional ten students is expected to increase the town's population by 18 . . ."[19] The multiplier was considered as 2.8, and was accepted as being a reasonable determinant. However, it was assumed that there would be a one-year time lag between present enrollment increases and the resulting population increase.[20]

The change in State College enrollment estimates was multiplied by the 2.8 multiplier and was then considered as the population for the next year. For example, the change in enrollment[21] from 1953 to 1954 was 221; this was multiplied by 2.8 and the product added to the 1954 population total. This then became the 1955 population estimate. This procedure was repeated again and again until the 1970 population had been estimated. The relationship among college enrollment estimates and population predictions is shown in Table I.

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[18]Omaha Industrial Foundation: Omaha, Nebraska, unpublished brochure.

[19]Koch, op. cit., p. 37.

[20]To clarify, an increase in students between the 1957 and 1958 fall quarter enrollments would not draw entrepreneurs or labor immediately, i.e., there would be a lapse of time between addition of students and the total increase in population.

[21]Actual enrollments were used until 1958 was reached, then the method relied upon the accepted enrollment estimates.

TABLE I. ACTUAL COLLEGE ENROLLMENTS, 1950 TO 1958, AND ESTIMATED FUTURE
ENROLLMENTS AT SOUTH DAKOTA STATE COLLEGE, 1959 TO 1970,
WITH ESTIMATED POPULATION OF BROOKINGS,
SOUTH DAKOTA, 1951 TO 1970.

Year	Actual Enrollments	Koch's Enrollment Estimate	AAUP Study Enrollment Estimate	Estimated Population of Brookings
1950	1,736		1,787	7,764
1951	1,481		1,570	8,030
1952	1,802		1,653	8,296
1953	1,877		1,840	8,562
1954	2,098	2,100	2,174	8,830
1955	2,685	2,680	2,693	9,449
1956	3,225	3,200	3,245	11,093
1957	3,485	3,500	3,533	12,605
1958	3,788	3,740	3,755	13,333
1959		3,890	3,903	14,181
1960		4,060	4,011	14,503
1961		4,220	4,385	14,805
1962		4,440	4,749	15,852
1963		4,550	5,090	16,871
1964		4,870	5,627	17,826
1965		5,410	6,351	19,330
1966		5,950	7,098	21,357
1967		6,400	7,969	23,421
1968		7,030	8,693	25,888
1969		7,470	9,241	27,915
1970		7,900	9,776	29,449

Sources: United States Bureau of Census, A Report of the Seventeenth
Decennial Census of the United States, Census of Population,
Volume One, Number of Inhabitants.

Registrar's Office, South Dakota State College.

Charles Benrud and Travis Manning, "A Report on Long-Range
Salary Trends and Requirements for Acquiring and Maintaining
an Adequate Faculty at South Dakota State College."

Norma Ruth Koch, "Estimating Commercial Expansion in Brookings
Resulting From the Anticipated Increase in Enrollment at South
Dakota State College."

CHAPTER III

ESTIMATING EXPANSION IN RESIDENTIAL HOUSING

There appeared to be a direct relationship between total population
and the demand for additional dwellings. A prerequisite to estimating
output and operating expenses for public utilities was a prediction of
the number of new dwellings that would have to be built during the
period under consideration.

Current Trends

Active demand for housing arises from the net increases in the
number of families and of single persons wishing to establish households
of their own. New families entering the housing market may come from
three major sources: (1) inward migration of population, (2) establish-
ment of new households by marriage, and (3) separation of families who
have lived together.[22]

With this in mind, it then seemed plausible that the demand for
housing should increase in Brookings due to the anticipated population
increase.

The United States was nearing the end of a residential building
boom in 1950. The demand for housing up to that time was due to World
War II; however, the housing market today does not stem from desperation,

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[22]Housing and Home Finance Agency, A Short-Term Forecast of the
Housing Market in Jacksonville, Florida, p. 7, Division of Housing
Research: Washington 25, D. C., June, 1953.

but rather "it is supported by increased population, economic prosperity, and a better product."[23]

Kaplan used a case study approach to measure specific homebuilding operations and production processes as applied by alert businesses. He concluded that since 1946 the residential building industry has expanded steadily each year and reached its peak in 1956.[24] For the nation as a whole, the homebuilding industry produced over one million homes yearly from 1950 to 1955.[25]

The homebuilding industry in Brookings has also expanded steadily since World War II, particularly since 1950. The total number of houses built from 1950 to 1958 was 504; the average number of houses built each year was 56.[26] A detailed breakdown of total dwellings and new houses built in Brookings during the base period is shown in Table II.

Estimating the Volume of Future Building

Initially an attempt was made to develop a relationship between the total number of dwellings and the total population of Brookings for the base period. The total number of dwellings was obtained from the records kept in the Brookings City Assessor's office. However, these

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[23]Urban Land Institute, op. cit., p. 5.

[24]Lawrence Jay Kaplan, Factors Affecting Productivity in the Home-building Industry, p. xiii, Doctoral Dissertation, Columbia University, 1958.

[25]Urban Land Institute, op. cit., p. 5.

[26]$504 \div 9 = 56$

TABLE II.   DWELLINGS BUILT AND TOTAL DWELLINGS, BROOKINGS
SOUTH DAKOTA, 1950 TO 1958.

Year	Dwellings Built*	Total Dwellings**
1950	67	
1951	30	
1952	34	
1953	33	1,533
1954	34	1,567
1955	72	1,636
1956	67	1,711
1957	66	1,799
1958	101	1,877

*Based on the number of residential building permits issued by Brookings
City Auditor's office.

**Data obtained from Brookings City Assessor's office (figures unavail-
able prior to 1954). The 1953 total was obtained by subtracting the
number of houses built in 1954 from the 1954 total number of dwellings
in the city of Brookings (1567 - 34 = 1533).

Source: Brookings City Auditor and Brookings City Assessor.

records had not been kept prior to 1954. This meant that the base
period of nine years could not be used to establish the relationship.
This problem was solved by correlating the total number of dwellings for
a six-year period, 1953 to 1958, to total population for those same
years. The 1953 figure of total number of dwellings was obtained by
subtracting the number of building permits issued in 1954 from the 1954

total number of dwellings. It should be pointed out that the relation-
ship obtained was highly significant. This can be seen in Table IX in
the Appendix.

A verification was made in order to ascertain the reliability of
the records pertaining to the total number of dwellings in the city.
The total number of dwellings built each year was obtained from the
Brookings City Auditor's office. This was accomplished by checking
building permits issued monthly for each year during the base period.
The monthly permits issued for new residential construction were tallied
for each year in order to obtain the total yearly number of permits
issued during the base period. It was assumed that the total number of
building permits issued for new residential construction accurately
reflected the number of dwellings built in Brookings during the base
period. In each case, the building permits issued during the month of
December were considered as part of the construction for the next year.[27]
When the total number of building permits issued yearly was compared with
the changes in total number of dwellings from year to year, it was found
that they did not correspond. This can be noted in Table II. The reason
they did not correspond is due to an outside influence. Some of the
factors giving rise to this outside influence are: (1) houses moved into
the city, (2) buildings not previously considered dwellings that have

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[27]For example, a yearly total of residential new building permits
issued in 1950 was 66; there was one permit issued in December of 1950,
this was added to the total for the year 1951. This procedure was
repeated for each year concerned.

TABLE III. ESTIMATED NUMBER OF NEW DWELLINGS WITH TOTAL INVESTMENT AT VARIOUS AVERAGE COSTS, BROOKINGS, SOUTH DAKOTA, 1959 TO 1970

Year	Number of New Dwellings*	Total Investment at Various Average Costs		
		$15,000	$20,000	$25,000
1959	55	$ 825,000	$1,100,000	$1,375,000
1960	21	315,000	420,000	525,000
1961	20	300,000	400,000	500,000
1962	68	1,620,000	1,360,000	1,700,000
1963	67	1,005,000	1,340,000	1,675,000
1964	62	930,000	1,240,000	1,550,000
1965	98	1,470,000	1,960,000	2,450,000
1966	132	1,980,000	2,640,000	3,300,000
1967	135	2,025,000	2,700,000	3,375,000
1968	161	2,415,000	3,220,000	4,025,000
1969	132	1,980,000	2,640,000	3,300,000
1970	100	1,500,000	2,000,000	2,500,000

*These projections were made with reference to total dwellings previously in existence as a base for the relationship. This included minor influences such as houses moved into the city, buildings not previously considered dwellings that have been converted into livable units, and apartments or units added to existing dwellings that were then counted as separate households.

been converted into livable units, and (3) apartments or units added to existing dwellings that were then counted as separate households. This outside influence was held as having no bearing on the decisions to build new homes, and was held constant in relation to future estimates. The estimated number of new dwellings is shown in Table III.

Investment in Residential Housing

An attempt was made to calculate the yearly level of investment
that may result in new residential construction until 1970. No
prediction of yearly average cost of dwellings for the 1959 to 1970
period was attempted because construction costs seemed extremely
difficult to handle. For instance, between 1950 and 1958, the construc-
tion cost index rose from 106.7 to 138.3. Yearly construction cost
index figures for the base period are shown in Table IV.

TABLE IV. CONSTRUCTION COST INDEX, UNITED
STATES, 1950 TO 1958*

Year	Construction Cost Index
1950	106.7
1951	115.8
1952	120.8
1953	122.0
1954	122.1
1955	124.9
1956	131.1
1957	136.7
1958	138.3

*Base Period: 1947-1949.

Source: United States Department of Commerce,
Office of Business Economics, Survey
of Current Business, 1950 to 1958.

In order to present a forecast of future amount of gross investment in residential construction, a series of alternative costs were used. This consisted of multiplying the estimated amount of construction each year by three average alternative cost of construction figures. These are presented in Table III.

CHAPTER IV

ESTIMATING OUTPUT AND OPERATING EXPENSES
OF MUNICIPALLY-OWNED PUBLIC UTILITIES

Methodology

Population estimates for the base period were discussed in
Chapter II. These estimates were used to establish relationships between
output and operating expenses of: (1) electricity, (2) telephone, and
(3) water-sewer facilities. The 1950 to 1958 period was used as a basis
for the relationships. The future was predicted, then, by virtue of
what had happened during the base period.

The first step in predicting the future expansion in public
utilities was to secure the basic data. In order to establish a basis
from which to estimate future operating expenses for each of the
municipally-owned public utilities for the base period, financial
statements published for the years 1950 through 1958 were obtained from
the Brookings City Auditor's office. To facilitate the estimation of
output totals for each of the public utilities concerned, yearly
aggregates were obtained from each of the respective utility offices
(with the exception of electric output totals, which were obtained from
the Brookings City Auditor's office).

The final step was establishing the relation between the variable
or item in question and population by regression analysis. The resulting
regression equation was then used to obtain estimates for the years 1959

26

to 1970. A discussion of the statistical technique used in this study is
presented in the Appendix. A yearly breakdown of the output and operat-
ing expenses for the municipally-owned public utilities is shown in
Table V.

It was recognized that technological innovation of household
appliances or new uses for public utilities may increase the demand for
these conveniences. However, for purposes of this study, the present
technology is assumed to be constant. This means that the same rate of
increase that took place during the 1950 to 1958 period is projected into
the future.

Estimations for the Electric Department

The yearly total amount of power generated was obtained from the
records kept in the Brookings City Auditor's office. These were total
kilowatt hours either manufactured and/or purchased from other sources
that were made available to all consumers in Brookings. Total output
(kilowatt hours provided) for the base period was compared with total
population. Future population estimates were applied to the relationship
that was developed; thus future estimates of output were calculated. The
relationship between total population and total output of kilowatt hours
was highly significant.

Between 1950 and 1958, there was an increase of over six million
kilowatt hours provided for consumption. This represents an increase of
46 percent. The 1970 estimate showed that a total of over 38 million
kilowatt hours may have to be provided. This is an increase of slightly

TABLE V. OUTPUT AND OPERATING EXPENSES OF MUNICIPALLY-OWNED PUBLIC UTILITIES,
BROOKINGS, SOUTH DAKOTA, 1950 TO 1958

	Electricity		Telephone		Water-Sewer	
Year	Kilowatt Hours Provided	Operating Expenses*	Number of Telephones	Operating Expenses	Gallons of Water Pumped	Operating Expenses
1950	13,909,500	$359,736	2,841	$59,390	289,373,000	$55,960
1951	13,996,400	406,835	2,920	63,387	245,878,000	58,500
1952	13,591,740	362,169	3,037	70,011	280,274,000	59,825
1953	13,811,080	356,952	3,115	84,727	273,627,000	57,649
1954	14,865,980	360,198	3,246	81,330	307,089,000	67,877
1955	15,957,849	290,088	3,297	86,457	304,323,000	95,028
1956	17,340,724	291,149	3,624	99,355	339,153,000	100,173
1957	18,771,427	304,992	3,904	121,760	325,413,000	125,850
1958	20,247,130	322,622	4,300	137,247	330,180,000	138,954

*The 1950 to 1954 period was not used in establishing a relationship between population and electric operating expenses.

Sources: Brookings City Auditor, Financial Statements, City of Brookings, 1950 to 1958; Brookings City Telephone Department, Brookings City Water-Sewer Department.

more than 18 million kilowatt hours, or 91 percent, between 1958 and
1970.

In order to estimate future costs, it was necessary to eliminate
the years 1950 through 1954 from the base period used in setting up the
relationship. Upon examination of the financial statements for the
entire base period, it was found that total operating expenses were
highly irregular. Electric power had been locally manufactured in 1950
and 1951. Total operating costs in 1950 were $359,736; in 1951, costs
were $406,836. In 1952, 1953, and 1954, cut-backs were made in locally
generated electricity and the rest of the necessary power was purchased
from other sources. Total operating costs dropped somewhat in those
years and in 1955 the facility purchased the bulk of its electric power
from other sources. It was necessary, then, to eliminate those highly
inefficient years from the base period, with respect to this particular
relationship, because it would not have been an accurate reflection of
the nature of operation that will probably take place in the future. It
should be pointed out that, even though the base period was merely four
years in length, the resulting correlation coefficient obtained was
significant. (See Table IX in the Appendix.)

After the established relationship was applied to future population
estimates, total costs in 1970 were estimated at $443,062. This repre-
sents an increase of $120,440, or 37 percent above the 1958 total of
$322,622. Predictions of total operating expenses and total output of
the electric facility for the 1959 to 1970 period are presented in
Table VI.

TABLE VI.   ESTIMATED OUTPUT AND OPERATING EXPENSES OF THE
ELECTRIC DEPARTMENT, BROOKINGS, SOUTH DAKOTA,
1959 TO 1970

Year	Estimated Kilowatt Hours	Estimated Operating Expenses
1959	20,958,601	$324,445
1960	21,333,110	324,988
1961	21,694,358	327,374
1962	22,902,094	335,646
1963	24,087,264	343,696
1964	25,197,998	351,240
1965	26,947,209	363,122
1966	29,304,805	379,135
1967	31,705,386	395,441
1968	34,574,685	414,930
1969	36,932,232	430,943
1970	38,716,384	443,062

Part of the operating expenses for the Electric Department is
due to the cost incurred in maintaining the Steam Plant. This cost
was included with the total operating expenses of the Electric Depart-
ment. No attempt was made to establish estimates for output of steam
heat.

Estimations for the Telephone Department

In projecting the number of telephones and the resulting operating expenses for the Telephone Department until 1970, the yearly number of telephones and the population were correlated for the base period. The yearly total number of telephones for the base period was obtained from the Brookings City Telephone Department.

The total number of telephones increased by 1,459 during the base period; this represents a gain of 51 percent. After the relationship was developed and population estimates applied to it, the 1970 estimate of total number of telephones was 7,943, or 85 percent more than the 1958 total of 4,300. There was a high correlation between total population and total number of telephones in use; this correlation was highly significant.

In order to forecast the future operating expenses for the Telephone Department, previous total costs for the base period as reflected in the financial statements were again used. Telephone operating expenses in 1950 were $59,390; by 1958, costs had soared to $137,247, an increase of 131 percent. This was due largely to the amount of investment that resulted from converting to a dial type system in 1956.

After the relationship was established between population and operating expenses for the base period, future estimates were found by comparing population estimates with the relationship. The 1970 total telephone operating expenses were predicted to be $333,338. This is an

TABLE VII. ESTIMATED NUMBER OF TELEPHONES AND OPERATING EXPENSES
FOR THE TELEPHONE DEPARTMENT, BROOKINGS,
SOUTH DAKOTA, 1959 TO 1970

Year	Estimated Number of Telephones	Estimated Operating Expenses
1959	4,390	$143,963
1960	4,465	147,957
1961	4,536	151,703
1962	4,779	164,689
1963	5,016	177,328
1964	5,239	189,174
1965	5,588	207,828
1966	6,060	232,970
1967	6,540	258,571
1968	7,114	289,170
1969	7,586	314,312
1970	7,943	333,338

increase of $196,091, or 143 percent, more than the 1958 total. A
further breakdown of number of telephones and operating expenses for the
Telephone Department is found in Table VII.

Estimations for the Water-Sewer Department

The Water-Sewer Department has been a combined facility since
1954. Prior to that time, sewer disbursements were handled under the

Incorporation Fund. In order to calculate total operating expenses for
the base period, sewer operating expenses, as reflected in the Incorpor-
ation Fund, were combined with operating expenses of the Water Department
which had operated as a separate facility until 1954. After arriving at
accurate figures for total operating expenses for both water and sewer
costs during the 1950 to 1958 period, the relationship concerning total
population for that period was established. Total expenses in 1950 were
$55,960; by 1958, costs had risen to $138,954. This is an increase of
$82,994, or 148 percent over the entire base period. Then future
population estimates were applied to the relationship, estimated total
operating expenses for 1970 were $381,423, which is an increase of 174
percent from 1958 to 1970. Other yearly totals for the Water-Sewer
Department are shown in Table VIII.

In order to calculate a relationship for the base period for the
total number of gallons of water pumped, it was necessary to tabulate
daily pumpage totals from records kept by the Brookings Water-Sewer
Department. After yearly total number of gallons pumped in Brookings
for each year of the base period was obtained, a relationship between
total population and pumpage was developed. Total pumpage of water
increased by 40,807,000 gallons between 1950 and 1958. This is an
increase of 14 percent over the base period.

When future population estimates were applied to the established
relationship, it was found that a total of 529,878,340 gallons of water
will have to be pumped in Brookings in 1970. This is an increase of

TABLE VIII.   ESTIMATED GALLONS OF WATER PUMPED AND OPERATING
EXPENSES FOR THE WATER-SEWER DEPARTMENT,
BROOKINGS, SOUTH DAKOTA,
1959 TO 1970

Year	Estimated Gallons of Water Pumped	Estimated Operating Expenses
1959	351,090,060	$150,954
1960	354,860,680	155,814
1961	358,397,100	160,373
1962	370,657,470	176,177
1963	382,589,960	191,559
1964	393,773,010	205,975
1965	411,384,850	228,677
1966	435,121,020	259,275
1967	459,290,460	290,431
1968	488,179,030	327,670
1969	511,915,200	358,267
1970	529,878,340	381,423

199,698,340 gallons pumped over the 1959 to 1970 period. Yearly

estimates of total number of gallons of water pumped for the entire

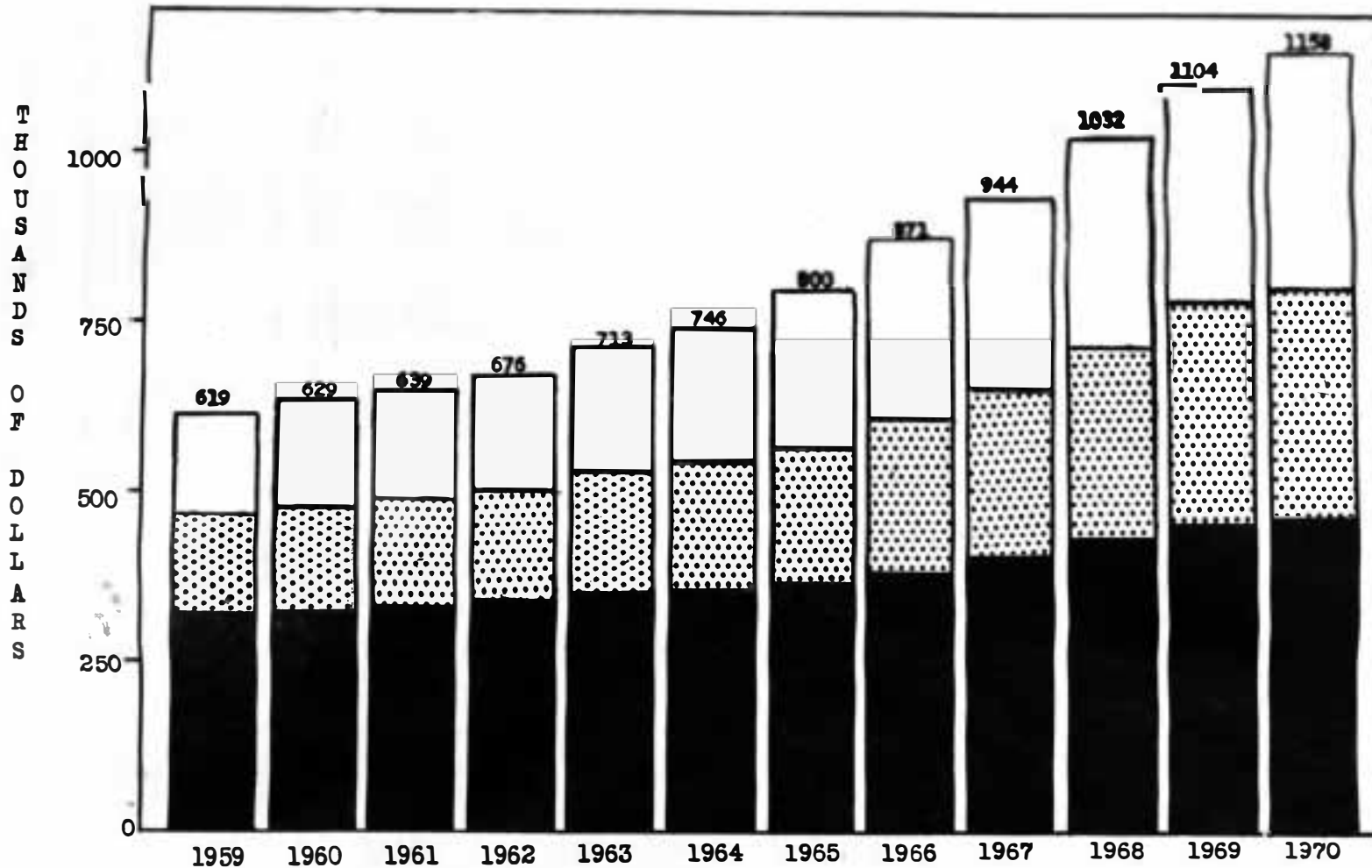1959 to 1970 period are shown in Table VIII.

Figure 1. Estimated Total Operating Expenses for Municipally-owned
Public Utilities, Brookings, South Dakota, 1959 to 1970.
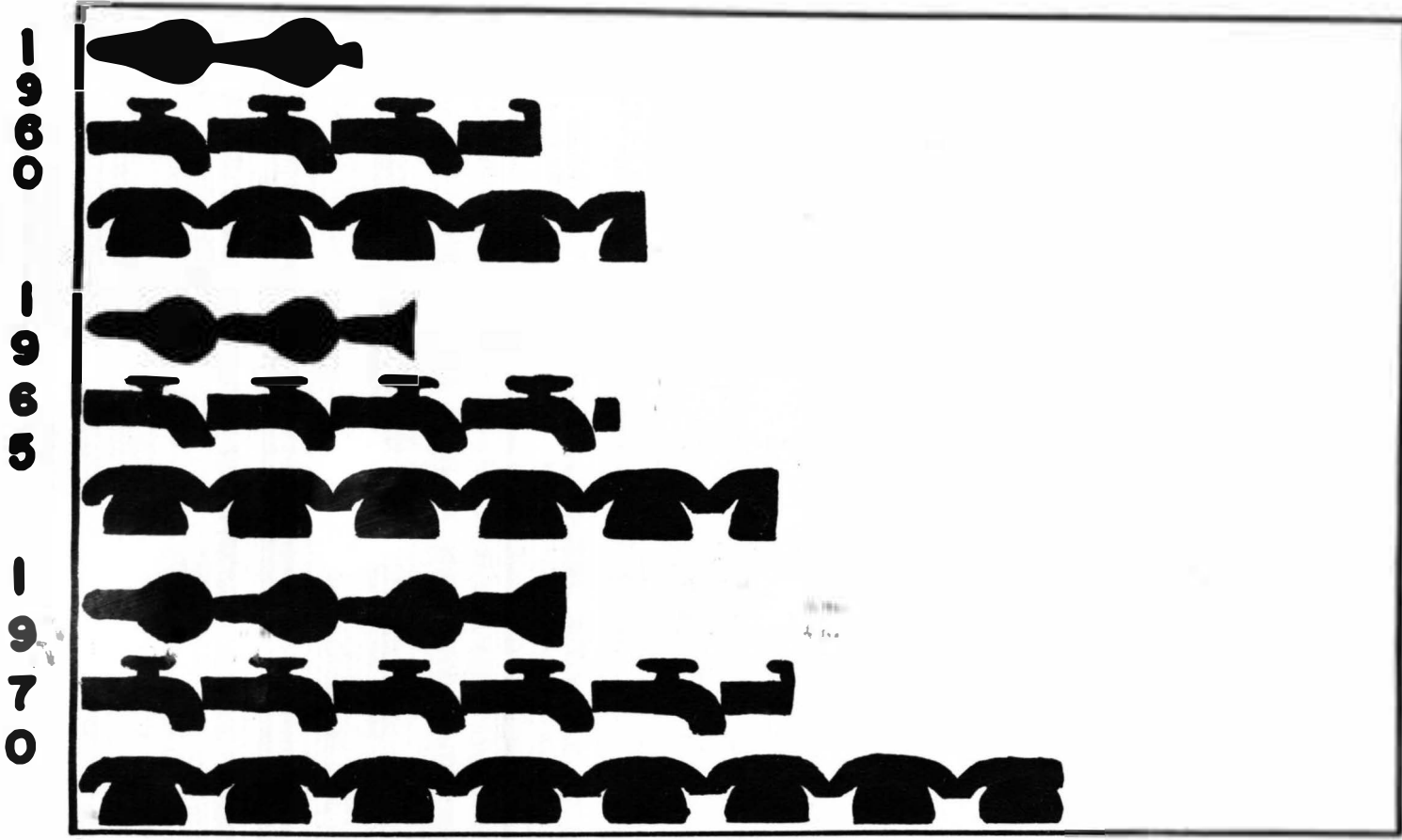
LEGEND: Electric   Telephone   Water-Sewer

34

Figure 2. Estimated Output for Municipally-owned Public Utilities, Brookings, South Dakota, 1960, 1965 and 1970.

LEGEND:

100,000,000 Gallons Water   10,000,000 Kilowatt Hours   1,000 Telephones

CHAPTER V

SUMMARY AND CONCLUSIONS

The purpose of this study was to predict output and operating expenses of municipally-owned public utilities for Brookings, South Dakota, until 1970.

The enrollment at South Dakota State College was considered the dynamic factor in determining the population of Brookings. From work previously accomplished, future enrollment estimates were obtained. The 1970 enrollment at State College was estimated at 9,700. Allowing for a one-year time lag between college enrollment and the resulting population, the future population of Brookings was calculated by the use of a 2.8 multiplier. The total population of Brookings in 1970 was estimated to be 29,449.

The study was limited to include only predictions of future output and operating expenses, and not a cost analysis of materials and equip-ment, or expansion by direction or area. It was assumed that per capita income, purchasing power of the dollar, consumer tastes and spending patterns, family size and the amount of manufacturing carried on in Brookings were constant. In setting up all of the required relationships, a base period of 1940 to 1958 was used. It was assumed that this period of time was of sufficient length to set up reliable relationships.

Total population of Brookings was considered a determinant of the demand for public utilities. The demand for new dwellings was also considered a function of the population of Brookings.

By use of regression analysis, relationships were established between population and dwellings, between population and output of municipally-owned public utilities, and between population and operating expenses of municipally-owned public utilities. Future population estimates were applied to each relationship in order to arrive at predictions of the future activity in the residential housing sector and among the public utilities.

Between 1959 and 1970, a total of 1,051 dwellings will be built in Brookings; this is an average of 87.6 dwellings built each year. In 1970, a total of 100 homes will be built.

The city of Brookings will need a total of 7,943 telephones by 1970. Yearly operating expenses of the Telephone Department will be $333,338 in 1970, which is 243 percent of the 1958 total.

A total of over 38 million kilowatt hours of electric energy will have to be provided the consumers of Brookings in 1970. This represents a gain of slightly more than 18 million kilowatt hours over the 1958 total. Operating expenses in 1970 will be $443,217 for the Electric Department; this is an increase of $120,395 between 1958 and 1970.

The Water-Sewer Department will pump a total of 529,878,340 gallons of water in 1970, which is an increase of 199,698,340 gallons, or 60 percent, more than the 1958 total of 330,180,000 gallons of water. The total cost of operating this facility will be $381,423 in 1970. This represents an increase of $247,459 over the 1958 to 1970 period.

APPENDIX

In order to further explain the nature of methodology used in this study, it is necessary to clarify parts of the operations followed in reaching the conclusions stated.

After all necessary data were collected, relationships were established between population and other data used in setting up the base period. It was assumed that the 1950 to 1958 period was a sufficient length of time to establish the relationship. The technique used in establishing these relationships was regression analysis. Population was, in each case, considered the independent variable. Total number of dwellings, along with operating expenses and output for each of the municipally-owned public utilities in Brookings, for the base period, were considered the dependent variables in each case.

Seven sets of relationships were set up. They were:

(1) Population and total number of dwellings.

(2) Population and kilowatt hours provided.

(3) Population and electric operating expenses.

(4) Population and number of telephones.

(5) Population and telephone operating expenses.

(6) Population and gallons of water pumped.

(7) Population and water-sewer operating expenses.

A scatter diagram was set up for each of the relationships for the base period. Inspection of these indicated that the relationships were linear in character.

For the base period, the constants in the regression equations, $Y = a + bx$ were obtained, where

Y = dependent variable

X = population.

The population estimates were then substituted in the equations to obtain estimates of the dependent variable for the years 1959 to 1970. The regression equations, coefficients of correlation and standard error of estimates are given in Table IX.

Five of the relationships had reference to the base period of 1950 to 1958; two of the relationships had reference to only part of the base period. The five cases were population correlated to each of the following:

(1) Total number of telephones.

(2) Telephone operating expenses.

(3) Amount of kilowatt hours of electricity provided.

(4) Water-sewer operating expenses.

(5) Gallons of water pumped.

Each of these included nine observations, or seven degrees of freedom.[28] With seven degrees of freedom, a correlation coefficient must be at least .7977 in order to be statistically significant at the .01 level of confidence. Each of the above five relationships were above .7977; they were then highly significant.

Remaining were two relationships; population correlated to:

(1) Electric operating expenses.

(2) Total number of dwellings.

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[28] Degrees of freedom (D.F.) = $N - 2$.

For each of the above, the number of years used as a base period was less than nine. Factors giving rise to the inability to use nine observations for the above two relationships are stated in Chapter III and Chapter IV.

Only six observations were used in the correlation between population and total dwellings; this left only four degrees of freedom which made it necessary to attain a correlation coefficient of .9172 for significance at the .01 level. A correlation coefficient of .9471 was attained which made this significant at the .01 level.

The correlation between population and total electric operating expenses referenced only four years for a base period; this left only two degrees of freedom. This meant that in order to be significant at the .01 level, the correlation coefficient had to reach .9900. After the regression was completed, a correlation coefficient of .8569 was attained which was significant at the .90 level.

TABLE IX. STATISTICAL RELATIONSHIP OF POPULATION TO TOTAL DWELLINGS, AND OUTPUT AND
OPERATING EXPENSES OF MUNICIPALLY-OWNED PUBLIC UTILITIES,
BROOKINGS, SOUTH DAKOTA, 1950 THROUGH 1958

Dependent Variable* (Y)	Regression Equation (Y = a + bx)		Standard Error of Estimate (Sz)	Correlation Coefficient (r)	Degrees of Freedom (DF)	Level of Confidence ($\bar{o}/x$)
Total Dwellings	Y = 990.04	+ .06533x	39 houses	.9471	4	.01
Electric Costs	Y = 210,414.75	+ 7.9x	$6,790	.8569	2	.10
Electric Output	Y = 4,465,078.7	+ 1163.0718x	393,894 KWH	.8405	7	.01
Number of Telephones	Y = 1,090.77	+ .23268x	68 telephones	.9857	7	.01
Telephone Costs	Y = -31,929.3188	+ 12.4034x	$5,410	.9757	7	.01
Water Pumped	Y = 185,030.55	+ 11.71x	16,748 gallons	.8033	7	.01
Water-Sewer Costs	Y = -63,106.95	+ 15.0949x	$6,418	.9769	7	.01

*Population was the independent variable in each case.

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