

DETERMINING A CENTRAL PLACE
HIERARCHY BY USING ELECTRICAL
POWER DATA IN SOUTHWEST MANITOBA

A Thesis presented to
the Faculty of Graduate Studies and Research,
The University of Manitoba,
in partial fulfilment,
of the Degree of Master of Arts

By
William John Watts
September, 1968

Abstract

This study is concerned with determining the value of "Electrical Power Data" as a measure of the functional attributes of a center, thus, forming a base upon which a Central Place Hierarchy can be constructed. Having looked at the various measures of centrality it is concluded that the functional attributes of a center best reflect its centrality. This study is the application of Electrical Power Data as a technique of measuring functional attributes.

Two types of Electrical Power Data are tested to determine their validity as a measure of the functions of a center. (1) The urban commercial hydro meters recorded to a center. (2) The kwhr. consumption of electricity of a center and its hinterland. All the data used is for 1961.

The study deals with two survey areas in Manitoba. (1) A preliminary test of validity between functions and electrical power data was undertaken for the Interlake Region of Manitoba.¹ A high correlation was found to exist between functions and electrical power data, warranting further application of the electrical power method. (2) A virgin survey area in Southwest Manitoba which is relatively homogeneous, and appears to favour the emergence of a Central Place Hierarchy was used to apply the electrical power technique.

The application of the Electrical Power Data to Southwest Manitoba

1. The data on functions in the Interlake Region was available in T. G. Sosa, Service Centre Study of the Interlake Region, Manitoba, unpublished M. A. thesis, University of Manitoba, 1964.

resulted in the emergence of 5 groups in the Central Place Hierarchy. The division between the groups was not arbitrary but rather based on statistical methods using both urban commercial meters, and kwhr. consumption of the centers in the area. Having formulated the hierarchy on the bases of Electrical Power Data, Dun and Bradstreet reference books with supplementary government services information was used to determine what services each group offered. It was found that, "Centers of each high order group performed all the functions of lower order centers plus a group of central functions that differentiated them from and set them above the low order." ² Similarly the spatial distribution found to exist between the centers of each group was found to correspond to the spatial distribution of the centers for the entire area, showing a regularity in pattern of distribution.

It is concluded that although this technique of forming a hierarchy is not perfect it is worthy of consideration. It does provide the researcher with a method of comparing communities and a starting point for a Central Place Study.

2. B. J. L. Berry and A. Pred., Central Place Studies: A Bibliography of Theory and Applications, Bibliography Series No. 1, Philadelphia: Regional Science Institute 1961, p 4

ACKNOWLEDGEMENTS

The author wishes to thank all of those who have contributed to the writing of this dissertation. Particular thanks to my supervisor Dr. B. Perry and fellow student R. Baxter whose efforts on my behalf were deeply appreciated.

A special thanks to my wife whose contribution is unmeasurable.

Contents

	Page
ABSTRACT	II
ACKNOWLEDGEMENTS	IV
CONTENTS	V
FIGURES	VII
TABLES	VIII
INTRODUCTION	IX
 CHAPTER	
1. Previous Investigations of the Central Place Hierarchy	1
A. Population	3
B. Key Functions	5
C. Transportation Index	6
D. Functional Unit Classification	6
E. Postal Revenue	9
F. Telephone Connection	11
G. Assessed Values of Business Establishments	12
H. Turn Over; Value of Stock, Annual Profit; Number of Workers; Weekly Payroll of Businesses	13
I. Net Income Originating in a Center	13
J. Wholesale Trade	14
 CHAPTER	
2. Electrical Power Data as an Index of Centrality	16
A. Electrical Power Data	16
B. Test of Validity	19
 CHAPTER	
3. The Study Area	27
A. Selection of the Study Area	27
B. The Central Places in the Area	30
C. Space Relationship of the Centers in the Study Area	31
D. Correlation Between Electrical Power Data and Dun and Bradstreet in Survey Area	33

	Page
CHAPTER	
4. The Central Place Hierarchy	44
A. Graphing Urban Commercial Meters on Rank	45
B. Scatter Diagram	46
C. Services found within the Electrical Power Data Hierarchy Groups	50
Chapter	
5. Population and Space Relationships as applied to the Electrical Power Data Hierarchy	69
A. Population Relationship	69
B. Space Relationship of the groups	72
Chapter	
6. Conclusion	77
A. Urban Commercial Meters of a Center as a Measure of its Functional Attributes	77
B. Kwhr. consumption as a Measure of Centrality	78
C. The Significance of the Electrical Power Data Hierarchy when applied to Southwest Manitoba	80
D. Domestic meters as a Measure of a Center's population for Central Place Studies	81
BIBLIOGRAPHY	83
APPENDIX A: Correlation and Regression Analysis	86
APPENDIX B: Correlation and Regression Line Computer Programs	89
APPENDIX C: The Measurement of Dispersed Pattern of Settlement	93
APPENDIX D: The Selected Services in the Centers of Southwest Manitoba	Folder

Figures

<u>Number</u>		<u>Following Page</u>
1.	Regression Line of Urban Commercial Meters on Range of Services, Interlake Region.	24
2.	Regression Line of Kwhrs. consumed in 1961 on Range of Services, Interlake Region.	24
3.	Regression Line of Urban Commercial Meters on Total Services, Interlake Region.	24
4.	Regression Line of Kwhrs. consumed in 1961 on Total Services, Interlake Region.	24
5.	Southwest Manitoba	27
6.	Municipal Corporations	28
7.	Trunk Highways and Railways	29
8.	Central Places in Southwest Manitoba	31
9.	Theoretical Central Place Pattern	31
10.	Commercial Urban Meter Rank of Southwest Manitoba	45
11.	Groups of Central Places in Southwest Manitoba	47
12.	Group A Centers	73
13.	Group B Centers	74
14.	Group C, D, and E Centers	74

Tables

<u>Number</u>		<u>Page</u>
1.	Electrical power, services, and population data for Interlake Region, Manitoba	21
2.	The Product Moment Correlation Coefficients for Electrical Power Data and Services of the Interlake Region	24
3.	Electrical power, service and population data for Southwest Manitoba	34
4.	The Product Moment Correlation Coefficient for Electrical Power Data and Services of Southwest Manitoba	42
5.	Central Place Hierarchy Based on Ranking of Urban Commercial Electrical Power Meters	48
6.	Central Place Hierarchy Based on Scatter Diagram using Urban Commercial Meters and Kwhr. Consumption	49
7.	The Selected Services found in each Group of the Electrical Power Data Hierarchy	52
8.	Major and Variable Selected Services in Each Group	64
9.	Population Size of the Electrical Power Data Hierarchy	72
10.	Domestic Meter in the Electrical Power Data Hierarchy	72

Introduction

The prime purpose of this study is to determine the usefulness of Electrical Power Data as a measure of the functional attributes of a center and providing a base to construct a Central Place Hierarchy. The concern of the study is not a Central Place study per se but rather attempts to establish the validity of using electrical power data as a possible index upon which such a study can be undertaken. The results found pertaining to types of services offered by each group of the Electrical Power Data Hierarchy, spatial distribution of the centers within each group, and population correlations, are provided as further evidence of the validity of the electrical power method and not to be interpreted as an end in themselves.

The study deals with two types of electrical power data, both of which are readily available. (1) The number of urban commercial meters recorded to a center. The Manitoba Hydro requires that in order for a premise to have an urban commercial meter the premises must conduct business activities associated with services and / or the distribution of goods. Based on their classification it was felt this offered a relatively reliable measure of functions of a center, by definition, and was in addition made more meaningful through consistency of collection of data. (2) Kwhr. consumption of electricity for the center plus its hinterland served as a second source of electrical data. The kwhr. consumption represents electricity used by all users within the center for 1961, regardless of whether they are commercial, domestic or industrial users. Included within this

1. A "Central Place" is a settlement which is predominantly concerned with serving the needs of the surrounding area. The centrality of a place is the tie between a central place and its complimentary region.

total figure is the electricity used by the farmers around the center. These two sources of information both on electricity, offered different types of information. The urban commercial meters are indicative of only the functions and are not influenced by the size of the establishment, while kwhr. consumption is influenced by not only the size of the center and its hinterland, but the size of the various services within the center.

Two survey areas are dealt with in this study. The first is the Inter-lake Region of Manitoba which was selected because data on the functions offered by each center within the region was available. This area was used as a test area to determine the relationship that existed between functions and electrical power data. The major survey area was Southwest Manitoba. It was selected as it appeared to be suitable as a sample area to test the Electrical Power Data as a method of forming a hierarchy. The method employed in this second survey area was to establish a Central Place Hierarchy based entirely on the two types of Electrical Power Data, followed by finding what selected services are characteristic of each group within the hierarchy and the spatial relationship of the centers within each group.

Method and Objectives

The Study Method involved:

1. Obtaining data on kwhr. ² consumption for 1961, and the number of urban commercial meters ³ for each center in Manitoba.
2. An experimental correlation test between four main sets of

2. Kwhr. Consumption data obtained from: Comparative Statement of Metased Kwhrs. sold in 1961, Manitoba Hydro.

3. Commercial meter statistics available for all of Canada from: Dominion Bureau of Statistics, Electric and Gas Meter Registration, 1961

data for the Interlake Region of Manitoba (a) Urban Commercial Hydro meters (b) Kwhr. consumption (c) Range of central services (d) total number of central services.⁴ This data was obtained for each center in the Interlake Region and correlated on the I. B. M. computer at the University of Manitoba. Regression lines were computed to make the relationship more meaningful.

3. Justifying the selection of the study area of Southwest Manitoba.
4. Application of the index of Electrical Power Data to Southwest Manitoba, and statistically illustrating that a grouping does exist within the resulting hierarchy.
5. Determining the type and frequency of occurrence of selected services⁵ within each group of the hierarchy.
6. Testing the spatial relationship found to exist for the centers of each group as compared to all the centers in the area.
7. Analysis of population data.⁶

The data was analyzed in terms of validity of electrical power data as an index of measuring the functional attributes of a center. The I.B.M.

4. Data on the "range of services" and "total services" was obtained from T. G. Sosa, Service Centre Study of the Interlake Region, Manitoba, unpublished M.A. thesis, University of Manitoba, 1964.

5. The selected services included services listed in Dun and Bradstreet, Reference Book, July, 1961; with supplementary information from Manitoba Telephone System; Department of Education; Department of Industry and Commerce and Federal Post Office.

6. Dominion Bureau of Statistics, Census of Canada, 1961; with supplementary information from Dun and Bradstreet Reference Book, July 1961, and estimates.

computer at the Computer Center in the University of Manitoba was used to determine correlations and regression lines.

The Main Objectives are:

1. To establish through statistical methods the validity of
(a) urban commercial meters (b) kwhr. consumption as a
technique of measuring the functional attributes of a
center.
2. To select an area which compares favourably to the Central
Place Model and apply the Electrical Power Data as the
criteria to determine the Central Place Hierarchy.
3. Demonstrate through types of selected services offered
by each group, spatial relationships existing between
centers of each group, and population relationships, that
the resulting hierarchy is a valid contribution to a
Central Place Study.

Additional Objectives Included:

1. A presentation of the type and frequency of occurrence of
selected services for each center in the survey area as
well as each group in the hierarchy.
2. The possibility of "domestic hydro electric" meters as a
measure of population size when pertaining to a Central
Place Study.

Presentation:

This study consists of 6 chapters. Chapter I puts the study in its proper perspective with a summary of the major indices of centrality used in the past to establish a Central Place Hierarchy. This section concludes with a summation on the characteristics of a good index of centrality. Chapter II is concerned with Electrical Power Data as a measure of centrality, establishing its validity through correlations with a functional study of the Interlake Region of Manitoba. Chapter III justifies the selection of Southwest Manitoba as the survey area where the electrical power data index can be applied to formulate a hierarchy of Central Places. Chapter IV on the basis of statistical evidence constructs a Central Place Hierarchy consisting of 5 groups. Supporting evidence as to the validity of this hierarchy in respect to Central Place Studies is presented in the data on the selected services offered by each group. Chapter V is concerned with the spatial relationship of the centers within each group with respect to substantiating the hierarchy, and relationship between electrical power data and population. Chapter VI comprises the concluding chapter of the study.

Chapter 1

Previous Investigations of the Central Place Hierarchy

The hierarchical class system implication is an integral part of the spatial model of central place developed by Walter Christaller, the generic base and single most important statement of central place theory.¹

It is obvious that centers differ each from the other. The terms: hamlet, village, town and city are commonly used on intuitive level. Any investigation of central place must commence with a classification of the centers in question. The history of the Central Place Theory is a development of various methods and techniques of classifying the functional attributes of a center.

The Central Place theory was first formulated by the German geographer, Walter Christaller.² The central place is a trade center which exists primarily to provide goods and services for surrounding tributary areas. The trade centers in an area, ranging from the largest to the smallest centers, form a system of central places. The central place theory was an attempt to explain the size and spacing of these centers.

W. Christaller's theory has been well summarized by B. J. L. Berry and A. Pred.

- (1) The basic function of a city is to be a central place providing goods and services for a surrounding tributary area. The term "central place" is used because to perform such a function efficiently, a city locates at the center of minimum aggregate travel of its tributary area, i.e., central to the maximum profit area it can command.

1. B. J. L. Berry and W. L. Garrison, "The Functional Bases of the Central Place Hierarchy", Economic Geography, 34 (1959) p. 146

2. W. Christaller, Die Zentralen Orte in Suddeutschland, Jena: Gustav Fischer Verlag 1933. (Translated As Central Places in Southern Germany, by C. W. Baskin, 1966, 230 p.p.)

- (2) The centrality of a city is a summary measure of the degree to which it is such a service center; the greater the centrality of a place, the higher is its "order".
- (3) High order places offer more goods, have more establishments and business types, larger population, tributary area and tributary population, do greater volumes of business and more widely spaced than lower order places.
- (4) Low order places provide only low order goods to low order tributary areas; these low order goods are generally necessities, requiring frequent purchasing with little consumer travel. Moreover low order goods are provided by establishments with relatively low conditions of entry. Conversely high order places provide not only low order goods but also high order goods sold by high order establishments with greater conditions of entry. These high order goods are generally "shopping goods" for which the consumer is willing to travel long distances, although less frequently. The higher the order of goods the fewer are the establishments providing them, the greater the conditions of entry and trade areas of the establishments, and fewer and more widely spaced are the towns in which the establishments are located.
- (5) More specifically, central places fall into a hierarchy comprising discrete groups of centers. Centers of each high order group perform all the functions of lower order centers plus a group of central functions that differentiate them from and set them above the low order. A consequence is a "nesting" pattern of low order trade areas within the trade area of high order centers plus a hierarchy of routes joining the centers.³

The centralized services of administration, culture, health, social services, organization of economic and social life, finance, trade, service industries, the labour market and traffic form the bases upon which the centrality of a settlement is measured. It is virtually impossible to combine all of these diverse elements for comparative purposes, as how can one add net income originating economically, expressed as money, to ideal net income of an educational, administrative or entertainment institution.

3. B. J. L. Berry and A. Pred., Central Place Studies: A Bibliography of Theory and Applications, Bibliography Series No. 1, Philadelphia: Regional Science Institute 1961, pp 3 - 4

Despite the realization of the impossibility of the perfect method, various indices have been used as a measure of centrality. The remainder of the chapter is a summation of the pros and cons of selected indices.

A Population

Population is possibly the oldest and simplest index used to rank a center.

Each center possesses specific groups of central functions and is characterized by a discrete population level of its center. This discrete population level arises for each class, possibly because the income which supports the population of a central place is brought into the center by the activities which provide goods and services for the surrounding consumers.⁴

Ranking of centers by population on the Prairies has definite advantages. The population of a center gives the size of the settlement in terms of the number of persons residing in a center, and it incorporates all the diverse elements of the settlement into a common denominator. The population data is generally accessible.

Despite recent and more complex methods of ranking center, population is still used. The Municipal Act of Manitoba distinguishes the following categories; hamlet, less than 500; village, at least 500; town, over 1,500 and cities over 10,000. S. Chittick⁵ classifies South Dakota centers by their population size (eg. village, 250 - 499 inhabitants) and then assigns particular functions and an average number of businesses as characteristic of each size class.

4. B. J. L. Berry and W. Garrison, op. cit., p 146 & 147

5. S. Chittick, "Growth and Decline of South Dakota Trade Centers, 1901-51," South Dakota State College Agriculture Experiment Station Bulletin, 448, May, 1955, p. 7

H. Stafford ⁶ employs statistical methods to defend population as a measure of functional attributes. He studies the relationship between goods and services offered by a town and its population. The study was carried out in Iowa and was followed by a similar comparison in New Zealand and Snohomish county, Washington. A high correlation of ($r = .929$) was found between the number of establishments and population. The correlation coefficient between number of functions and population was ($r = .892$) while the correlation coefficient between number of functional units and population was ($r = .934$). All three correlations were similar in Iowa, Washington and New Zealand.

However the population index has distinct limitations. A. E. Smailes ⁷ considers the population criteria as unsatisfactory, since population figures include persons employed in manufacturing and non-occupational residents, (retired persons, farm families and disabled persons), who should not be considered in a measure of centrality. P. Woroby ⁸ found population is

6. H. A. J. Stafford, "The Functional Bases of Small Towns", Economic Geography, 39 (1963), pp 165 - 175.

Dr. Stafford calculated the coefficient of correlation between functions and population for Southern Illinois, Berry and Garrison's Snohomish County in Washington, King's comparative study of the Canterbury Provincial District of New Zealand, and Thomas's study of the functional bases for small Iowa towns.

7. A. E. Smailes, "The Urban Hierarchy in England and Wales", Geography, 29 (1944) p 41

8. P. Woroby, Functional Relationship between Farm Population and Service Centers in S. W. Saskatchewan, unpublished M. Sc. thesis, University of Manitoba., 1957, p 80

further influenced by religious and racial factors which influence the size of families. J. E. Brush, in a Wisconsin study concluded:

Population alone does not provide a satisfactory criterion. One suspects that any functional classification of trade centers based exclusively on population is purely arbitrary. The number of inhabitants is the product of a multiplicity of factors besides trade, such as number of family dependents, retired persons, and persons employed outside the settlements.⁹

B. Key Functions

A. E. Smailes¹⁰ carried out the first functional ranking of centers in England and Wales. A major division of services was determined under the categories of retail trade, educational and health services, entertainment and social organization. Indices were selected to be representative of each category. They included banks, Woolworth store, secondary school, hospital, cinema and newspaper. The problem with this system was that if a center did not possess the indices it could not be classified.

H. E. Bracey¹¹ devised an index of centrality for using fifteen services representative of clothing stores, household good stores, medical services, and professional services. Questionnaires were sent out to responsible persons in each parish who indicated where they would go for each of the fifteen services. The villages and towns thus received a numerical value based on the services they provided to the surrounding area. The hierarchy was formed and measured on this basis.

9. J. E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin", Geographical Review, 43 (1953) No. 3., p. 384

10. A. E. Smailes, op. cit., p p. 41 - 51

11. H. E. Bracey, "Towns as Rural Service Centers", Transaction and Papers, Institute of British Geographers, 19 (1953) pp 95 - 105

C. Transportation Index

The classification of centers in England and Wales on the bus service index was proposed by F. H. W. Green¹² and expanded on by I. Carruthers.¹³ The classification is based on the town - country relationship with bus service an indication of nodality of a center. Using bus service time-tables, Green plotted the size of the hinterland of a center and used the size of the hinterland to rank the center. I. Carruthers classified the center rather than the hinterland. The ranking was based on the number of bus journeys into or through the town from centers larger and smaller than itself.

The bus service index has met only with a small degree of success. Centers where the bus did not stop, or were by - passed by the bus, were not classified. Today the automobile serves as the major mode of travel between a town and its hinterland, especially in North America, further detracting from the validity of the bus index, as far as the present study is concerned.

D. Functional Unit Classification

The most reliable method of classification is to record all the diverse services in a center and use these as the bases for ranking a center.¹⁴ H. E. Bracey found that by counting the urban establishments in a center

12. F. W. H. Green, "Urban Hinterland in England and Wales: An Analysis of Bus Services", Geographical Journal, 96 (1950) pp 64 - 81

13. I. Carruthers, "A Classification of Service Centers in England and Wales", Geographical Journal, 123 (1957) pp. 380 - 404

14. H. E. Bracey, op. cit., 95 - 105

and expressing them as rate per 1,000 persons was the most accurate method of ranking centers below 2,000 persons. The Wisconsin study of hamlets by G. T. Trewartha¹⁵ was based on the ranking by number of functional units.

The outstanding work done by J. E. Brush¹⁶ which has served as a basis for recent studies in the Prairie Provinces of Canada is based on a functional classification. The Royal Commission on Agriculture and Rural Life in Saskatchewan, after investigating all possible avenues of ranking available to them, concluded that a classification based on the range of services offered by a center was the most reliable.

The validity of the functional classification has recently been verified statistically by B. J. L. Berry and W. Garrison.¹⁷ They proved a hierarchy of central places does exist when the functional units are considered. The Centers were arranged into three types on the bases of the urban functions within the center. It was shown that these center types differed more one type from another than they differ within types. Thirty-three small centers were dealt with in the study and each was classified on the basis of 63 central functions. The 63 central functions were divided into two groups; variates which were functions varying in number from place to place, and attributes which were functions a place

15. G. T. Trewartha, "The Unincorporated Hamlet: One Element in the American Settlement Fabric", Annals, Association of American Geographers, 33, (1943) pp 32 - 81

16. J. E. Brush, op. cit., p.385

17. B. J. L. Berry and W. Garrison, op. cit., pp 145 - 154

either possessed or did not possess. A graph plotting the number of activities in a center against the population of a center was used to prove quantitatively the tendency towards three distinct groups existing in reality in the central place hierarchy.

In spite of these advantages the difficulty of obtaining reliable information of the various functions provided by a center has discouraged this approach. G. Trewartha¹⁸ commented on the absence of even rudimentary data for unincorporated centers in his Wisconsin study.

J. F. C. Hodge¹⁹ and the Saskatchewan Royal Commission²⁰ when faced with the problem of classifying the multi-functional businesses common in the smaller centers, made the classification by the main function of the business. All other functions of the multi-function business were ignored. This problem has been a major concern in dealing with the smaller centers.

The Dun and Bradstreet²¹ report has been the common source of information for determining the functional hierarchy of larger survey areas on the Prairies and Wisconsin. The population figures given for the

18. G. T. Trewartha, op. cit., p 33

19. J. F. G. Hodge, The Prediction of Trade Center Viability in the Great Plains, unpublished Ph.D. thesis, Massachusetts Institute of Technology, February, 1965, pp 98 - 124 and Appendix A.

20. Saskatchewan, Royal Commission on Agriculture and Rural Life, Report No. 12 Service Centres, Regina, 1957, p.29

21. The Dun and Bradstreet Reference Book is an attempt to report on the credit rating and the type of service of every merchant in Canada and the United States. The report is published every two months by the Agency for its subscribers.

smaller centers in this report are often merely estimations by the local inhabitants. Not every center is listed. Trewartha²² found that a small population grouped around a church or a school, but having no business establishment, is not included in Dun and Bradstreet. Business establishments in small centers which do not have a post office are listed as being in the center which they use for a mailing address.

Professional business such as those of doctors, lawyers, veterinarians, and insurance agencies, auction marts, barber shops are some of the businesses generally excluded from the Reference Book. Hotels are listed only if they incorporate a cafe and if the Branch Manager has purchasing authority. Furthermore some businesses (eg. blacksmith shops and laundries) are generally listed only if they have two or more employees, and some retail shops are not listed unless they have sufficient turnover to warrant credit appraisal.²³

E. Postal Revenue

The use of Postal Data affords an index of consideration. Three studies best illustrate its use; Smailes²⁴ used the presence of a post office as the most satisfactory rough indicator of a town's status. P.²⁵ Woroby relied partially on Postal Data to determine a functional hierarchy in Saskatchewan for the lowest ranking centers. The final use of the data which is most significant, is using the postal revenue of a center to determine its position in the central place hierarchy.

22. G. T. Trewartha, "The Unincorporated Hamlet: an Analysis of Data Sources", Rural Sociology, 6 (1941), pp 35 - 42

23. J. Anderson, Changes in a Central Place System: Trade Centres and Rural Services in Central Alberta, unpublished M. A. thesis, University of Alberta, 1967, p 112

24. A. E. Smailes, op. cit., p 44

25. P. Woroby, op. cit., p 84

26

H. Jones postulated postal revenue used as an index to formulate a hierarchy focuses on both time and space. He found a close correlation in both 1931 and 1961 between postal revenue and tertiary revenue of service centers over 1,000 inhabitants in British Columbia.

27

J. Anderson supports the postal revenue as an economic index. The post office has a very low "condition of entry" into a center and provides a basic function. Annual reports are available in Canada from sales of stamps and money orders for all centers in Canada in which a post office is located. The post office is used by all types of businesses, individuals of all religious and social groups, and changes in a center are slow to be reflected in post office revenue. The post offices charges are standardized and not affected by provincial boundaries.

The gross revenue of a center's post office is a combination of people living outside the center and people residing within. Both populations contribute directly and indirectly to postal revenue. Directly by using the service as a consumer and indirectly by supporting businesses using the postal revenue. This is rather an index of centrality than an index of economic activity within the center. The contribution from outside the center would be a more accurate reflection of centrality but this component of postal revenue is not readily available.

26. H. G. I. Jones, Postal Revenue as an Index of Centrality, a paper presented at the Annual meeting of Canadian Association of Geographers, Vancouver, May 29, 1965, p 1.

27. J. Anderson, op. cit., pp 39 - 41

Another weakness of postal revenue is that it is expressed in "current dollars". Thus as value of the dollar changes from year to year, the index is not suitable to compare from one year to the next unless the figures are converted to "constant dollars".

F Telephone Connection

The telephone has been used as a measure of central activity. Christ-
28
aller recognized the need for a more practical and convenient method of classification than that of compiling and classifying data on kinds and numbers of central services in each place. The telephone served as his measure of centrality of a place (the tie between a central place and its complimentary region). Christaller claimed telephones were a reliable index as they were used mainly for business at the time in Germany.

The application of this method in Manitoba is basically unsound. The telephone is found nearly in every home in Manitoba, it is no longer limited to businesses. The removal of residential users from the total still does not leave a reliable index. The assumption in using the telephone index is that all users employ the service with the same intensity. This however is not the case as larger commercial services will make greater use of their phones than a smaller commercial or institutional user. This variation is not reflected in the index.

29

Ullman suggests a more accurate method of using the telephone ser-

28. W. Christaller, op. cit., pp 139 - 150

29. E. Ullman, "A Theory of Location of Cities", American Journal of Sociology, 46 (1941) p 858

vice as an index would be to measure out of town calls per hour and use
³⁰
 this data to formulate a hierarchy.

G. Assessed Values of Business Establishments:

The criteria of the "assessed value of business establishments" offers an interesting avenue of investigation. It serves to classify all central establishments paying a municipal tax. The assessed value reflects not only the number of service units but is also an indicator of the size of the service. (eg. a supermarket will pay a larger municipal tax than a corner store).

This index when applied proved unsuccessful as a measure of centrality.
³¹
 Peter Woroby found in Saskatchewan that services such as hospitals, schools, churches, government services and other tax free establishments played a major functional role in the center, but were not calculated in the assessment role. The assessment role however included taxes collected on land,
³²
 buildings and manufacturing which were non central functions. T. G. Sosa made similar criticisms of this method in Manitoba. Possibly the major criticism of business assessments is that there is no uniformity in tax assessments from one center to another as a community's needs dictate the mill rate assessment.

30. For further use of telephone data see also John D. Nystuen and Michael F. Dacey, "A Graph Theory Interpretation of Nodal Regions", Papers and Proceedings of the Regional Science Association, Vol. 7 (1961) p²⁹ = 42

31. P. Woroby, op. cit., p 81

32. T. G. Sosa, Service Centre Study of the Interlake Region, Manitoba, unpublished M. A. thesis, University of Manitoba, 1964, p 39

H Turn Over; Value of Stock; Annual Profit; Number of Workers; and Weekly Payroll of Businesses:

33

James Anderson found a ranking on economic activities of businesses unsatisfactory in Alberta. The only source of information for the smaller centers was from the business owner himself and naturally he would be reluctant to divulge his financial position. Family help and part time workers complicated a ranking based on total number of workers and weekly payroll. He concluded that the total annual turnover of the business for a center appears to be the best index.

I Net Income Originating In a Center:

Peter Woroby supports net income originating in a center as a measure of centrality. It is determined

by first accounting the annual value of goods produced at the market price which means sold, when applied to business establishments, and add to this the net change in inventory valued at cost value (purchasing price). From this data deduct the "purchasing cost", that is the value of goods and services which were acquired for purpose of production or re-selling. This item does not represent the contribution of the retail establishment to the national economy. It was created by co-operative effort of capital, labour, and management of other firms and will show up as their production value. Further more deduct the depreciation costs which extend to buildings and fixtures. This item represents the annual portion of the deferred purchasing costs which will be acquired when the fixed assets terminate their economic life and have to be replaced. In addition to that allow for bad debts. As a final step deduct taxes which rest on the business premise and add government or municipal subsidy if applicable. The product of this calculation is net income which originates through the activity of the central service and was added to the national wealth.³⁴

33. J. Anderson, op. cit., pp 36 - 38

34. P. Woroby, op. cit., pp 85 - 86

This index accounts for the size of a center and size of the economic activity of the business. The basic drawback to this measure as far as this study is concerned is that data of this kind is not available in Canada.

J Wholesale Trade

35

W. R. Siddall has used employment data from wholesale trade in measuring urban centrality. This criteria has limited use as wholesaling is not a function of the small center nor is employment data available for small places.

From the foregoing review of the various indices of centrality, which have been tried by different writers, it is clear that while some have proved more accurate than others all have certain drawbacks.

This study is concerned with finding an index of centrality which can be applied to the Prairies. A review of the indices applied to similar areas, has produced 9 major requirements for a good indices.

The major requirements are;

1. It must be an accurate measurement of the tertiary services of the center.
2. It should reflect the population, as a definite relationship exists between the centrality of a place and its population.
3. It must reduce the diverse elements to be measured to a common denominator. This common denominator should not be subject to change from year to year like the dollar as this limits the comparative value of the criteria.

4. It should not only measure the number of service units in a center but also the size of the economic activity of the business.
5. It must be able to be applied to large as well as small centers.
6. It should be a measure of the surrounding area which the center serves.
7. It must not be influenced by outside factors like social and religious attitudes.
8. The data must be readily available and such that it can be applied to a study of a large or small survey area.
9. In a central place system the data used should identify a distinct grouping, proving that a hierarchy of centers does exist.

Chapter 2

Electrical Power Data as an Index of Centrality

The universality and relative ease of accessibility of electrical power data offers an avenue of investigation. The purpose of this chapter is to explain the types of electrical power data which are available, followed by a validity test where a correlation between the accepted functional method of forming a central place hierarchy and an electrical power data hierarchy are made.

A Electrical Power Data

Electric power data provides a basis by which the centrality of a central place can be measured and a hierarchy can be formed. Like postal revenue data, electrical power data is available for the smaller centers, and it converts the diverse elements to be measured to a common denominator. The near universal use of electricity in North America permits the use of this index in most areas. This allows one to select a study area which corresponds closely in size to Christaller's model, rather than selecting a survey area which is too small to be a fair sample area, or being forced to limit the size of the area because of availability of data. The electrical power consumption of a center is an indicator of the economic wealth of a central place as the number of electrical appliances can serve as a rough indicator of economic prosperity.

I. W. Christaller, Die Zentralen Orte in Suddeutsehlend, Jena: Gustav Fischer Verlag, 1933 (Translated As Central Places in Southern Germany, By C. W. Baskin, 1966, 230 pp.)

The electrical generation and distributor in 1961 in the Province of Manitoba was controlled by two agencies.

... a municipal agency, City Hydro, participates in generation and distribution, with a provincial utility, Manitoba Hydro and is the distributing agency within the city of Winnipeg. The provincial organization on the other hand, is the distributing agency for the rest of the Province (including the suburban municipalities of Greater Winnipeg) and is responsible for all future generation capacity in Manitoba²

There are three classifications of urban users of electricity made by Manitoba Hydro. The commercial user, the power or industrial user, and the domestic or residential user. A fourth group referred to as "Farm service"³ includes the farms in the rural area around a center.

⁴
The residential classification includes individually metered private residences⁵ occupied by a single family or a group of people living as a family and where energy used for commercial ventures does not exceed 250 watts. Dwellings having a residentially classified meter include a single home, the private home in a duplex, row homes or apartments. A single residence adjoining a store as is common in many small centers

2. A. G. Gardiner, The Electrical Power Industry of Manitoba: An Economic Analysis, unpublished M. A. thesis, University of Manitoba, 1963, p I

3. The rural area includes the farms around a center. The farmer has in the past had freedom of choice as to which center he will pay his hydro bill and have his meter reading recorded.

4. The four classification descriptions as outlined in this chapter are those as specified by the Manitoba Hydro. As each province has to submit the number of rural and urban commercial, domestic and industrial meters for each center to the Dominion Bureau of Statistics, it is assumed other provinces have similar dwellings in each classification.

5. A residence is a dwelling with a structurally separate set of living quarters, with a private entrance either from outside the building or from a common hall or stairway inside.

would be classified as a residential service. Also included in this group would be the trailer or mobile home.

The power or industrial classification includes the heavy users of electrical power.

The more typical large user, however is the primary industry such as iron and steel, pulp and paper, non ferrous smelting and refining and large scale food processing, all of which are power intensive and whose requirements are more directly related to production levels.⁶

The commercial user is the third urban classification. To be classified in this group the Manitoba Hydro requires that this be a premises where the conduct of business activities or operations are associated with services and / or distribution of goods. This would include all commercial categories and general users such as stores, offices, schools, public buildings, institutions, hotels, motels, trailer courts, restaurants, service stations, railway crossing signals, magnetic traffic counters, signs and display lighting and any other premises or equipment used for commercial purposes. This group includes essentially those services used to measure the centrality of a center for a functional central place classification.

The fourth group is the farm service. The Manitoba Hydro requires that to be classified in this group it must be a portion of land and / or buildings used for the prime purpose of agriculture production. The range of farms includes grain, dairy, poultry, sheep, fur farms, market gardens, cattle feed lots and other food stuff.

6. A. G. Gardiner, op. cit., p 22

The electrical power data is available in two forms.

7

- (1) The number of meters in each center in Manitoba in the urban domestic, urban commercial, urban power, and rural groups.
- (2) The total amount of kwhrs. consumed by each center in Manitoba.

This includes commercial, domestic and power consumption in the urban center itself plus the farm consumption of the surrounding area.

8

B. Test of Validity

To test the validity of hydro power data as a valid index of economic activity of an area, the following two assumptions are made. First it is pre-supposed that the functional classification is the most accurate measure of centrality. Second it is assumed that both the range of services and total services are equally valid indices in the functional classification.

7. Dominion Bureau of Statistics, Electric and Gas Meter Registration, No. 57-201 (1961)

8. Comparative Statement of Metered Kwhrs. sold in 1961, available through the Manitoba Hydro.

9. Range of Services refers to diversity of services. If a center has 3 stores, 2 churches, 1 school, and 1 post office, its range of services is 4. This method of classification has been used by : Saskatchewan Royal Commission on Agriculture and Rural Life, Service Centers, Report No. 12, Regina, 1957, p 29. This has been the basis for most classifications on the Prairies of Canada, including T. S. Sosa, Service Centre Study of the Interlake Region, Manitoba, unpublished M.A. thesis 1964, pp 40 - 41.

10. Total services refers to all of the services. In the example in footnote 9 the total services would be 7. This functional method of classification has been used by B. J. L. Berry and W. L. Garrison, "The Functional Bases of the Central Place Hierarchy", Economic Geography 34 (1958) p 152 and J. E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin, The Geographical Review, 43 (1953) p 385

Based on the two previously mentioned assumptions, the validity test was applied to the Interlake Region of Manitoba. This area was selected as T. G. Sosa¹¹ had recently completed a study of all centers in the region recording both total services and range of services. For each center in the region the (1) kwhr. consumption (2) number of urban commercial meters (3) number of services (4) range of services (Table I) were recorded. Each group of data was correlated with itself plus each other group (Table II) to determine how valid the electrical power data indices were. Regression lines were determined for the various correlations.¹²

Significantly high correlations were found to exist between the electrical power data and the services for the region. The implication being that both the urban commercial meters and kwhr. consumptions were relatively reliable indices of the functions of a center. Regression lines were constructed for urban commercial meters on range of services (Figure 1), kwhr. consumption in 1961 on range of services (Figure 2), urban commercial meters on total services (Figure 3), and kwhr. consumption in 1961 on total services (Figure 4). The regression lines illustrated were the values that might be expected for one set of

11. T. G. Sosa, op. cit., pp 65 -66

12. Statistical techniques are explained in Appendix A. A computer was used for the correlations and construction of the regression line. The program used for the correlations and the program used to construct a regression line are found in Appendix B.

TABLE I (a)

**ELECTRICAL POWER, SERVICES, AND POPULATION
DATA FOR THE INTERLAKE REGION, MANITOBA**

Town ¹	Kwh. Consumption ²	Number of services	Range of Services	Population ³	Rural and Urban Domestic Meters	Urban Commercial Meters
Gimli	4,903,254	123	73	1841	998	139
Stonewall	5,281,262	123	68	1420	456	128
Arborg	3,223,863	106	63	811	269	80
Teulon	2,647,860	98	63	749	264	77
Ashern	1,461,497	82	46	374	128	65
Fisher Branch	1,536,902	67	45	369	137	56
Riverton	1,712,881	65	43	808	236	80
Lundar	1,454,444	54	40	713	438	61
Ericksdale	1,058,338	43	35	242	97	35
Moosehorn	538,297	45	31	208	79	31
Warren	1,342,206	26	20	241	75	27
Inwood	972,895	28	23	183	75	26
Gypsumville	258,544	30	22	235	53	24
St. Laurent	592,704	30	19	869	155	20
Hodgson	951,263	24	18	222	116	38
Steepprock	484,569	19	18	168	55	19
Fraserwood	376,234	21	14	78	40	18
Poplarfield	476,282	19	14	142	42	19
Woodlands	879,145	17	13	124	47	12
Oak Point	477,257	14	13	238	58	13
Chatfield	208,481	14	13	158	34	9
Balmoral	1,139,627	16	12	103	45	14
St. Martin	212,334	15	12	23	23	10

TABLE I (b)

INTERLAKE REGION, MANITOBA

Town	Kwh. Consumption	Number of services	Range of Services	Population	Rural and Urban Domestic Meters	Urban Commercial Meters
Petersfield	1,272,020	15	12	157	51	15
Clandeboye	612,163	13	11	119	48	15
Hnausa	254,328	11	10	102	23	7
Stony Mountain	148,792	14	9	1130	171	22
Grahamdale	132,972	11	9	44	14	8
Arnes	290,880	11	9	50	12	4
Komarno	289,456	14	8	101	34	15
Gunton	608,023	9	8	88	27	10
Netley	205,690	9	7	50	9	6
Camp Morton	298,628	8	7	50	13	4
Camper	164,447	8	7	50	8	4
Sandy Hook	172,000	7	6	93	380	10
Broadvalley	256,480	7	6	49	24	8
Husavick	40,274	6	6	50	6	3
Spearhill	607,965	6	6	75	21	1
Meleb	166,526	8	5	25	6	8
Silver	134,651	6	5	25	10	6
Faulkner	97,963	6	5	25	9	4
Hilbre	101,849	5	5	25	18	4
Fairford	124,179	5	5	37	27	7
Malanton	136,923	6	4	25	5	1
Rembrandt	54,971	5	4	25	1	1
Lake Francis	300,899	4	4	25	6	4

TABLE I (c)

INTERLAKE REGION, MANITOBA

Town	Kwh. Consumption	Number of services	Range of services	Population	Rural and Urban Domestic Meters	Urban Commercial Meters
Deerhorn	125,085	3	3	27	9	3
Clarkleigh	303,340	3	3	25	7	1
Mulvihill	113,196	3	3	13	15	3

Sources: Kwhr. Consumption: Comparative Statement of Metered Kwhrs Sold in 1961, Manitoba Hydro. Number of Services, Range of Services and Population: T. G. Sosa, Service Centre Study of the Interlake Region, Manitoba, unpublished M. A. thesis, University of Manitoba, 1964. Rural and Urban Domestic Meters and Urban Commercial Meters: Dominion Bureau of Statistics, Electric and Gas Meter Registration, 1961

1. Towns are ranked in order of range of services.
2. Kwhr. consumption includes both the rural and urban hydro consumption for the center.
3. Population figures of 25 and 50 are estimations as no data was available and computer calculation requires a numerical value.

TABLE II

The Product Moment Correlation Coefficients for Electrical Power
Data and Services of the Interlake Region

	Kwhr Consumption	Number of Services	Range of Services	Rural and Urban Domestic Meters	Urban Commercial Meters
Kwhr Consumption	1.00000	0.92383	0.90340	0.80723	0.94318
Number of Services	0.92383	1.00000	0.99159	0.76907	0.97032
Range of Services	0.90340	0.99159	1.00000	0.76030	0.96095
Rural and Urban Domestic Meters	0.80723	0.76907	0.76030	1.00000	0.84837
Urban Commercial Meters	0.94318	0.97032	0.96095	0.84837	1.00000

FIGURE 1

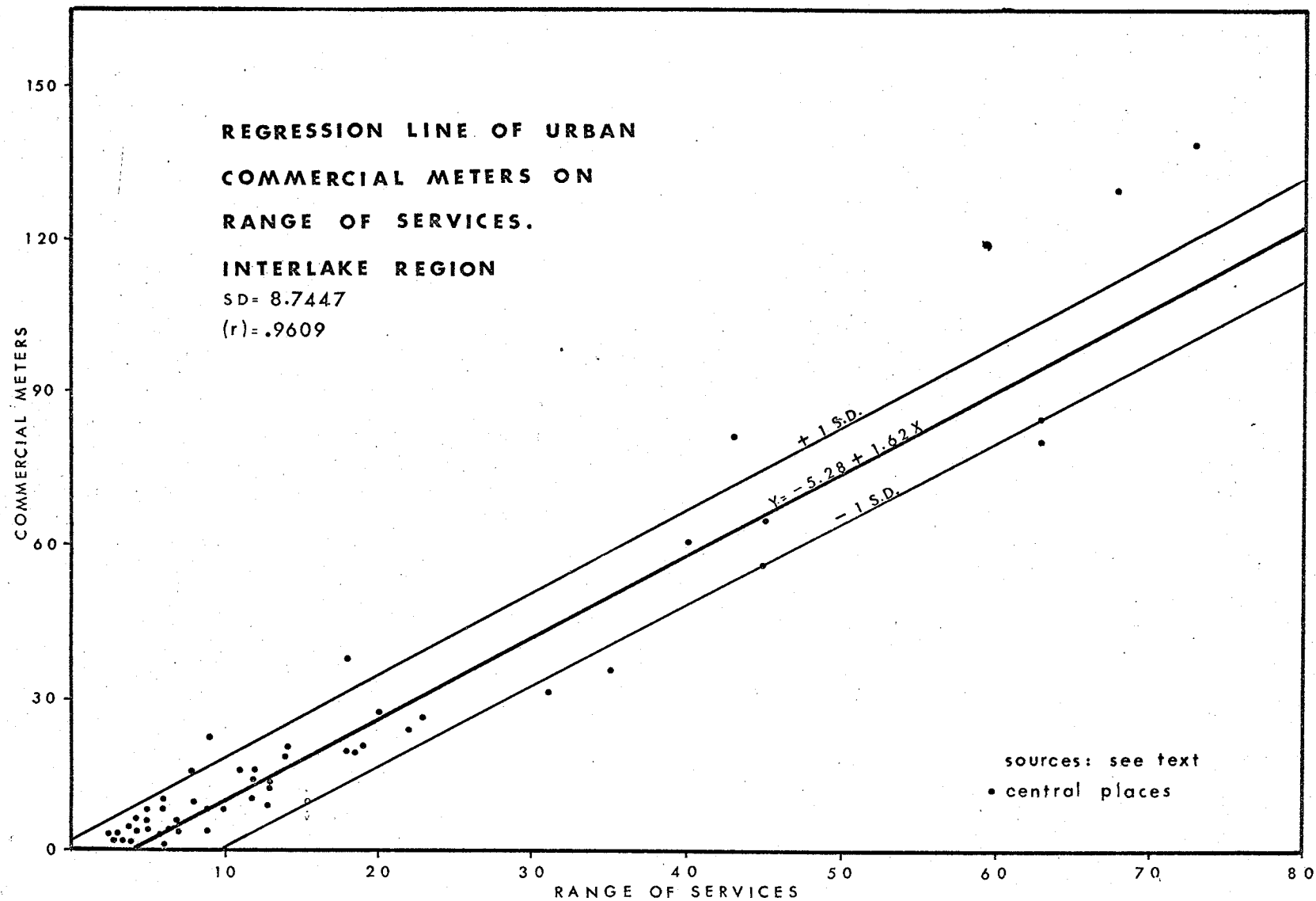


FIGURE 2

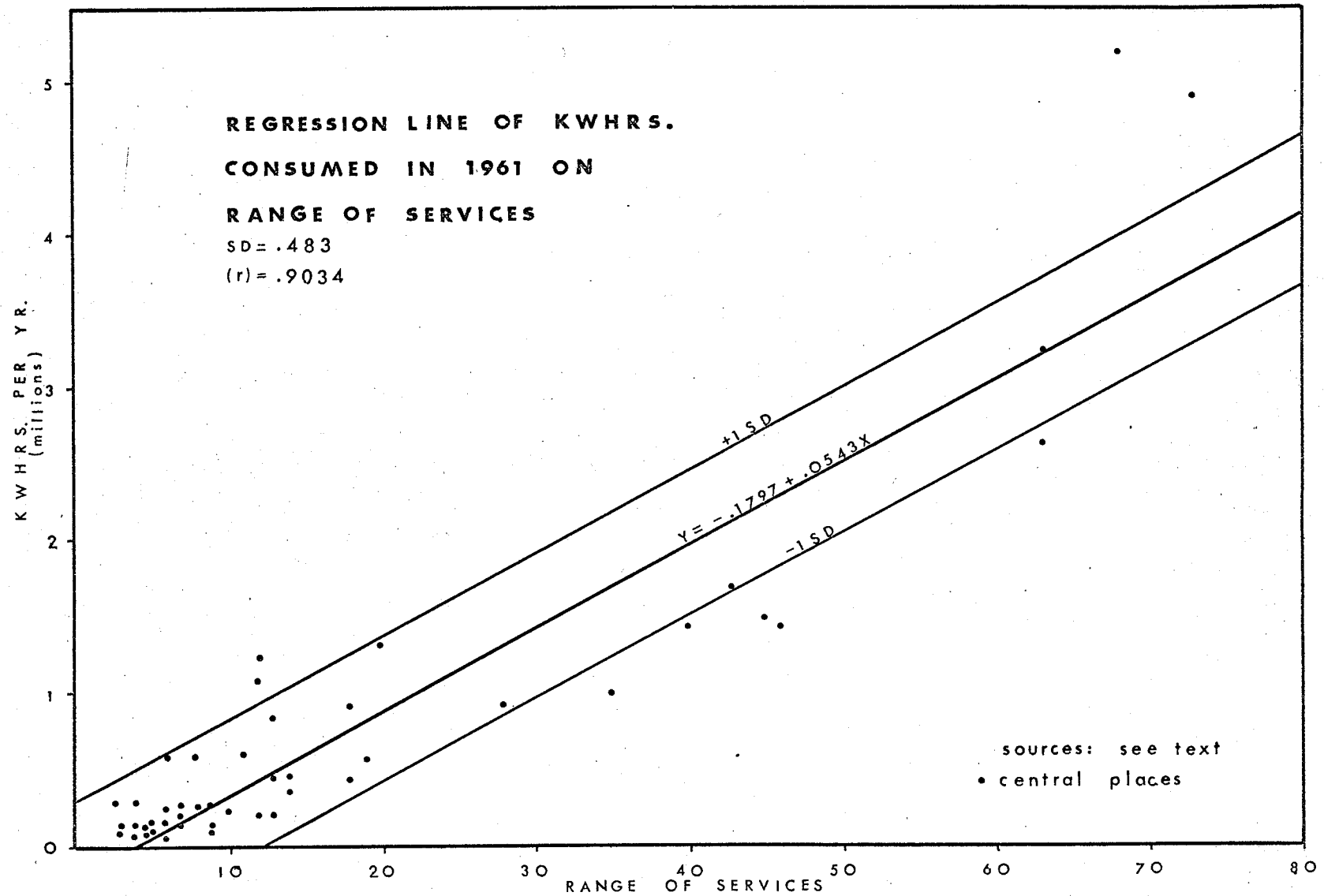


FIGURE 3

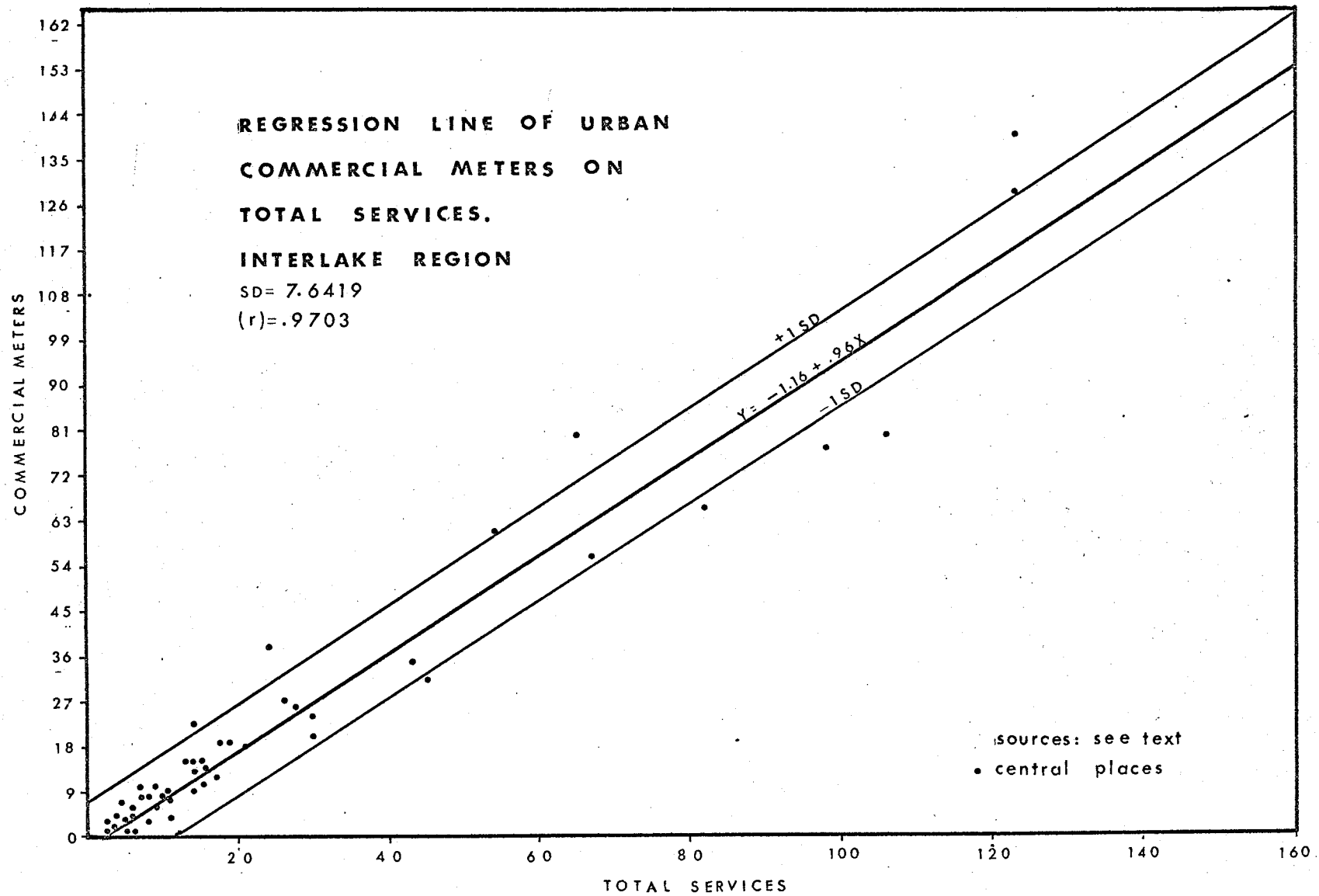
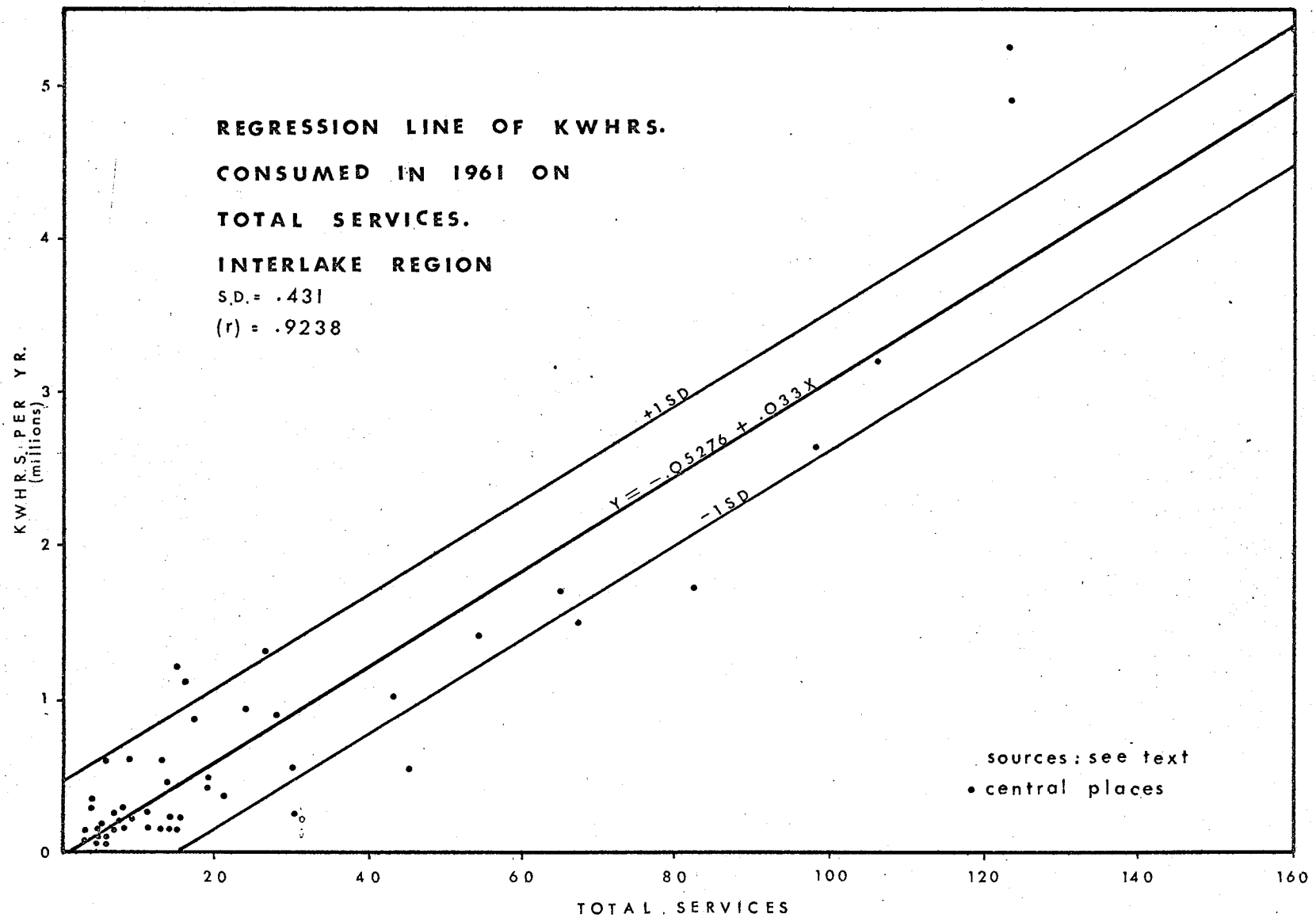


FIGURE 4



data would fall if some given set of value occurred in the other set.

The Product Moment Correlation Coefficient (r) between urban commercial meters and range of services (Figure 1) for the centers of the Interlake Region was .960, significant at the .1% level. Expressed as a coefficient of determination (r^2), 92% of the variation in urban commercial meters can be "explained" by the variation in range of services in a trade center. The regression line was determined by the formula $Y = -5.28 + 1.62X$. To be more meaningful a distance of one standard deviation¹³ along the Y axis, on either side of the regression line was drawn illustrating the high degree of correlation between urban commercial meters and range of services.

The Product Moment Correlation Coefficient (r) between kWhrs. consumed in 1961 and range of services (Figure 2) with a regression line was calculated. The resulting value for (r) was .903 significant at .1%. The regression line based on the equation $Y = .1797 + .0543 X$ with the one standard deviation was constructed.

The highest degree of correlation was found to exist between urban commercial meters and total services (Figure 3) where (r) = .970. The correlation was found to be significant at the .1% level with a coefficient of determination (r^2) = 94%. The regression line equation is $Y = -1.16 + .96X$.

The final correlation and regression line (Figure 4) was between kWhr. Consumption in 1961 and total services. The coefficient

13. One standard deviation measured both plus and minus about the regression line shows the area in which 68.26% of the values fall.

$(r) = .923$, significant at .1% level with $(r^2) = 85\%$. The regression line equation was found to be $Y = .0527 + .033X$.

As both number of services and range of services have received general acceptance as valid indices of centrality, both have been used in the correlations with hydro data. The highest correlations were found to exist between the services and urban commercial meters, supporting the previously mentioned view that by the Manitoba Hydro's definition of urban commercial meters, they were also producing a functional measure of the centers. This high degree of correlation for urban commercial meters is well illustrated in Figures 1 and 3 where especially in the smaller centers there exists a high correlation between services and number of urban commercial meters. Although the correlation between kWhrs. and services (Figure 2 and 4) is not as high as for urban commercial meters it is still very significant. Discrepancies found to exist in kwhr. correlations may partially due to the fact that a heavy user of electricity within a center could upset the correlation. These high correlations indicate electrical power data is a valid measure of the functions of a center and consequently its centrality.

Chapter III

The Study Area

A. Selection of the Study Area

It was concluded in Chapter II that both kwhr. consumption and urban commercial meters are valid indices of centrality. This now enables one freedom to select a sufficiently large and homogeneous survey area where a Central Place Hierarchy can be determined on the basis of electrical power data.

The Central Place Hierarchy as formulated by W. Christaller¹ is applicable to a hypothetical area. The area must be perfectly uniform in both productivity and population distribution, allowing freedom of movement from one place to another. Because there is no perfectly uniform territory, geographers have tried to find areas which would seem to fulfill the ideal conditions as nearly as possible.

The Great Plains of Anglo-America has been generally accepted as nearly fulfilling the Central Place requirements. In the Wisconsin study, J. E. Brush comments:

Small towns and villages in agricultural areas of Anglo America exist mainly because of their function as central places for the exchange of goods and services, each for its local farm trade. In any given area small centers offer greater services, are more widely spaced and less numerous.²

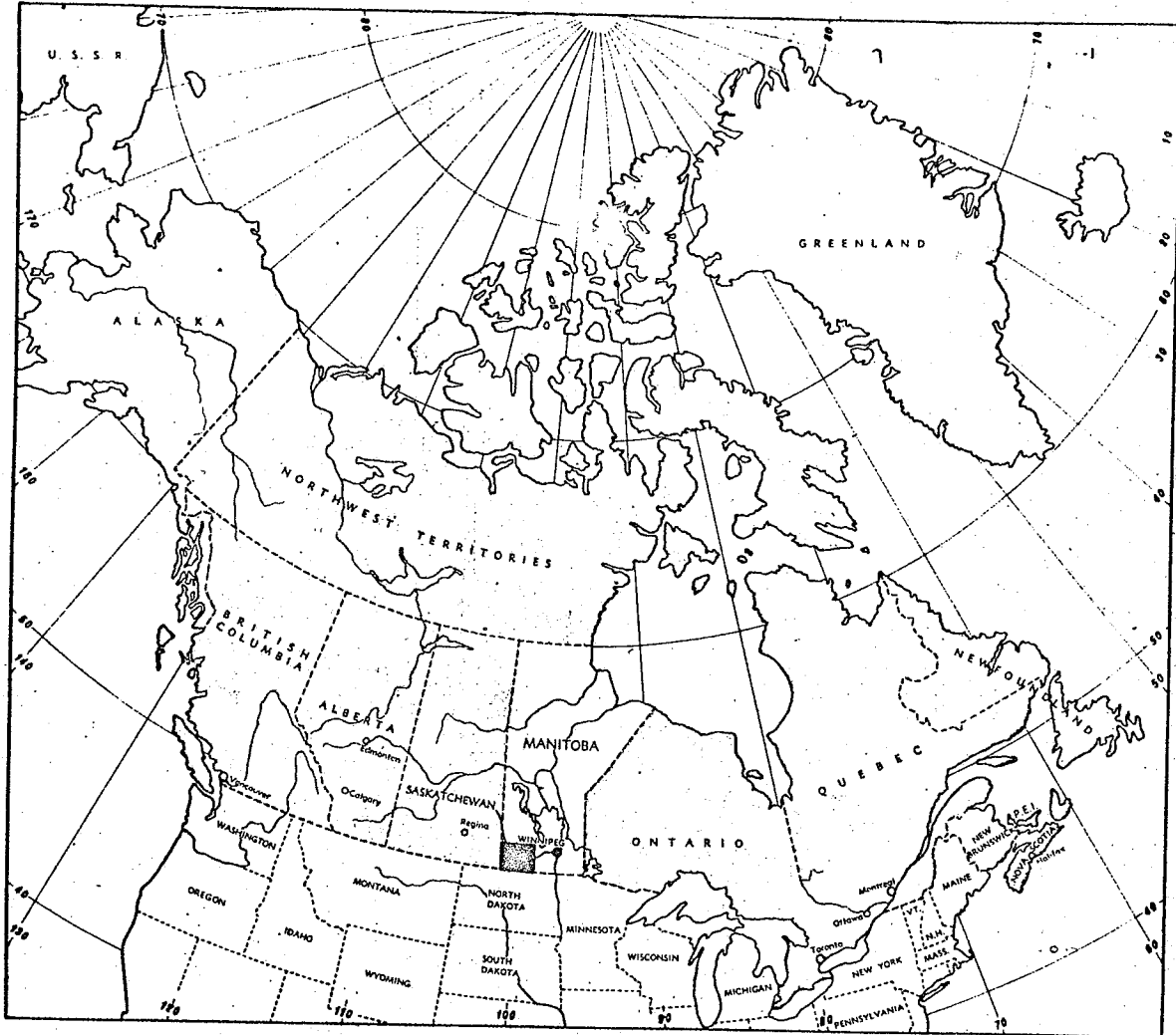
The area selected for this study is located in southwestern Manitoba (Figure 5). The selection was made on the basis of three criteria:

1. W. Christaller, Die Zentralen Orte in Suddeutschland, Jena : Gussav Verlag, 1933. (Translated as Central Places in Southern Germany, by C. W. Baskin, 1966, 230 pp)

2. J. E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin," The Geographical Review, 43 (1953) p 380.

FIGURE 5

SOUTHWEST MANITOBA



- (1) The area has three well defined boundaries.
- (2) The area is relatively uniform, in respect to physical relief, population distribution and human activity.
- (3) The area corresponds to the Southwest Development Region³ as established by the Department of Industry and Commerce for the Province of Manitoba.

The survey area is approximately 13,568 square miles, extending 128 miles from north to south and 106 miles from east to west.⁴ The southern limit is set by the Manitoba-United States border while the Manitoba-Saskatchewan boundary forms the western edge (Figure 5). The northern extremity is established by Riding Mountain National Park. The eastern edge is set according to the Rural Municipalities of McCreary, Glenella, Landsdowne, North Cypress, South Cypress, Argyle and Roblin. (Figure 6)

The area is relatively uniform in productivity being agriculturally oriented.

The farm industry in Southwest Manitoba has been and still is by far the most important industry of this region. While there are other resources and other industries, to a very considerable extent they have developed to serve agriculture . . . It may safely be presumed that in this Region the net value of farm production would run 70 to 80 % of all production activities. Other economic activities, largely identified with the service industries would be relatively small in comparison and exist largely to serve agriculture.⁵

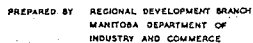
There is a marked absence of industry in the Central Places of the area,

3. Information on this region is available in Economic Research Corporation of Montreal - Toronto Ltd., Economic Survey of Southwest Manitoba, 1961, 160 pp. The statistics stated in this chapter are based on their findings.

4. Ibid., p I

5. Ibid., p34

‘



which further substantiates the argument that the centers exist to serve their surrounding hinterland. In 1961⁶ the only industrial mineral deposits being worked in the area was a salt basin at Neepawa and local sand and gravel deposits. Although oil was being extracted at Virden it was at a declining rate. Of the 198 manufacturing establishments in the region, 97 establishments were concerned with the processing of agricultural goods.⁷ The plants were small with 166 of the 198 establishments employing under 10 men.⁸ The industry in the area was furthermore concentrated in Brandon which contributed 71% of the total value of factory shipments.⁹

The population distribution is fairly uniform throughout the area and of rather low density. There are 3 population voids in the area (Figure 8). The Turtle Mountain Forest Reserve on the Manitoba - United States border is a hilly end moraine rising in elevation to over 2500 feet. The land is presently being used as a Provincial Park. The second area is the Spruce Woods Forest Reserve which is jointly occupied by the Department of National Defence and the Manitoba Forest Service. Riding Mountain National Park forms the third population void. It is a hilly forested upland of end and ground moraine, rising up and over 2000 feet above sea level, presently covered with forests. Over the remainder of the area where relief ranges from 1000 to 2000 feet, the population is evenly distributed.

The uniformity of the area is well illustrated by the transportation features (Figure 7). The grid type patterns and tendency of the routes

6. Ibid., p.47

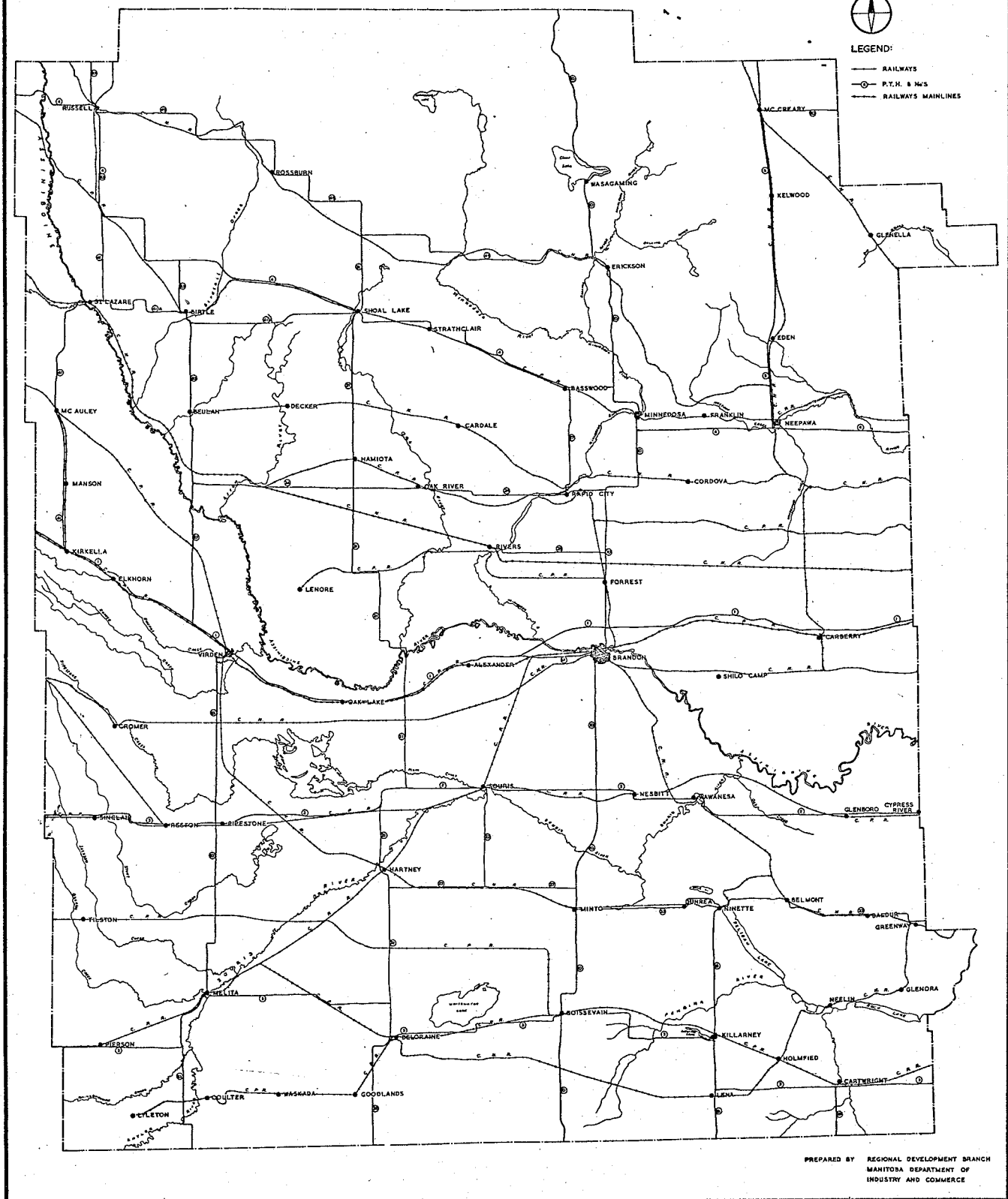
7. Ibid., p.2

8. Ibid., p 58

9. Ibid., p 2

FIGURE 7

TRUNK HIGHWAYS AND RAILWAYS



to converge on Brandon reveal very minor topographical control. The entire area is well served by both highways and railways.

The degree to which this area corresponds to the perfect uniform plain
10
as visualized by W. Christaller maybe well summed up as follows:

The development of urban communities is primarily a response to the economic and social needs of the rural population. The predominance of a specialized agricultural exporting industry in Manitoba, with the absence of factory towns and the lack of significant transportation bottlenecks has resulted in growth of an urban structure which reflects its basically distributive and administrative functions.¹¹

B. The Central Places in the Area

The names and numbers of centers located in the survey area was obtained
12
from a published map of the region. There were found to be 147 centers listed on the map. Electrical power data was available for 140 of the centers. The 7 centers without electrical power data were very small, having neither a post office or elevator.

The size of the central places varied considerably. Brandon is the largest center in the region and is located near the center of the area where it serves as the dominant communication, transportation and service center. Its commanding position is well illustrated by the fact that its population is approximately 9 times larger than the second largest center of the region while its kwhr. consumption is 5 times its nearest rival.

10. W. Christaller, op. cit., 230 pp

11. Research Corporation of Montreal - Toronto Limited., op. cit., p. 18

12. Department of Industry and Commerce, Province of Manitoba, Map of Southwest Area, 1967.

At the other end of the scale is a number of extremely small centers which provide only one or two services and whose total population is under 10 person.¹³

C. Space Relationship of the Centers in the Study Area

The arrangement of central places (Figure 8) in the study area appears to be dispersed favourably for a central place study. To be more specific a statistical measure of the area was made to determine the manner and degree to which the distribution of the central places in the area depart from a random distribution.¹⁴ The pattern can be random, agglomerated or regular. A random pattern would appear in the area if at the time of settlement each acre of land in the survey area had an equal chance of being the site of the central place, regardless of its size, or other centers located around that point. This would occur in an area where perfect uniformity existed and where transportation routes did not influence location. The agglomerated pattern would emerge in an area where one location would be more favourable for the central places to emerge such as an oasis on a desert. The regular pattern would occur in the perfect central place pattern where each point would have 6 equal distant neighbours. This pattern would emerge in the hypothetical situation as visualized by W. Christaller (Figure 9).

13. For a complete listing of the names, population, number and range of services and electrical data on the centers, see Table III.

14. For further information on method employed see P. J. Clarke and F. C. Evans, "Distance to Nearest Neighbours as a Measure of Spatial Relationship in Population," Ecology, 35 (1954) pp 445 - 453

FIGURE 8

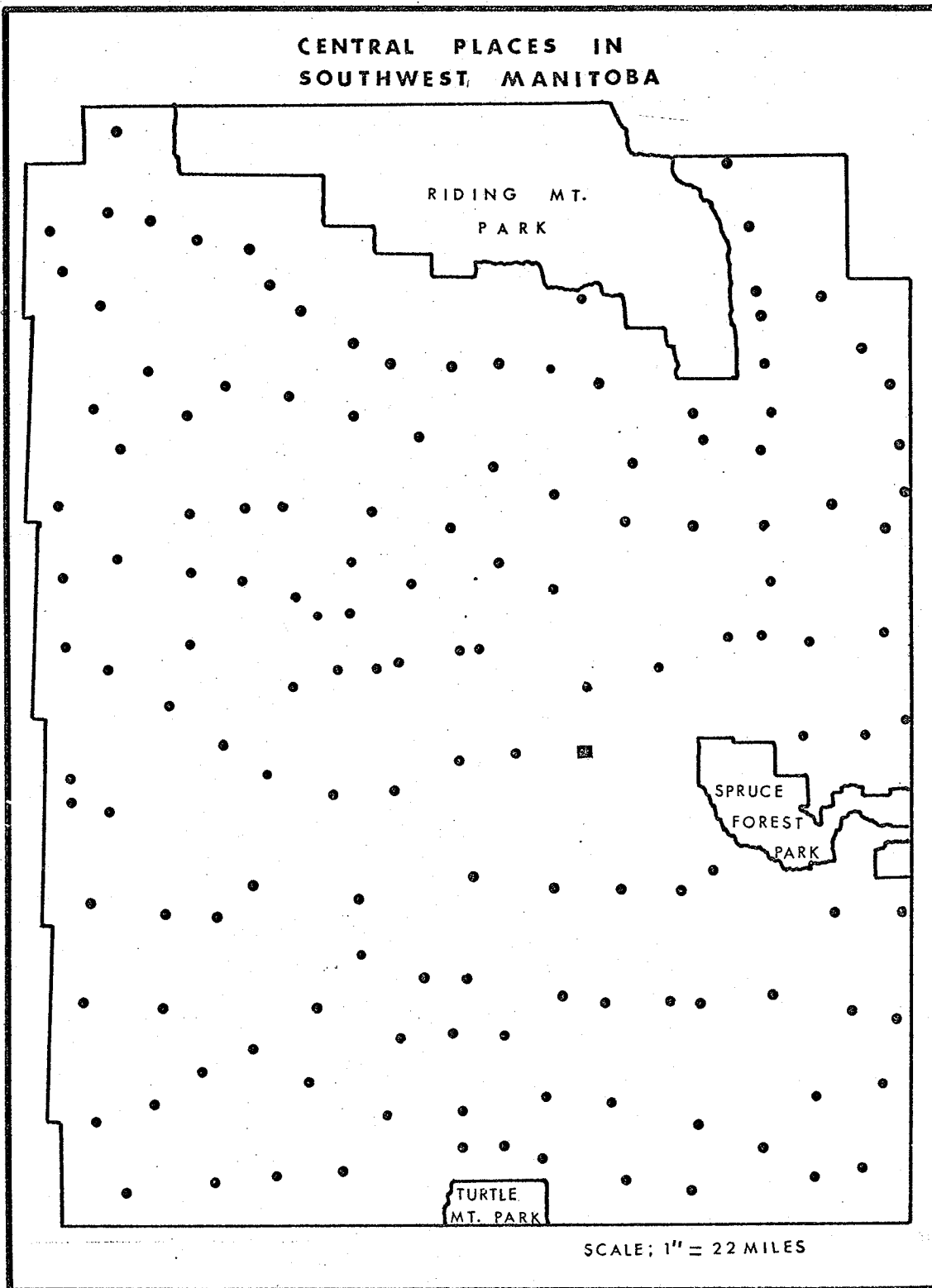
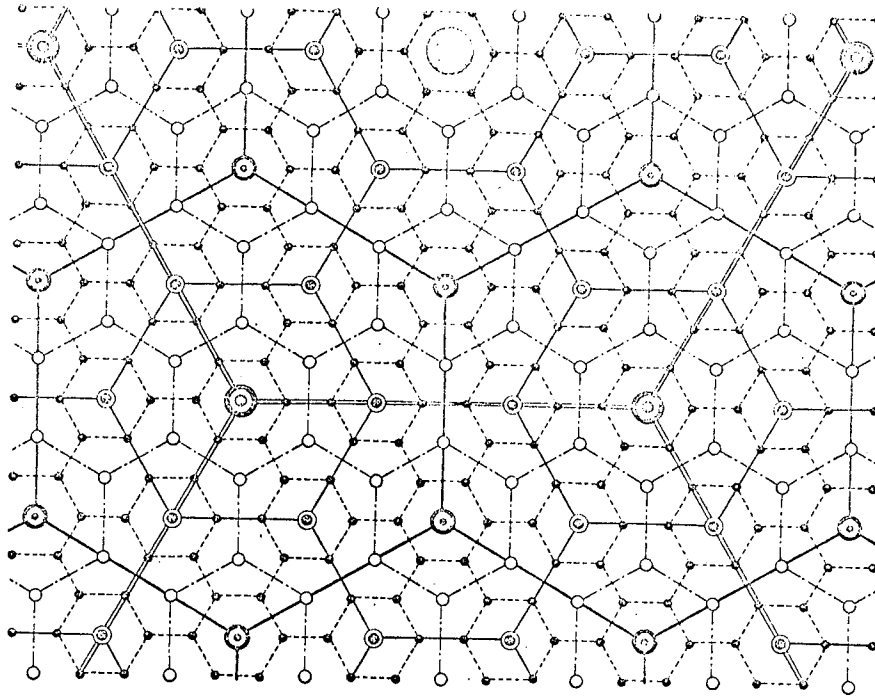


FIGURE 9

THEORETICAL CENTRAL PLACE PATTERN



LEGEND

HAMLET

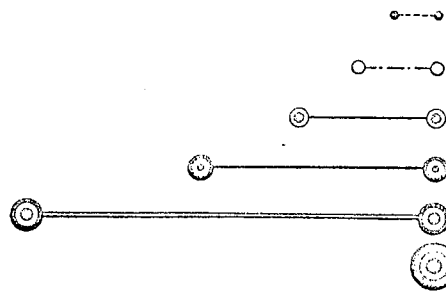
VILLAGE

TOWN

GREATER TOWN

CITY

PROVINCIAL CITY



Measurements of the distance to the nearest neighbour were calculated for each center and the area of the settled survey area was determined. This information was applied to the following formula.

$$R_I = \frac{rA}{.5\left(\frac{N}{A}\right)^{-\frac{1}{2}}} \quad I5$$

where:

rA = the means of the straight line distance to the nearest central place neighbour for each of the 147 central places in the area.

A = the area of the survey area.

N = the number of central places.

$$R_I = \frac{1.95}{.5 \left(\frac{147}{1161} \right)^{-\frac{1}{2}}} \quad I6$$

$$R_I = \underline{1.4}$$

The degree to which the survey area departed from the random distribution was found to be $R_I = 1.4$.^{I7} In the case of complete agglomeration $R_I = 0$, for

I5. P. J. Clarke and F. C. Evans, "Distance to Nearest Neighbour as a Measure of Spatial Relationship in Population," Ecology, 35 (1954) pp 445 -453

I6. The numerical values (except for R_I) are distances measured on Figure 7 where 1/6 of an inch = 1.

I7. See: Appendix C for measurements to nearest neighbour.

random distribution $R_I = 1$, while for the perfectly regular pattern $R_I = 2.1491$.¹⁸ The statistical results as determined for the Southwest Manitoba region imply that the pattern of central places is greater than random but not perfectly regular. The indication however is that the central place pattern of distribution in the area tends towards the perfectly regular one where centers would tend to locate at maximum repulsion from each other in the hexagon shape. The linear arrangement of centers resulting from transportation routes is a major force acting against the emergence of the perfectly regular pattern. The survey area statistically has a distribution pattern of central places in which a hierarchy of central places could occur.

B Correlation Between Electrical Power Data and Dun and Bradstreet in Survey Area.

The correlations found to exist in the Interlake Region of Manitoba between the total services and the urban commercial meters or Kwhr. consumption for 1961 was felt to be sufficiently high to justify electrical power data as an index of centrality. Further correlations were undertaken in the study area to find if similar correlations existed between power data and the services of other areas.

The number of services and the range of services in the survey area was obtained from Dun and Bradstreet.¹⁹ This source set two limitations.

18. P. J. Clarke and F. C. Evans, op. cit., p 447

19. Dun and Bradstreet, Reference Book, July 1961

TABLE III (a)

Electrical Power, Services and Population
Data for Southwest Manitoba

Center	Kwhr. Consumption 1961	Number of Services ¹	Range of Services ²	Population 1961 ³	Domestic Meters ⁴	Commercial Meters ⁵	Power Meters ⁶
Two Creeks	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Wattsvie	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Melbourne	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Ebot	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Routledge	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Croll	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Wasewa	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Kelloe	60,000	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Millwood	88,563	N.D.	N.D.	N.D.	7	I	0
Harrowly	33,955	N.D.	N.D.	N.D.	8	I	0
Hallboro	62,788	N.D.	N.D.	N.D.	I	I	0
Keyes	122,116	N.D.	N.D.	N.D.	6	I	0
Horton	122,053	N.D.	N.D.	N.D. ⁷	7	3	0
Regent ⁸	349,588	2	2	25	7	I	I
Wakope	274,157	2	2	20	4	I	0
Pope	187,502	2	2	25	3	I	0
Mountainside	165,826	2	2	5	6	I	0
Ogilvie	162,260	2	2	17	3	I	0
Norgate	119,400	2	2	25	8	I	I
Menzie	114,531	3	3	25	8	I	0
Birdtail	113,973	2	2	25	4	I	2
Willen	103,595	3	2	25	3	I	0
Mountain Road	95,975	2	2	25	5	I	I
Polonia	63,977	2	2	25	5	I	0

Table III (b)

Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services ¹	Range of Services ²	Population 1961 ³	Domestic Meters ⁴	Commercial Meters ⁵	Power Meters ⁶
Glencairn	28,478	2	2	25	3	1	0
Whitewater	204,077	2	2	25	7	2	0
Underhill	115,887	2	2	10	3	2	0
Tenby	65,342	2	2	8	4	2	0
Alexander	1,047,640	8	6	269	157	4	25
Deleau	396,050	5	5	40	10	4	1
Ewart	188,983	2	2	25	4	4	0
Broomhill	119,274	2	2	25	7	4	0
Lena	410,267	3	3	50	12	5	1
Treesbank	201,976	2	2	25	10	5	1
Edrans	122,159	2	2	50	12	5	0
Oberon	297,828	2	2	20	3	6	1
Moline	222,731	3	3	50	6	6	0
Butler	210,962	3	3	50	12	6	0
Kirkelle	165,098	4	4	25	10	6	1
Rackham	107,638	4	4	56	13	6	0
Dand	422,957	2	2	50	8	7	2
Elva	279,597	2	2	85	14	7	0
Belleview	249,079	5	5	50	9	7	1
Greenway	220,892	2	2	50	8	7	2
Bradwardine	552,243	7	7	75	27	8	1
Wheatlands	416,911	7	7	195	56	8	2
Franklin	402,275	4	4	33	20	8	2
Coulter	340,065	3	3	50	11	8	0

Table III (c)
Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services	Range of Services	Population 1961	Domestic Meters	Commercial Meters	Power Meters
Harding	309,852	5	5	50	18	8	1
Silverton	265,792	2	2	25	8	8	1
Arrow Head	228,557	2	2	34	14	8	1
Hargrave	394,944	2	2	50	9	9	2
Oakner	268,881	4	4	50	14	9	1
McConnell	307,887	3	3	50	9	9	1
Justice	491,990	4	4	50	16	10	1
Glenora	397,541	5	4	51	26	10	1
Birnie	364,350	5	4	88	33	10	1
Wellwood	642,490	5	5	73	27	11	1
Carroll	541,116	4	4	50	16	11	2
Margaret	484,110	7	7	78	25	11	3
Isabella	418,865	3	3	52	17	11	2
Manson	372,746	5	5	50	16	11	1
Lauder	363,848	5	5	72	34	12	2
Sinclair	637,609	7	6	85	25	13	2
Lenore	607,522	7	7	98	35	13	2
Cromer	562,233	6	6	71	39	13	4
Kemnay	300,706	5	5	81	22	13	0
Medora	755,703	8	6	90	32	14	3
Decker	607,116	10	7	67	28	14	4
Holmfield	468,116	9	7	112	31	14	0
Neelin	408,718	6	6	50	22	14	4
Vista	262,061	5	4	79	24	14	3

Table III (d)

Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services	Range of Services	Population 1961	Domestic Meters	Commercial Meters	Power Meters
Cardale	724,572	7	7	91	31	15	4
Riding Mountain	371,338	9	6	212	75	15	2
Nesbitt	757,344	5	4	86	30	17	3
Basswood	632,030	5	5	121	43	17	5
Ninga	578,765	8	8	129	44	17	5
Lyleton	662,489	10	8	123	42	17	2
Solsgirth	441,304	5	3	78	31	17	0
Beulah	405,261	3	3	50	24	17	2
Mather	739,994	7	6	125	47	18	4
Crandall	489,694	8	6	105	39	18	1
Griswold	658,195	9	9	137	52	19	4
Goodlands	865,747	8	7	138	53	20	4
Tilston	608,890	7	6	101	34	20	4
Brookdale	538,387	9	6	108	41	20	4
Eden	550,353	10	10	146	42	21	7
Sidney	474,075	10	7	154	53	21	2
Dunrae	801,153	14	10	196	59	22	8
Lauder	612,771	12	10	262	64	22	4
Douglas	969,741	8	6	289	95	23	3
Arden	808,096	10	8	188	58	23	4
Clanwilliam	523,255	12	10	182	56	24	3
McAuley	697,883	10	9	199	58	25	5
Napinka ⁹	592,443	9	8	50	65	26	4

Table III (e)

Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services	Range of Services	Population 1961	Domestic Meters	Commercial Meters	Power Meters
Pipestone	905,650	16	13	226	76	29	3
Elgin	1,257,898	13	11	259	86	32	7
Miniota	1,061,285	21	16	248	87	32	7
Kelwood	918,414	20	14	323	112	32	4
Kenton	1,312,885	18	14	222	76	33	10
St. Lazare	871,518	14	11	449	79	34	6
Pierson	1,069,459	15	13	218	80	35	16
Oak River	1,162,261	21	15	243	87	36	11
Foxwarren	1,069,036	19	11	272	94	36	7
Minto	1,023,249	15	11	171	59	36	7
Newdale	1,044,470	24	15	299	100	38	12
Angusville	597,216	22	12	208	75	38	8
Cypress River	1,416,031	17	13	288	93	41	13
Sandy Lake	652,623	17	13	383	121	41	14
Elphinstone	652,546	24	13	386	203	41	8
Belmont	1,477,840	22	16	378	129	42	7
Oakburn	870,502	25	15	357	146	42	6
Ninette	800,797	16	12	673	296	42	3
Inglis	1,072,956	22	15	295	110	43	11
Plumas	1,359,016	22	15	344	118	44	7
Binscarth	1,321,575	23	20	456	152	44	10
Strathclair	1,745,900	25	16	465	170	45	7
Waskada	1,732,216	20	13	297	119	45	14
Cartwright	1,663,816	27	23	482	179	49	15

Table III (f)

Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services	Range of Services	Population 1961	Domestic Meters	Commercial Meters	Power Meters
Forrest	1,099,188	N.D.	N.D.	N.D.	22	50	10
Oak Lake	1,632,242	28	20	430	152	51	7
Baldur	1,590,765	28	22	370	127	51	20
Rapid City	1,544,455	24	16	467	143	51	13
Wawanesa	1,650,543	26	17	456	151	53	12
Elkhorn	2,064,141	41	29	666	208	55	24
McCreary	1,389,636	29	19	579	178	62	50
Hartney	1,992,818	30	24	592	201	64	15
Hamiota	2,436,305	41	28	779	267	65	22
Reston	3,033,486	40	24	529	174	75	18
Rosburn	1,445,694	43	25	591	253	75	14
Glenboro	1,868,149	47	32	797	243	77	18
Birtle	2,352,020	43	27	846	251	83	26
Shoal Lake	2,488,483	52	31	774	283	87	29
Deloraine	3,233,778	49	33	916	373	95	32
Carberry	3,050,555	40	25	1,113	374	100	30
Rivers	3,647,125	52	29	1,574	430	104	30
Melita	3,697,828	49	34	1,038	326	120	32
Boissevain	4,681,298	56	36	1,303	435	122	43
Russell	3,758,464	61	37	1,263	456	127	38
Erickson	1,545,551	30	22	531	491	130	24
Souris	6,478,840	67	42	1,841	615	142	45
Minnedosa	6,078,373	96	50	2,211	680	162	47
Killarney	5,531,985	83	48	1,729	622	176	50

Table III (g)

Southwest, Manitoba

Center	Kwhr. Consumption 1961	Number of Services	Range of Services	Population 1961	Domestic Meters	Commercial Meters	Power Meters
Neepawa	8,043,854	129	68	3,197	1,015	225	83
Virden	12,928,601	126	69	2,708	958	252	71
Brandon	64,877,907	545	151	28,166	7,658	1,110	337

Sources: Kwhr. consumption: Comparative Statement of Metered Kwhrs. Sold in 1961, Manitoba Hydro. Number of Services and Range of Services: Dun and Bradstreet Reference Book, 1961. Population: Dominion Bureau of Statistics, Census, 1961. Domestic Meters, Commercial Meters and Power Meters: Dominion Bureau of Statistics, Electric and Gas Meter Registration, 1961.

1. Number of Services includes all the services offered by a center as listed in the Dun and Bradstreet Reference Book, 1961, plus a post office. One building often contained two, three or more services.

2. Range of Services information was obtained as for Number of Services, however where a center with 2 grocery stores and 1 post office had 3 for its number of services, it would only have 2 for its range of services.

3. Population data of 25 and 50 are estimations as no data was available, and for computer calculation a numerical value was necessary.

4. The Domestic meters include both rural and urban domestic meters recorded to the center.

5. The centers have been ranked on the basis of the number of their urban commercial meters.

6. Power meters are also referred to as Industrial meters.

7. N. D. no data available.

It limited the number of centers in the sample area to 133 as there was no listing for 14 of the centers in the area. The second limitation was that all the services of a center are not included in Dun and Bradstreet, however because all centers were subject to these same limitations it was felt this could serve as relatively reliable measure.

The 133 central places were ranked according to their urban commercial meters (Table III). For each center the Kwhr. consumption for 1961, total services and range of services as tabulated from Dun and Bradstreet, population, residential meters for each center, urban commercial meters and industrial or power meters were listed. Each group was correlated with itself and each other group.²⁰

The Product Moment Correlation Coefficient (r) between kwhr. consumption and total services for the survey area (Table IV) was determined to be $(r) = .945$. In the similar correlation in the Interlake region $(r) = .924$. The coefficient of determination $(r^2) = 89\%$ for Southwest Manitoba indicates that 89% of the variation in the kwhr. consumption can be "explained by" the variation in the total services in a trade center of the region. Similarly the correlation between kwhr. consumption and range of services was determined to be $r = .930$ with the coefficient of determination $(r^2) = 86\%$.

20. See: Appendix A for method used for correlations.

Table IV

The Product Moment Correlation Coefficients for Electrical Power
Data and Services of Southwest Manitoba^I

	Kwhr. Consumption	Number of Services	Range of Services	Rural and Urban Domestic Meters	Urban Commercial Meters
Kwhr. Consumption	1.000	0.945	0.930	0.938	0.944
Number of Services	0.945	1.000	0.990	0.966	0.971
Range of Services	0.930	0.990	1.000	0.953	0.968
Rural and Urban Domestic Meters	0.938	0.966	0.953	1.000	0.975
Urban Commercial Meters	0.944	0.971	0.968	0.975	1.000

I. The data used in the correlations is found in Table III. All the centers listed from Regent to Virden were included. The first 13 centers as listed on Table III (a) were omitted because of lack of data and the largest center (Brandon) was not included in the correlations as it would have a skewing effect in the results.

The corresponding correlation in the Interlake was $(r) = .903$.

The urban commercial meters were correlated with both the total services and the range of services to determine if similar high correlations as existed in the Interlake Region would appear in Southwest Manitoba. The correlation between urban commercial meters and total services was found to be $(r) = .971$ with $(r^2) = 94\%$ as compared to the Interlake where $(r) = .970$. The correlation between urban commercial meters and range of services was $(r) = .968$ with $(r^2) = 94\%$. The identical correlation in the Interlake gave an $(r) = .961$.

The high degree of similarities in the correlation found to exist in the two separate areas of Manitoba combined with the very high product moment correlation coefficient are significant. Both kwhr. consumption and urban commercial meters are reliable indicators of the functions to be found within a center. The urban commercial meter was found to have a higher correlation with the services in both areas and in addition nearly identical correlations in the Interlake and Southwest regions.

Based on the previous finds the following conclusions have been drawn;

1. Both kwhr. consumption and urban commercial meters are an accurate method of measuring the functions of a center for comparison purposes in a central place hierarchy study.

2. The survey area of Southwest Manitoba is a relatively uniform area where central places are dispersed in a pattern tending towards regularity which would encourage a central place hierarchy to emerge.

Chapter 4

The Central Place Hierarchy

There exists a great deal of controversy over the existence of a central place hierarchy as opposed to the idea of a continuum. Although B. J. L. Berry and W. L. Garrison found the hierarchy concept to exist in reality at the beginning of their study state, "there has been no satisfactory evidence proving that a hierarchial class system of centers does indeed exist".¹

I. R. Vining in criticizing the work of J. E. Brush comments;²

"There is no evidence . . . that exactly three natural partitions may be observed in this array of numbers of establishments . . . the terms hamlet, village, and town are convenient modes of expression; but they do not refer to structurally distinct natural entities . . . clearly it is arbitrary to divide the array into three partitions rather than into a greater or lesser number; and similarly arbitrary is the determination of where to put the dividing point separating the different classes or types. Having drawn the lines one may list certain kinds of activities which are typically found within each of the designated classes of center . . . not all members of a class will contain all the activities listed and most of the communities within a class will contain activities not listed. (This) . . . is not an independently derived basis for a classification of communities by type. Rather it is itself derived from a previous partitioning of an array which appears as something similar to an arrangement of observation that have been made upon a continuous variable."³

The above criticism by leading authors in the field of the Functional Central Place Hierarchy make it obvious at the outset, that a distinct

1. B. J. L. Berry and W. L. Garrison, "The Functional Bases of the Central Place Hierarchy," Economic Geography, 34 (1958) p 145

2. J. E. Brush, "The Hierarchy of Central Places in Southwestern Wisconsin," Geographical Review, 43 (1953) pp 380 - 402

3. I. R. Vining, "A Description of Certain Spatial Aspects of an Economic System," Economic Development and Cultural Change, 3 (1955) pp 167 - 169

grouping will not occur on the basis of urban commercial meter ranking, however, although not distinct, a grouping may occur.

Two methods of computing a hierarchy will be used in this chapter with the results compared. Two assumptions are made at the outset. First it is assumed that the functional measure of a center is the most reliable, and secondly that the urban commercial meters found in a center are an accurate measure of the functions of that center. The two graphical methods of determining the hierarchy are:

(1) Plotting the urban commercial meters in each center of the survey area on the rank position of that center based on its urban commercial meters.

(2) Plotting the kwhr. consumption of electrical power for each center on its urban commercial meters in a scatter diagram.

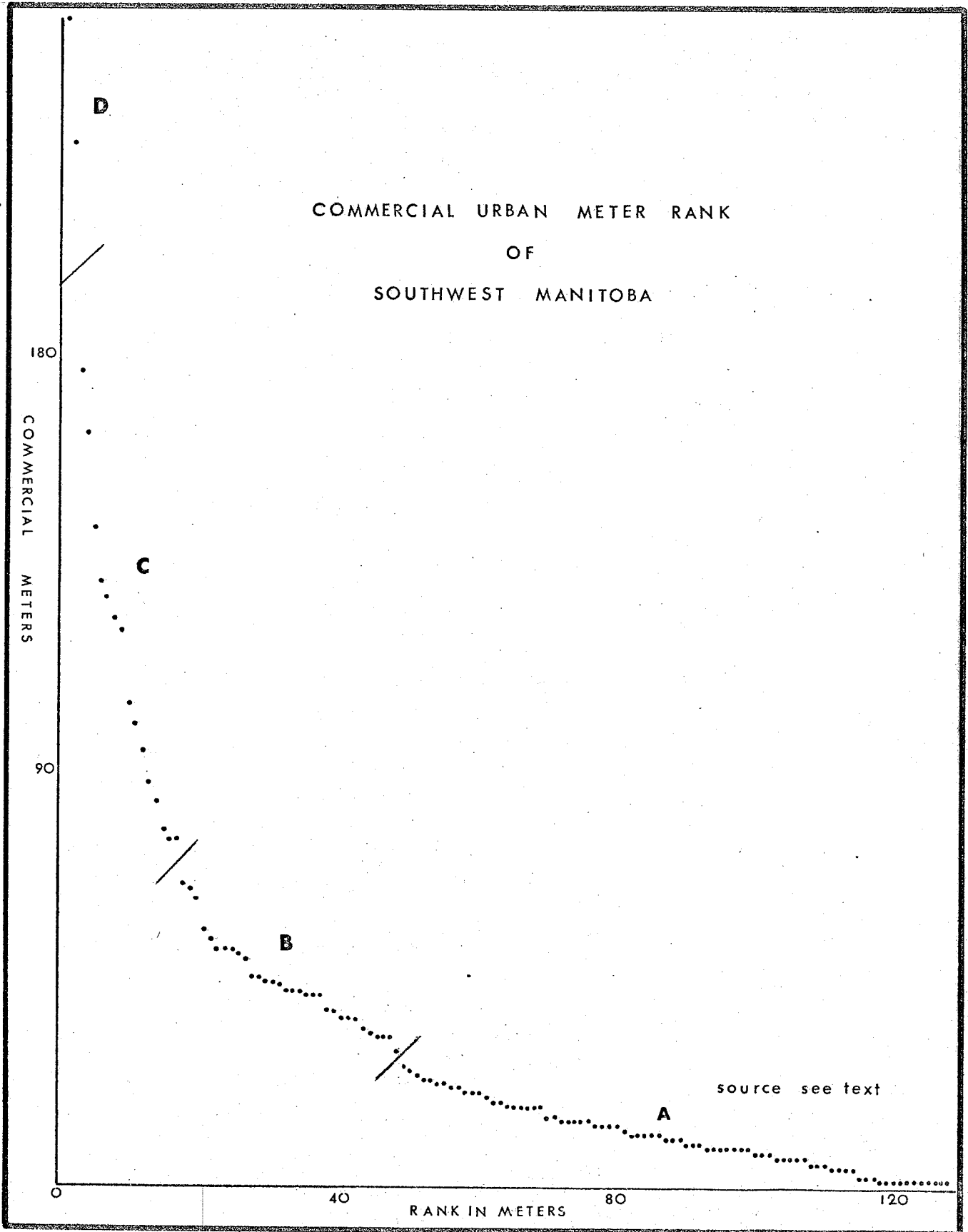
A. Graphing Urban Commercial Meters On Rank

The information on the graph (Figure 10) consists of the number of urban meters recorded to each center along the X axis while the Y axis consists of the rank of that center as compared to all other centers in the survey area with respect to their urban commercial meters.

Two criteria were used to formulate a hierarchy of groups along the progression line of centers in Figure 10. P. J. Clark's definition of a group, "as a collection of points in which every individual is closer to some member of the collection than to any individual outside of it"⁴ was used to justify the classification. The second criteria was the

4. P. J. Clark, " Grouping in Spatial Distributions", Science, 123 (1956) pp 373 - 374

FIGURE 10



visual " line of best fit " with respect to members of each group, revealing a marked change in gradient of regression line for each group.

The break between group A and B was made at the first major break point in the continuum of points, (Figure 10) as one moved along the X axis towards zero. The increase along the Y axis till this point, had always been 1 unit except for one case where an increase of 2 units occurred, At the selected break point the increase along Y axis was a 3 unit increase followed by a second 3 unit increase yielding a marked division..

The break point between group B and C reflected a marked gradient change. The unit increase is 1 to 4 units except for the break point. The last three centers in group B appear to be midway between group B and C. These three centers with urban commercial meters of 62, 64, 65 were included in group B because of P. J. Clark's ⁵ group definition.

The division between group C and D was placed between the central place having 176 urban commercial meters and the center with 225 urban commercial meters.

The remaining two groups consisted of 3 centers. Group D has the two centers with 225 and 252 urban commercial meters while group E ⁶, not appearing on the graph, has 1110 urban commercial meters.

B. Scatter Diagram

The second method of formulating a hierarchy was the construction of

5. Ibid., p 374

6. Group E consists only of Brandon which has been omitted from (Figure 10) in order to make graphing easier. Its existence as a separate group is self evident as the commercial urban meter break between group D and E is 858 units.

a scatter diagram (Figure II) where urban commercial meters were plotted on Kwhr. consumption to determine if a clustering of points emerged. Again Clark's ⁷ criterion of a group where every member of the group should be closer to some other member of the group than to any other point was used. The urban commercial meters represented the number of functional units within the center. The kwhr. consumption along the X axis measured the amount of electricity consumed by all electrical power users within the center plus the electrical power consumed by the rural users. The kwhr. consumption for a center in a non industrial area serves as an economic yardstick as more prosperous centers will possess more electrical appliances and machines which will be reflected in the electrical power consumed by a center.

The Product Moment Correlation Coefficient (r) for urban commercial meters on kwhr. consumption was (r) = .944. This high correlation indicates that the commercial urban meters in a center is determined to a large degree by the kwhr. consumption of the center and its surrounding hinterland.

The scatter diagram yielded four groupings (Figure II). The formation of the groups was based on Clark's criterion for a group. The clustering was most noticeable in group A and group B where a high correlation between meters and kwhr. consumption is found. Of greater

7. P. J. Clark, op. cit. pp 373 - 374

FIGURE 11

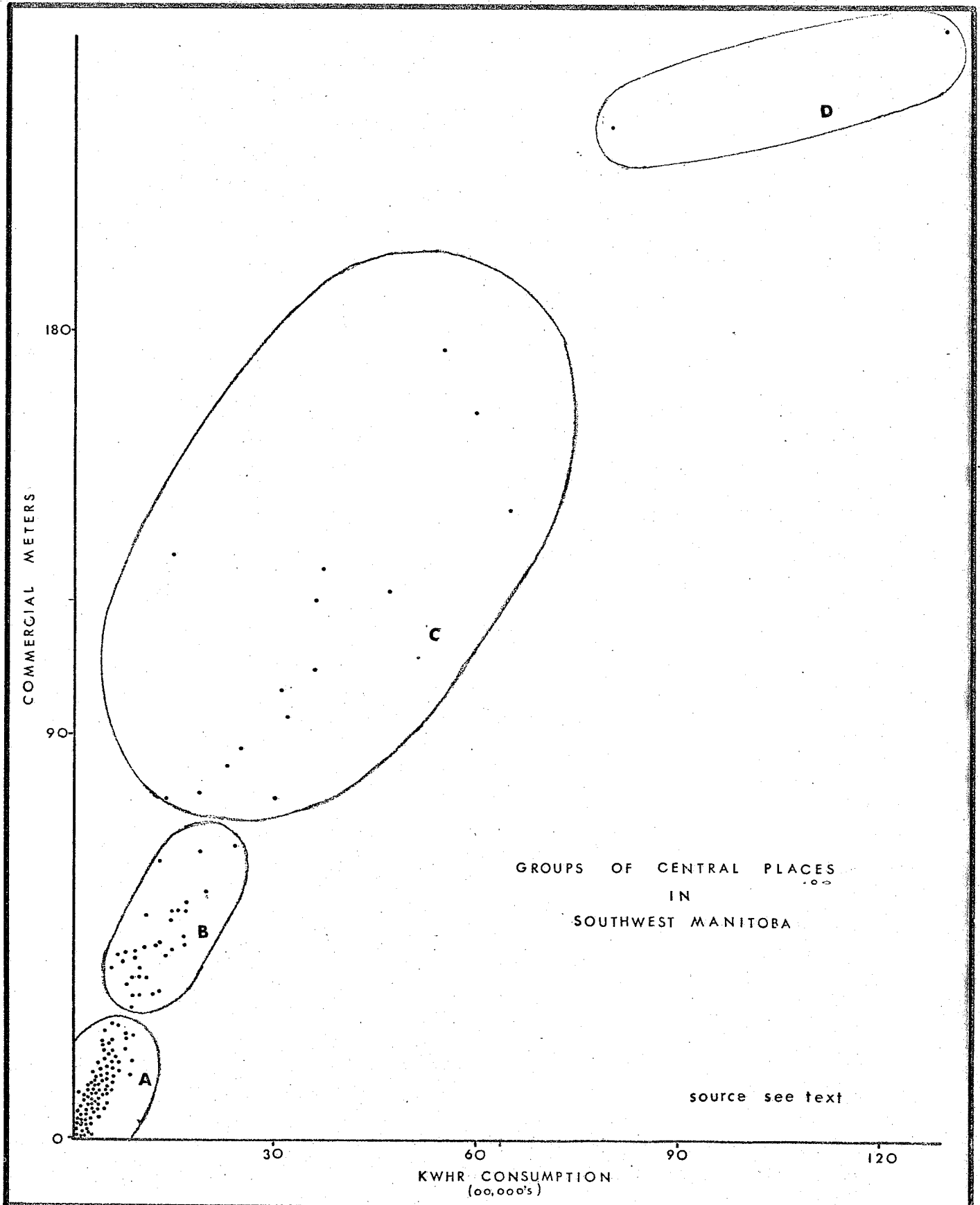


TABLE V

Central Place Hierarchy Based on Ranking of Urban
Commercial Electrical Power Meters

Group	Range of U.C. Meters	Number of Centers
A	I to 26	96 ^I
B	29 to 65	33
C	75 to 176	15
D	225 to 252	2
E	III0	I

I. The graph in Figure 10 shows only 82 centers, however an additional 14 centers were omitted because of non availability of Data. They form however part of group A.

TABLE VI

Central Place Hierarchy Based on Scatter Diagram using
Urban Commercial Meters and Kwhr. Consumption

Group	Range of Urban Commercial Meters	Range of Kwhr. Consumption	Number of Centers
A	I - 26	63,977 - 1,047,640	96 ¹
B	29 - 65	652,623 - 2,436,305	33
C	75 - 176	1,445,694 - 6,078,373	15
D	225 - 252	8,043,854 - 12,928,601	2
E ²	IIII0		1

1. The scatter diagram shows only 82 centers, however an additional 14 centers were omitted because of non availability of data. They form however part of group A.

2. Group E includes only Brandon, not included in Figure II

significance to this study however was the fact that the members of each group as determined by the scatter diagram were exactly the same as the members in each group formed in the ranking of centers on the number of urban commercial meters they possessed. (Tables V and VI)

C. Services Found Within the Electrical Power Data Hierarchy Groups

Having formulated the Central Place Hierarchy on the bases of the electrical power data (Table VI), it follows that an investigation of the type of services offered by each group of the 5 groups in the hierarchy must be undertaken. If the Electrical Power Data Hierarchy is to be accepted as a valid measure of centrality, proof of its validity should be obvious in the types of services offered by each group.

The method employed was first to place each center in Southwest Manitoba in its proper group according to electrical power classification. This was followed by selecting a number of services hereafter referred to as selected services and recording the following information to each center in the survey area,

- a. The number of each selected service offered by a center.
- b. If more than one service was offered from the one business premises, what the other services were.

The services attributed to each center in Appendix D, do not include the

8. For detailed information on the selected services found within each center see Appendix D.

complete range of central services offered by the center, but rather include only the selected services chosen on the bases of the availability of data for all centers in the survey area.

The second stage was to compile the information in Appendix D into more manageable figures. The results of this calculation (Table VII) was the following information, on Group bases, for each of the selected services.

- a. The percentage of the centers in a Group offering a particular selected service. This was calculated by finding the number of centers providing a selected service in a Group, and converting this to percent, based on the number of centers in the Group. This figure is not affected by the number of that particular service within a center, only if the service is offered by the center.
- b. The percentage of selected services which were offered in conjunction with one or more other services from the same business premises. This was calculated by finding the number of shared services in one of the selected services, for a particular Group, and converting this figure to percent based on the total number of that particular service in the Group.

EXAMPLE

Number of centers in Group C	=	15
Number of General Stores in Group C	=	34
Number of General Stores offering additional services	=	5

TABLE VII

The Selected Services Found in Each Group
of the Electrical Power Data Hierarchy

Service	Group A ¹			Group B			Group C			Group D			Group E		
	I %	2 %	3	I %	2 %	3	I %	2 %	3	I %	2 %	3	I %	2 %	3
Post Office ²	98		I	100		I	100		I	100			100 ³		
General Store	95	4	3	91	7	5	100	15	5	50			100		I
Grain Elevator	92		3	100		5	100		4	100		2	100		6
Elementary Schools ⁴	72		I	100		I	100		I	100			100		
Garage	47	37	3	88	57	5	100	60	5	100	100	3	100	55 ⁵	9
High School	32		I	88		I	100		I	100		2	100		4
Implements	28	65	3	91	56	5	100	51	7	100	21	7	100		9
Restaurant	25	19	I	97	19	3	100	9	9	100	17	9	100		33
Service Station	22	38	3	67	41	5	73	40	5	100	45	6	100	15	26
Telephone Exchange	22		I	88		I	100		I	100		I	100		I
Hardware	21	29	2	67	33	3	100	31	4	100	50	2	100	40	5
Grocery Store	18	38	I	58	74	2	93	56	4	100	18	6	100		40
Auto Dealer	12	80	I	67	89	3	100	61	6	100	60	5	100	45	9
Blacksmith	9	12	I	48	6	I	73	22	2	100		I	100		2
Billiard Parlour	7	16	I	64	22	2	100	11	2	100	33	2	100		2
Lumber Yard	6	60	I	64	65	2	87	51	4	100	33	2	100	25	8
Fuel Dealer	6	60	I	36	69	2	53	56	5	100	67	2	100	16	8
Road Contractor	6	40	I	39		4	33		2	50		I	100		6
Auto Repair	6	40	I	15		I	33		I	50	25	4	100	14	7

TABLE VII (continued)

Service	Group A			Group B			Group C			Group D			Group E		
	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)
Trucking	5	25	I	45	6	2	100	17	3	100	20	II	100	16	18
Confectionery	2	50	I	15	60	I	13	100	I	50	50	I	100	45	9
Repair	2		I	3	100	I	7		I				100		I
Carpenter	2		I	3	100	I	13		I				100		20
Electrical Contractor	2	100	I	18		I	60	8	2	100	33	4	100		6
Plumber	2	50	I	9	67	I	67	75	2	100	100	4	100	64	II
Radio and Television	II	100	I	12		I	60		2	100		I	100		7
Appliances	I		I	9		I	40	25	2	100	67	2	100	100	2
Feed Service	I		I				20	33	I	50		I	100		I
Hotel	I		I	64	9	2	100		2	100		2	100		6
Bakery	I		I	21	14	I	73	14	2	100		I	100		7
Household Furnishing	I		I	3	100	I	33	67	2	100	67	2	100	43	7
Bank	I		I	55		I	100		2	100		2	100		6
Drug Store				45		I	100		3	100		3	100		8
Food Locker				36	69	2	100	73	I	100	50	I	100		I
Hospital				21		I	87		I	100		I	100		2
Roofing and Sheet Metal				18	14	2	20	67	I	100	33	2	100		7
Building Contractor				15		2	53	18	2	100		2	100		14
Shoe Repair				15		I	40	14	2	100	33	2	100		2
Printing and Publishing				15	20	I	67	70	I	100	100	I	100		6
Motel				12	60	2	20		2	100		2	100		6
Women's Wear				12		I	53	22	2	100		2	100		8
Jewelry				12		I	80		2	100		3	100		6
Family Clothing				9		I	47	18	3	100		2	100		4
Bowling				9	100	I	33	60	I	100		I	100		2

TABLE VII (CONTINUED)

Service	Group A			Group B			Group C			Group D			Group E		
	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)
Shoe Store				9	33	I	33	20	I	100	33	2	100		2
Creamery				9		2	27		I	100		I	100		I
Mortician				6	50	I	40	33	I	100		I	100		2
Men's Wear				6		I	33	33	I	100	57	2	100		4
Seed Cleaning				3		I	33	40	I				P ⁶		
Flour Mill				3	100	I	7		I				P		
Heating and Tinsmith				3		I	73	83	2	100	100	2	100	22	9
Millinery				3		I	13		I				100		3
Newspaper				3	100	I	80	58	I	100	100	I	100		I
Sporting Goods				3	100	I	13	50	I				100		4
Florist				3	100	I				50		I	100	33	3
Dry Cleaning							40		I	100		2	100		5
Photography							33		2	100		I	100		4
Children's Wear							27	50	I	P			100		2
Dry Goods							27	50	I	100		I	100		I
General Merchandise							20		I				100		I
Hatchery							20		2	50		I	100		5
Tires							13		2	100	3	2	100	17	6
Egg Grading							13		I				100		2
Variety Store							13		I	100	50	I	100		I
Woodworking							13		I	100		I	100		I
Children's Shoes							7		I				100		I
Dairy and Poultry							7		I				100		3
Paints							7		I				100		4
Stationary							7		I				100		2

TABLE VII (Continued)

Service	Group A (1)			Group B			Group C			Group D			Group E		
	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)
Poultry Packing							7		I				100		2
Equipment Rental							7	100	I				100		I
Excavation Contractor							7		I	100		I	100	14	7
Painting and Decorating							7		I	100	33	3	100	33	3
Greenhouse							7		I				P		
Upholstery							7		I				P		
Gift Shop							7		I				P		
Well Digging										50		I	P		
Chartered Bus										50		I	P		
Crop Dusting										50		I			
Auto Parts										100	67	2	100		4
Tobacco Wholesale										50		I	100		I
Monuments										50		2	100		2
Wholesale Fruit										50		3	100		I
Department Store										50		2	100		4
Canvass Products										50		I	100		I
Storage										50	100	I	100		2
Farm Supplies										50		I	P		
Machine Shop										50		I	100	67	3
Signs										50		I	100		I
Meat Packing										50		I	100		2
Taxi										100	33	2	100		2
Oil Field Contractor										50	33	3	100		I
Boy's Wear										50	100	I	P		
Boat Repairs										50	100	I	100		I

TABLE VII (Continued)

[illegible]

TABLE VII (continued)

[illegible]

TABLE VII (Continued)

Service	Group A			Group B			Group C			Group D			Group E		
	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)	(1) %	(2) %	(3)
Shoe Manufacturing													100		I
Detergents													100		I
Used Cars													100		I
Motor Carrier													100		I
Business Machines													100		I
Washing Machine Repairs													100		I
Fish and Butcher Supplies													100		I
Used Furniture													100		I
Novelty Store													100		I
College													100		I

1. Groups A, B, C, D, and E have been divided into columns. Column (1) gives the percentage of centers in that group offering the particular service. Column (2) gives the percentage of the businesses in the group offering an additional service from the same premises. Column (3) is the maximum number of that particular service any one center in the group offers.

2. Post offices information for Column (2) was not available.

3. In Group E there is only one center causing column (1) to always equal 100%.

4. Information on the maximum number of elementary schools in Groups D and E was not readily available.

5. In Group E the 55% means that there are 9 garages in Group E of which 55% of them offer additional services.

6. The letter P denotes that service is offered in the Group, but other information was not obtained.

Source : See Appendix D

$$\text{Percentage of shared General Stores} = \frac{5}{34} \times 100 = 15\% \quad 9$$

- c. The maximum number of a selected service to be found in any one center in a particular group was recorded.

EXAMPLE

RESTAURANT as found in Table VII, Group A.

The maximum number of restaurants to be found in any one center in Group A is 1

Certain facts must be considered when viewing the results found in Table VII. The use of percent as an indicator of the amount of the centers within a group offering a particular service must be viewed in respect to the number of centers within the Group. Realizing this limitation the percent term is meaningful for Groups A, B, and C, however for Groups D and E the term percent is meaningless. Regardless of this limitation percentage was found to be the best method allowing comparison from one Group to another.

The three columns of information as recorded on Table VII were selected on the grounds of utilitarian value. The first column recording, "The Percentage of the Group Offering the Selected Service," reveals the degree of importance of that service to the Group and permits comparison

9. The percentage has been rounded off to the nearest 1%

of changes in importance of a service from one Group to the next. Column 2 records, "The Percent of the Selected Service being Shared." This information was included to find if the tendency for a service to be shared in the same premises changed from one Group to the next, or if rather certain services regardless of their Group encouraged sharing. The final column, "Maximum Number of a Selected Service in a Group," was included to determine if the number of a particular service were inclined to increase with higher order groups. The information was set up in a manner which would allow for comparisons.

The increase in specialization of services (Table VII) from Group A through to Group E supports the premise that the Electrical Power Data Hierarchy is an accurate method of determining the Central Place Hierarchy. All the services found in Group A are also found in Group B, plus Group B offers additional and more specialized services. The same was found true for Group C which offered in addition to the services found in Groups A and B, additional specialized services. Although Group D offers additional specialized services ~~above Group C~~, it does not offer the complete array of services found in Group C. This discrepancy may be due to the fact that only 2 centers in the survey area have been placed in Group D, however, if the survey area had been expanded, peripheral centers like Dauphin and Portage la Prairie would have fallen into this Group, and their influence would definitely be reflected in the services. The only center in Group E, Brandon, offers not only the services of Group D but the highly specialized services for

the area. This increase in specialization within the hierarchy supports the validity of the Electrical Power Data Hierarchy.

Another major observation made from Table VII was a general increase from Group to Group in the percentage of centers offering each selected service. In the case of grocery stores, 18% of the centers in Group A support a grocery store, 58% of Group B, 93% of Group C, 100% of Group D, and 100% of Group E. Increase such as this is the rule rather than the exception for the selected services. This increase is evidence, through its consistency, of the reliability of the Electrical Data Hierarchy.

The results obtained from the "Percentage of the Selected Services Being Shared," appears to indicate that certain services are inclined to be offered in a group of 2 or more from the same business premises. Certain of these sharing type services tend to decrease in their tendency to share as they move into higher Groups in the hierarchy. For example in Group A, 65% of all the implement services offer an additional service, 56% in Group B, 51% in Group C, 21% in Group D, and 0% in Group E. Similar declines appear for restaurants, auto dealers, lumberyards, household furnishings and other services to a lesser degree. This trend can be interpreted as evidence of a higher degree of specialization from one Group to the next. There are other cases where the percentage of shared services remains relatively constant from one group to the next, while others are haphazard with no pattern,

or shows a general increase. The type of service being considered determines its own pattern. Consequently the implication appears to be that shared services are not affected to any significant degree by the Group they belong to, although many services appear to show a decline in the importance of sharing from Group A through to Group E.

There is a general increase of maximum number of a selected service from Group A through to Group E. The newer and more specialized services found in a Group, and which were not found in the preceding group, tend to have a maximum number of 1, in a few cases 2, in rare cases 3, and in one case for the entire survey area, 5. Although this is partially due to the fact that there are fewer centers in the Group offering the service and naturally less chance of a larger number of the service in a center, it is indicative of the fact that the service has entered a Group for the first time, while in the next Group its maximum number increases revealing the establishment of the service within the hierarchy.

To be more specific, the services found in each of the 5 Groups of the hierarchy were placed in one of 3 classes depending on the percentage of centers in the Group offering the service.

- a. Class 1; Major Selected Service: To be included in this class 75% - 100% of the centers within the Group had to offer the service.
- b. Class 2; Common Variable Selected Service; 25% to 74% of the centers in a Group offer the service.
- c. Class 3; Uncommon Variable Selected Service; under 25% of the centers in a Group offer the service.

This method was used to make the hierarchy more meaningful by listing in the Major Selected Services, those services which best depict the particular Group. A study was made at the same time to determine the changes in class from one Group to the next.

The findings (Table VIII) indicate that each Group in the Electrical Power Data Hierarchy has a number of typical services which one would expect to find in all central places within the Group. These typical services have been classed as " Major Selected Services". The number of services in this class increases in number as one moves upward through the Groups from A to E. Except for the General Store in Group D, all major services found within the Major Selected Services of the preceeding Group. The increase in specialization of services as illustrated in the Major Selected Services is evidence of the existance in reality of a Central Place Hierarchy.

As one advances through the hierarchy from Group to Group additional services are added to each class. For example in Group B, class I has added to it all services found in the "Common Variable Selected Services" of Group A. The general rule is for the additional services found within a class of a new Group to come from the lower percentage class in the preceding Group. There are a few services such as telephone exchange of Group A, food locker, hospital, jewellery and newspaper of Group C which moved up two classes from Class 3 to Class I from the preceding Group.

Table VIII (a)

Major and Variable Selected Services
In Each Group

GROUP A

Major Selected Services	Common Variable Selected Services	Uncommon Variable Selected Services
-------------------------	-----------------------------------	-------------------------------------

Class I	Class 2	Class 3
Post Office	Garage	Service Station
General Store	High School	Telephone Exchange
Grain Elevator	Implement	Hardware
Elementary School ^I	Restaurant	Grocery Store
		Auto Dealer
		Blacksmith
		Billiard Room
		Lumberyard
		Fuel dealer
		Road Contractor
		Auto Repair
		Meat
		Confectionery
		Repair
		Carpenter
		Electrical Contractor
		Plumber
		Radio and T.V.
		Appliances
		Feed Service
		Hotel
		Bakery
		Household Furnishings
		Bank

I. Elementary schools have been included in Class I although only 72% of the centers contain elementary schools. This low percentage is due to the Manitoba government's policy of encouraging consolidation of rural schools.

Table VIII (b)

Group B

Class I	Class 2	Class 3
S ² Post Office	u Service Station	S Auto Repair
S General Store	u Hardware	S Confectionery
S Grain Elevator	u Grocery	S Repair
S Elementary School	u Auto Dealer	S Carpenter
S Garage	u Blacksmith	S Electrical Contractor
C ³ High School	u Billiard Room	S Plumber
C Implement	u Lumberyard	S Radio and T.V.
C Restaurant	u Fuel dealer	S Appliances
u ⁴ Telephone Exchange	u Road Contractor	S Bakery
	u Trucking	S Household Furnishings
	u Meat	Hospital
	u Hotel	Roofing and Sheet Metal
	u Bank	Building Contractor
	⁵ Drug Store	Shoe Repair
	Food Locker	Printing and Publishing
		Motel
		Women's Wear
		Jewellery
		Family Clothing
		Bowling
		Shoe Store
		Creamery
		Mortician
		Men's Wear
		Seed Cleaning
		Flourmill
		Heating & Tinsmith
		Millinery
		Newspaper
		Sporting Goods
		Florist

2. The S in front of a service indicates that service was in the same class in the previous Group.

3. The C in front of a service indicates in the previous Group that service was classed as a " Common Variable Selected Service ".

4. The u in front of a service indicates in the previous Group that service was classed as an " Uncommon Variable Selected Service ".

5. No letter indicates the service appears for the first time in a Group.

Table VIII (c)

Group C

Class 1	Class 2	Class 3
S Post Office	S Service Station	S Confectionery
S General Store	S Blacksmith	S Repair
S Grain Elevator	S Fuel Dealer	S Carpenter
S Elementary School	S Road Contractor	S Feed Service
S Garage	S Auto Repair	S Roofing and Sheet Metal
S High School	u Electrical Contractor	S Motel
S Implement	u Plumber	S Flourmill
S Restaurant	u Radio and T. V.	S Millinery
S Telephone Exchange	u Appliances	S Sporting Goods
C Hardware	u Bakery	General Merchandise
C Grocery	u Household Furnishings	Hatchery
C Auto dealer	u Building Contractor	Tires
C Billiard Room	u Shoe Repair	Egg grading
C Lumberyard	u Women's Wear	Variety
C Trucking	u Family Clothing	Woodworking
C Meat	u Bowling	Children's shoes
C Hotel	u Shoe Store	Dairy and Poultry
C Bank	u Creamery	Paints
C Drug Store	u Mortician	Stationery
C Food Locker	u Men's wear	Poultry Packing
u Hospital	u Seed Cleaning	Equipment Rental
u Jewellery	u Heating and Tinsmith	Excavation Contractor
u Newspaper	Dry Cleaning	Painting and Decorating
	Photography	Greenhouse
	Children's Wear	Upholstery
	Dry Goods	Gift Shop

Table VIII (d)

Group D⁶

Class I	Class I	Class I
S Post Office	C Blacksmith	u Variety Store
General Store ⁷	C Fuel Dealer	u Woodworking
S Grain Elevator	C Electrical contractor	u Excavation contractor
S Elementary School	C Plumber	u Painting and Decorating
S Garage	C Radio and T. V.	u Auto Parts
S High School	C Appliances	u Taxi
S Implements	C Bakery	
S Restaurant	C Household Furnishings	
S Telephone Exchange	C Building contractor	
S Hardware	C Shoe Repair	
S Grocery Store	C Women's wear	
S Auto dealer	C Family Clothing	
S Billiard Room	C Bowling	
S Lumberyard	C Shoe Store	
S Trucking	C Creamery	
S Meat	C Mortician	
S Hotel	C Men's Wear	
S Bank	C Heating and Tinsmith	
S Drug store	C Dry Cleaning	
S Food locker	C Photography	
S Hospital	C Dry Goods	
S Jewellery	u Roofing and Sheet Metal	
S Newspaper	u Motel	
C Service Station	u Tires	

Group E⁸

6. Group D includes only the " Major Selected Services ", where both centers in the Group offered the service. The percentage division is meaningless for this Group.

7. The General Store is unique in that it is the first and only major service to fall from the Major Service Class once it was placed in the class.

8. Group E has not been included in the table as Table VII contains the complete listing of all the services.

The Electrical Power Data Hierarchy has been proven to be a firm base upon which a Central Place Hierarchy can be formed. Statistical evidence through graphs (Figures IO and II) reveals that a hierarchy does indeed exist in reality if electrical data is used as the measure of centrality of a central place. Further substantiating evidence of the ~~existence~~ of the hierarchy have been illustrated through a study of selected services for all the Groups in the hierarchy. In conclusion the entire hierarchy has been made more meaningful by determining what has been referred to as " Major Selected Services " to demonstrate how each Group differs from its preceeding Group.

Chapter 5

Population and Space Relationships as applied to the Electrical Power Data Hierarchy

Two final areas of investigation are studied in this chapter as further checks on the validity of the Electrical Power Data Hierarchy. The first investigation is to study the relationship between urban commercial electric meters and population, and kwhr. consumption and population for the survey area. The correlations found to exist are compared to a similar correlation study of H. A. Stafford.¹ The second study is concerned with applying P. J. Clarke's and F. C. Evans' ² formula of determining randomness, to each group in the Electrical Power Data Hierarchy.

A Population Relationship

"That a positive relationship exists between functions performed and population size is generally assumed."³ The method of determining this relationship for the survey area was by calculating the coefficient of correlation.⁴ The urban commercial meters and the kwhr. consumption of a center were each used as the method of measuring the functions of a center. Two separate methods of measuring the population of a center

1. H. A. Stafford, "The Functional Bases of Small Towns," Economic Geography, 39 (1963) pp 165-175.

Dr. Stafford has calculated the coefficient of correlation between functions and population for southern Illinois, Berry and Garrison's Snohomish County in Washington, King's comparative study of the Canterbury Provincial District of New Zealand, and Thomas' study of the functional bases for small Iowa towns.

2. P. J. Clarke and F. C. Evans, "Distance to the Nearest Neighbour as a measure of Spatial Relationship in Population, Ecology, 35 (1954) pp 445-453

3. H. A. Stafford, op.cit., p 168

4. The method of calculating the coefficient of correlation is found in Appendix B.

were also used. The main method was to use D. B. S. reports to determine 1961 population figures. This measure of population did not provide population size for many small ~~unincorporated~~ centers, and despite the supplementary use of Dun and Bradstreet for population figures, 33 centers in the survey area were without a population figure. (Table III) Consequently population figures (Table III) of 25 and 50 persons are estimated as no data was available, and for computer correlations a numerical value is necessary. The second method of measuring population was by the Domestic Electric Meters⁵ recorded to a center. This figure has the advantage of being available for the small centers, includes not only the center itself but also the hinterland around the center, and represents the number of family units in the center rather than the number of people, which is possibly a better measure of the population necessary to support specific functions.

The Product Moment Correlation Coefficient for H. A. Stafford's⁶ Illinois study between population size and number of functional establishments⁷ was found to be $(r) = .929$. Similarly high correlations were found to exist for the other survey areas studied by H. A. Stafford.⁸

5. The Domestic Electric Meters of a center measure the number of homes, apartments and trailers where energy used for commercial uses does not include 250 watts recorded to a center. For more detail see Chapter II.

6. H. A. Stafford, op. cit., p 169

7. Functional establishments as defined by H. A. Stafford measured the number of establishments from which services were offered, (ie) if an establishment offered a combined food store and service station it was classed as only one establishment.

8. H. A. Stafford, op.cit., pp 165 - 175

The correlation coefficient between urban commercial meters and population size in Southwest Manitoba was found to be $(r) = .958$, while the coefficient of r for kwhr. consumption and population for Southwest Manitoba was $(r) = .947$. The similarity in high correlations indicates that a close relationship exists between population and functions of a center, regardless of the method used to measure the functions of a center whether it be by field work or using electrical power data.

The Product Moment Correlation Coefficient between Domestic Meters, as a measure of population, and both kwhr. consumption and urban commercial meters were calculated. The coefficient (r) for kwhr. consumption and domestic meters for Southwest Manitoba was $(r) = .938$ while coefficient (r) for urban commercial meters and domestic meters in the same area was $(r) = .975$. These correlations were found to be very similar to coefficients between population and electrical power data, and population and functions in both the survey area and in H. A. Stafford's⁹ study area. This appears to indicate not only the validity of electrical power data as a means of measuring the functions of a center or its centrality, but domestic meters can serve as a relatively reliable measure of population size of a center.

To be more meaningful the range of population size found to exist within each group of the Electrical Power Data Hierarchy and the average size of each group was found. (Table IX). A similar comparison was made (Table X) for the Domestic Meters for each group.

9. Ibid, pp 165 - 175

Table IX
Population Size of the Electrical Power
Data Hierarchy

Group	Population Range	Average Population
A	5 - 289	78.8
B	171 - 779	383.7
C	529 - 2211	1137
D	2708 - 3197	2952.5
E	28166	28166

Table X
Domestic Meter in the Electrical Power Data Hierarchy

Group	Domestic Meter Range	Average Number of Domestic Meters
A	3 - 95	26.3
B	59 - 296	133.5
C	174 - 680	400.2
D	958 - 1015	986.5
E	7656	7656

B. Space Relationship of the Groups

P. J. Clarke and F. C. Evans¹⁰ measurement of distribution is used to test the validity of the results of the Electrical Power Data Groups.

10. P. J. Clarke and F. C. Evans, *op. cit.*, pp 445 - 453
For more detailed information on how this method is applicable to South-west Manitoba see Chapter III, sub section C

It is assumed that the type of pattern emerging for each group should approach the "regular" pattern which would occur in a perfect central place pattern. If the pattern emerging for each group shows no signs of regularity then the Electrical Power Data Hierarchy would be invalid.

¹¹
The formula applied as the measure is;

$$R_1 = \frac{r A}{.5 \left(\frac{N}{A} \right)} - \frac{1}{2}$$

where:

$r A$ = the means of the straight line distance to the nearest neighbour, dealing only with members of that particular group.

A = the area of the survey

N = the number of central places in the group

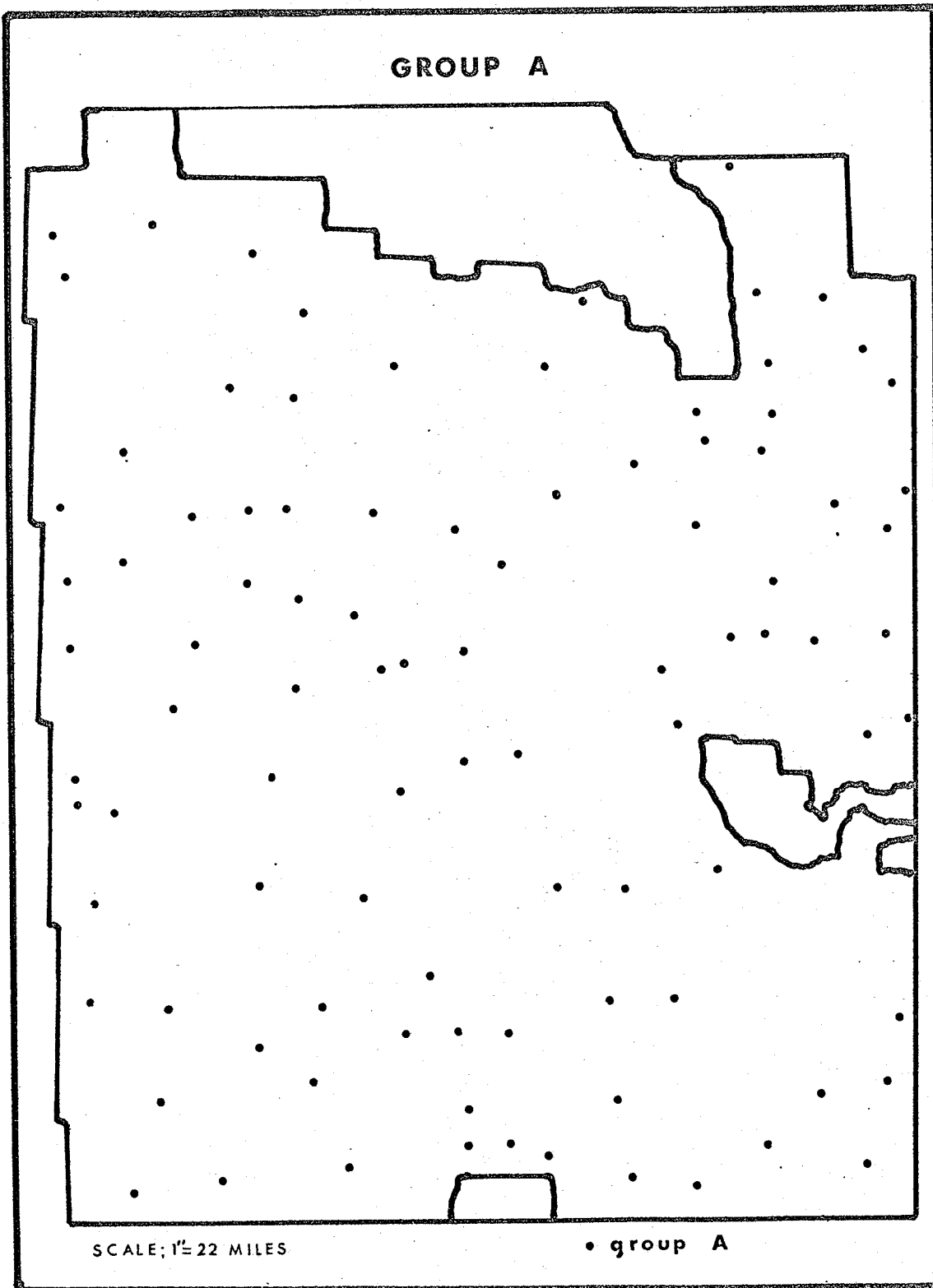
The equation was applied to the 96 members of Group A giving the following results:

$$R_1 = \frac{2.35}{.5 \left(\frac{96}{1161} \right)} - \frac{1}{2}$$

$$R_1 = 1.3$$

R_1 indicates the degree to which the centers in Group A depart from the random distribution. An R_1 of 1.3 indicates a pattern that is more regular than random. A visual impression (Figure 12) reflects the emergence of a pattern in Group A.

FIGURE 12



Group B gave the following value for R_1 -

$$R_1 = \frac{3.6}{.5 \left(\frac{33}{1166} \right)} - \frac{1}{2}$$

$$R_1 = 1.21$$

The results although not as high as Group A are still greater than a random distribution which appears when $R_1 = 1$. The results reflect a more regular than random distribution. The distribution of the centers in Group A are illustrated in Figure 13.

Group C results were:

$$R_1 = \frac{6.1}{.5 \left(\frac{15}{1161} \right)} - \frac{1}{2}$$

$$R_1 = 1.39$$

The results from Group C gave the highest value for R_1 reflecting the greatest tendency towards a regular pattern. This has been empirically demonstrated in Figure 14.

The calculations were not done for Groups D and E as Group D only has 2 centers while Group E contains only Brandon. The distribution of these 3 centers appears in Figure 14.

The patterns of distribution that emerged in Groups A, B and C where R_1 equaled 1.3, 1.21 and 1.39 are all indicative of a distribution which is more regular than random. It is worth noting that the R_1

FIGURE 13

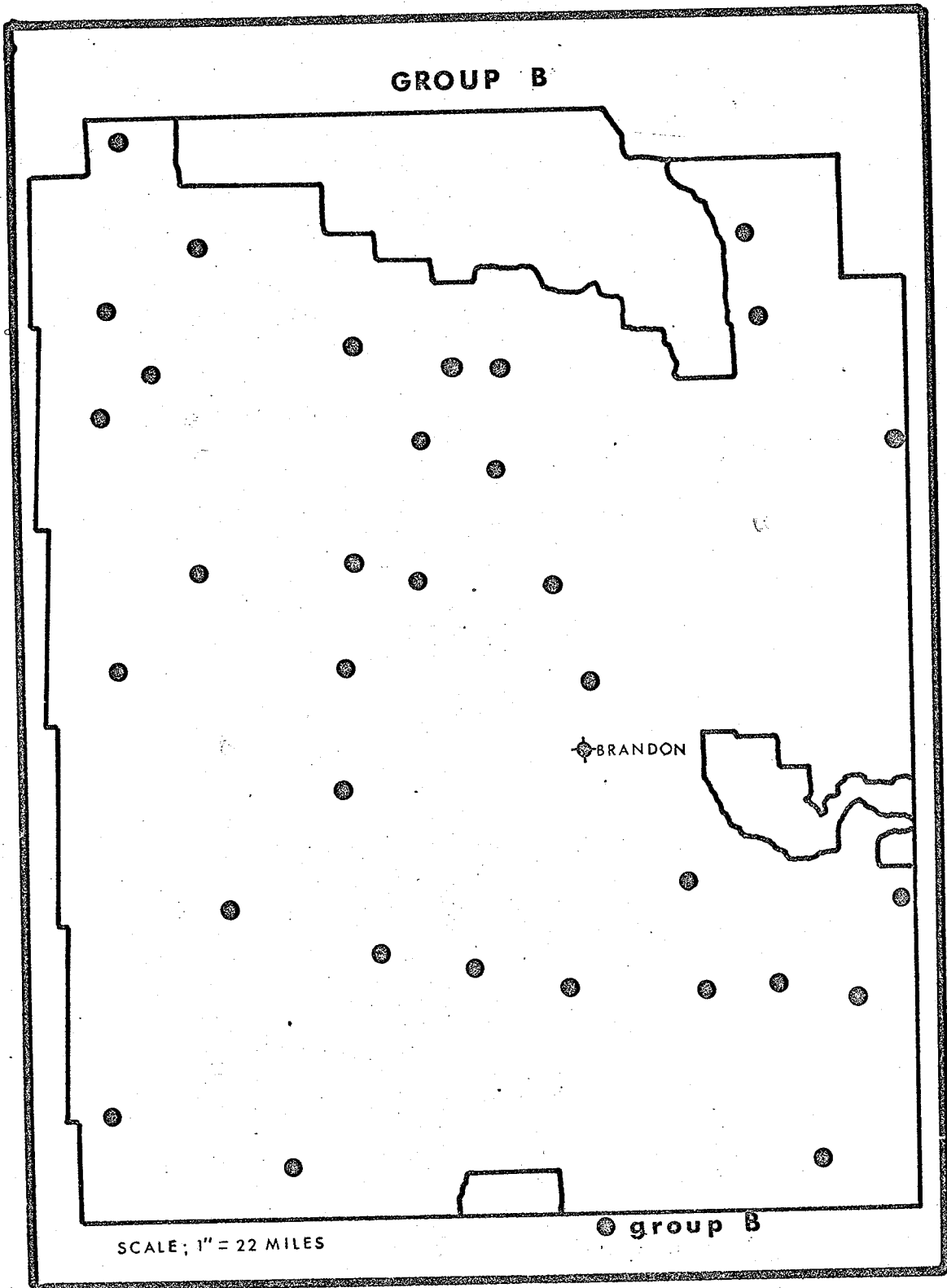
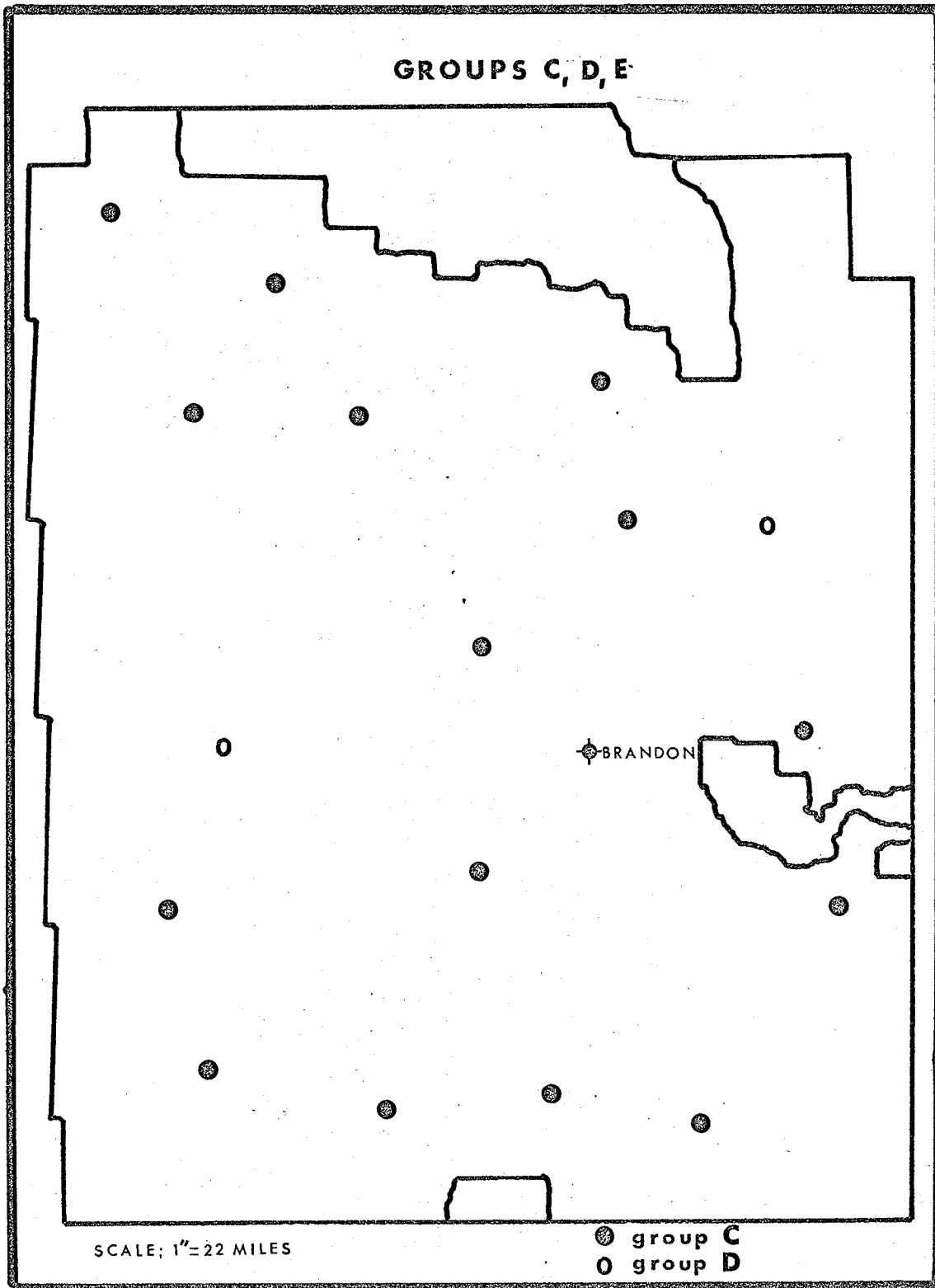


FIGURE 14



value for all the central places in Southwest Manitoba is 1.4. A value greater than 1 indicates the distribution is neither agglomerated or random but is more regular. If the theoretical distribution emerged where each center had 6 equal distance neighbours the value for R_1 would be 2.1491. Southwest Manitoba is not a perfectly uniform plain and transportation patterns have caused a linear arrangement of settlement patterns. The fact that the values of R_1 for each of the three groups corresponds closely to the value for the entire survey area would appear to indicate that the centers in each of the Electrical Power Data Hierarchy groups are relatively equally spaced in Southwest Manitoba.

The population and distribution of centers in the survey area appear to support the Central Place Hierarchy formed on the bases of Electrical Power Data. The Electrical Power Data Hierarchy was determined on the bases of urban commercial meters in a center and the kwhr. consumption of the center with its hinterland. The high correlation found to exist between kwhr. consumption and population, plus urban commercial meters and population, reveals a close relationship between electrical power data and population. The fact that H. A. Stafford¹² found similarly high correlations between functions of a center and population further substantiates the Electrical Power Data Hierarchy as a measure of the centrality or functions of a center. When the distribution of the centers in Groups A, B, and C were measured for randomness it was found the spatial distribution of the members within each group corresponded to the pattern for the area as a whole. The distribution

12. Ibid, pp 445 - 453

in all cases was that of a pattern more regular than random approaching the perfectly regular pattern that would emerge if the theoretical Central Place Hierarchy existed.

Conclusion

The main conclusions drawn from this study follow from its objective and relate to; (1) urban commercial meters of a center as a measure of its functional attributes (2) kwhr. consumption as a measure of centrality (3) the significance of the Electrical Power Data Hierarchy when applied to Southwest Manitoba (4) domestic meters as a measure of a center's population for central Place Studies.

A. Urban commercial meters of a center as a measure of its functional attributes

The urban commercial meters recorded to a center were found to be a very reliable measure of its functions. The relative ease of determining the number of services offered by a center through total urban commercial meters, indicated this method is a valid contribution to central place studies. However, when assessing the value of urban commercial meters as a measure of centrality, one is really assessing the functional index of centrality.

The major limitations of the functional index are in measuring the hinterland and size of economic activities within the center, both being important in considering centrality. The urban commercial meters of a center serve as a measure of the services within the center and do not measure the size of the hinterland. A corner store and a supermarket, although their economic importance differs greatly, will each be represented by 1 urban commercial meter. These limitations have been a problem in the functional measure of centrality.

There exists a unique limitation created by urban commercial meters as a measure of the functions of a center. Information as to the total number of urban commercial meters in a center is readily available, however, there is no indication as to what these commercial services are. This limits use of the urban commercial meters to preliminary work of determining the hierarchy as a base for further investigation.

The method of determining the number of functions in a center by its urban commercial meters has definite advantages. (1) Information is readily available in D. B. S. reports on the number of urban commercial meters in each center in Canada. (2) The number of urban commercial meters as recorded by Manitoba Hydro is available for small centers and is an extremely reliable measure of the functions of the centers. (3) The data is published yearly reflecting changes in the number of services offered by a center. The above contributions are worth consideration in a central place study.

B. Kwhr. Consumption as a Measure of Centrality

The kwhr. consumption of a center for a year can serve as a measure of centrality. When kwhr. consumption is considered in respect to the nine requirements found necessary of an index of centrality (Chapter 1) for the Prairies, the following results;

- (1) Kwhr. consumption is a measure of the tertiary services of a center, as generally tertiary services require electricity. The total consumption of electricity of a center will reflect tertiary activities. The kwhr. consumption of a center can

be broken down into domestic, commercial, industrial and farm electrical power used. The commercial kwhr. electrical power used would correspond closely to tertiary activities.

- (2) Kwhr. consumption reflects the population of a center. This is especially true in smaller centers where residential power users contribute greatly to the total consumption. The close correlation (Chapter V) found between kwhrs. consumption and population in the survey area supports the value of the index.
- (3) Kwhr. consumption reduces all the diverse elements of the center to the common denominator kwhr.
- (4) The variation in economic importance when considering one type of service is reflected to a certain degree in kwhr. consumption. ie. a supermarket would consume more kwhr. per year than a corner store.
- (5) Information on kwhrs. consumed by a center is available for large and small centers. Of the 196 centers studied in the two survey areas, kwhr. consumption data was available for 189 centers. The other 7 centers although listed on a road map had no elevator, post office nor a Dun and Bradstreet report on any services.
- (6) The kwhr. consumption for a center includes a category referred to as farm or rural users. The farmers in 1961 had freedom to select where they would pay their hydro bill and have their kwhr. consumption recorded. Assuming the farmer selects the center he frequents the most, this category can serve as a

measure of the hinterland of a center.

- (7) Although there is no supporting evidence, in the opinion of the author, kwhr. consumption on the Prairies is not affected to any appreciable amount by social or religious factors as far as this study is concerned.
- (8) The data is readily available through reports published both monthly and yearly by the Manitoba Hydro. This allows considerable freedom in selection of a survey area to carry out a Central Place Study.
- (9) The final requirement implies a central place grouping should emerge if the data is applied to a survey area.

A discussion on this point will be considered later.

The including of domestic, commercial, industrial and rural kwhr. consumption for a center in one figure created the major problem. The data can be broken down into the four categories but with great difficulty. For this particular study the total kwhr. consumed by the 4 classifications combined was used in determining the hierarchy, however in certain areas heavy industrial users of electricity might deem it necessary to remove industrial consumption from the total figure.

C. The significance of the Electrical Power Data when applied to Southwest Manitoba.

Two accepted statistical techniques to determine if a grouping would occur in the Electrical Power Data Hierarchy in Southwest Manitoba gave positive results. The first method of ranking the number of urban commercial meters on a graph resulted in 5 groups emerging. The second method

used a scatter diagram in which urban commercial meters for a center were plotted on its kwhr. consumption for 1961. The results gave 5 groups. The important factor however was that both methods not only gave the 5 groups but each of the 147 centers in the survey area fell into the same group regardless of which of the two methods of determining the hierarchy was used.

The selected services found to exist in each of the five groups substantiated the validity of the hierarchy. The higher order groups were found to offer not only those services found in the lower groups but also additional and more specialized services. It was also found that the percentage of centers in a group offering a selected service increased with the order of groups. Results such as these are expected of a Central Place Hierarchy.

The spatial relationship found to exist among the centers of each group were favourable to the study. Realizing the survey area is not the perfect uniform plain one cannot expect the perfect distribution of centers to emerge. The distribution of the centers of each group was found to be similar to the distribution of all the centers of the survey area.

D. Domestic Meters as a Measure of a centers population for Central Place Studies

Electrical power data was found to offer further contributions to a Central Place Study. The relationship existing between centrality and population has been found to vary from area to area. A possible reason for the variation is due to varying family sizes. Preliminary investigation

between domestic meters or family units recorded to a center and the centrality of a center as determined by Urban Commercial Meters and kwhr. consumption indicate possibilities of a new measure of population for Central Place Studies. The total domestic meters for a center are more accessible than populations of centers. Another consideration is possibly a closer relationship between additional family units and new services than between an increase in population and new services.

The Electrical Power Data is worthy of consideration as a measure of centrality. If this study has indicated that a valid hierarchy can be determined through use of Electrical Power Data it has achieved its purpose.

SELECT BIBLIOGRAPHY

- Anderson, J., Change in a Central Place System: Trade Centres and Rural Service in Central Alberta, unpublished thesis, University of Alberta, March, 1967, 196 pp.
- Berry, B. J. L., "Geography of Market Centres and Retail Distribution, Prentice - Hall Inc., Englewood Cliffe, N. J., 1967, 146 pp.
- Berry, B. J. L., and W. L. Garrison, "The Functional Bases of the Central Place Hierarchy," Economic Geography, 34 (1959) pp. 145 - 154
- "A Note on Central Place Theory and the Range of a Good," Economic Geography, 34 (1958) pp 304 - 311
- Berry, B. J. L. and A. Pred, Central Place Studies: A Bibliography of Theory and Application, Bibliography Series, Number One with Supplement, Regional Science Research Institute, Philadelphia, 1965, 202 pp.
- Birch, B. P., The Measurement of Dispersed Patterns of Settlement, Tijdschrift Voor Econ. En Soc. Geografie, 58 (1967) pp 68 - 75
- Brush, J. E. "The Hierarchy of Central Places in Southwestern Wisconsin," Geographical Review, 43 (1953) No. 3, pp. 380-402
- Canada, Dominion Bureau of Statistics, Census of Canada, 1961, Vol. 1 Part 1, Ottawa, 1963
- Canada, Dominion Bureau of Statistics, Electric and Gas Meter Registration, No. 57 - 201 (1961)
- Carruthers, I. "A Classification of Service Centers in England and Wales," Geographical Journal, 123 (1957) pp. 380- 404
- Chittick, D. "Growth and Decline of South Dakota Trade Centers, 1901 - 51," South Dakota State College Agricultural Experimental Station Bulletin, 448, May 1955
- Christaller, W. Die Zentralen Orte in Sueddeutschland, Jena: Gustav Fischer Verlag 1933. (Translated As Central Places in Southern Germany, by C. W. Baskin, 1966, 230 pp.)
- Clark, P. J. "Grouping in Spatial Distribution," Science, 123 (1956) pp. 373 - 374
- Clarke P. J. and F. C. Evans, "Distance to Nearest Neighbour as a Measure of Spatial Relationship in Population," Ecology, 35 (1954) pp. 445-453
- Dun and Bradstreet of Canada, Ltd., Reference Book, July 1961

- Economic Research Corporation of Montreal Toronto Ltd., Economic Survey of Southwest Manitoba, 1961, 160 pp.
- Gardiner, A. G., "The Electrical Power Industry of Manitoba: An Economic Analysis", unpublished M. A. thesis, University of Manitoba, 1963, 177 pp.
- Green, F. W. H., "Urban Hinterland in England and Wales: An Analysis of Bus Services," Geographical Journal, 96 (1950) pp 64 - 81
- Green H. L., "Hinterland Boundaries of New York and Boston in Southern New England," Economic Geography, 31 (1955) pp. 283 - 300
- Hodge, J. F. G., The Prediction of Trade Center Viability in the Great Plains, unpublished Ph.D. thesis, Massachusetts Institute of Technology, February, 1965, 307 pp.
- Jones, G. I. H., Postal Revenue as an Index of Centrality, A paper presented at the Annual Meeting, Canadian Association of Geographers, Vancouver, May 29, 1965, 14 pp.
- Manitoba Hydro, Comparative Statement of Metered Kwhrs. sold in 1961
- Nystuen, J. D., and M. F. Dacey, "A Graph Theory Interpretation of Nodal Regions," Papers and Proceedings of the Regional Science Association, 7 (1961) pp 29 - 42
- Saskatchewan, Royal Commission on Agriculture and Rural Life, Report No. 12 Service Centres, Regina, 1957, 154 pp.
- Siddall, W. R. Wholesale - Retail Trade Ratio as Indices of Urban Centrality Economic Geography, 37 (1961), pp 124 - 132
- Smailes, A. E., "The Urban Hierarchy in England and Wales," Geography, 29 (1944), pp. 41-51
- Snedecor G. W. and W. G. Cochran, Statistical Methods, Iowa State University Press, Ames 1966, 593 pp.
- Sosa, T. G., Service Centre Study of the Interlake Region, Manitoba, unpublished M. A. thesis, University of Manitoba, April, 1964
- Stafford, H. A. J. "The Functional Bases of Small Towns," Economic Geography 39 (1963) pp. 165 - 175
- Trewartha, G. T., "The Unincorporated Hamlet: an Analysis of Data Sources," Rural Sociology, 6 (1941), pp. 35 - 42

- Trewartha, G. T. "The Unincorporated Hamlet: One Element in the American Settlement Fabric," Annals, Association of American Geographers, 33 (1943) pp. 32 - 81
- Ullman, E., "A Theory of Location of Cities," American Journal of Sociology, 46 (1941) pp. 835 - 64
- Vining, I. R., "A Description of Certain Spatial Aspects of an Economic System," Economic Development and Cultural Change, 3 (1955), pp. 147 - 195
- Woroby, P., Functional Relationship between Farm Population and Service Centers in S. W. Saskatchewan, unpublished M. Sc. thesis, University of Manitoba, 1957 pp. 231
- Department of Industry and Commerce, Province of Manitoba, Map of Southwest Area, 1967

APPENDIX A

CORRELATION AND REGRESSION ANALYSES

The Product Moment Correlation Coefficient (r) is "an index that reflects the degree to which changes in direction (+ or -) and magnitude in one set of data are associated with comparable changes in the other set." ¹

"The possible values of this coefficient lie between +1 and -1, the former indicating that the two sets of data vary in the same direction and by the same amount on all occasions, while the latter indicates that although the amount of variation is always the same the direction of that variation is always opposite." ²

The nearer (r) approaches +1 or - 1, the closer the correlation. The formula used to find the coefficient (r) is ; ³

$$r = \frac{\sum xy}{\sqrt{\sum x^2 \cdot \sum y^2}}$$

WHERE

$$x = x - \bar{x}$$

$$y = y - \bar{y}$$

"This correlation coefficient (r) may more conveniently be expressed as a coefficient of determination (r^2). This expresses, as a percentage, the proportion of the variance in one set of data that is "determined" by the other set." ⁴

The Student's Test was applied to find the significance of (r).

The formula used is ; ⁵

-
1. S. Gregory, Statistical Methods and the Geographers, London, 1963 p.167
 2. Ibid, p p 169 - 170
 3. G. W. Snedecor, Statistical Methods, Iowa, 1966, pp 167 - 168
 4. J. Anderson, Change in a Central Place: Trade Centres and Rural Service in Central Alberta, unpublished M.A. thesis, University of Alberta, Edmonton, p 190
 5. G. W. Snedecor, op. cit. p 141

$$b = \frac{\sum xy}{\sum x^2}$$

$$\sum dy \cdot x^2 = \sum y^2 - (\sum xy)^2$$

$$S_y \cdot x^2 = \frac{\sum dy \cdot x^2}{n-2}$$

$$S_b^2 = \frac{S_y \cdot x^2}{\sum x^2}$$

$$t = \frac{b}{S_b}$$

The value found for (t) is related with the "Degrees of Freedom" to "The Distribution of (t) Table" ⁶ This gives the percent probability that (r) could have occurred by chance. The degrees of freedom are two less than the number of occurrences of the sample area calculated by $n - 2$ where n equals the number of occurrences.

The " regression line " ⁷ is calculated after the correlation coefficient is determined. This provides on a graph a line representing the relationship between the two sets of data. The regression line is calculated by using the following formulas:

Determine the means:

$$\bar{x} = \frac{\sum x}{N}$$

$$\bar{y} = \frac{\sum y}{N}$$

Find the gradient of the regression line through the means:

$$b = \frac{\sum xy}{\sum x^2}$$

Transpose the gradient onto the data graph where $\hat{Y}$ is an estimation

$$\hat{y} = b x$$

⁶ Ibid. p 46

⁷ S. Gregory, op. cit. p 185

Locating the regression line from the formula

$$\hat{y} = (\bar{y} - b\bar{x}) + bx$$

APPENDIX B

Computer Program for Correlation and Regression Line

```

DIMENSION X(200,10),XBAR(10),S(10),V(100),R(60),B(10),D(10),T(10)
M=8
WRITE(6,5)
5 FORMAT('1'//)
WRITE(6,4)
4 FORMAT(' TOWN CODE      POWER      TOTAL SERVICES      RANGE OF SERVICES
1      POPULATION      DOMESTIC      COMMERCIAL      URBAN COMMERCIAL      PO
2WER ')
DO 2 I=1,200
READ(5,3)L,(X(I,J),J=1,M)
3 FORMAT(13,F9.3,2F4.0,F6.0,3F5.0,F4.0)
IF(L)12,13,12
12 WRITE(6,9)L,(X(I,J),J=1,M)
9 FORMAT(5H0TOWN/(17,F14.3,F11.0,F18.0,F20.0,F12.0,F13.0,F17.0,F14.0
1))
X(I,8)=X(I,5)+X(I,6)+X(I,8)
2 X(I,9)=X(I,5)+X(I,6)
13 N=I-1
M=M+1
WRITE(6,5)
DO 10 I=1,M
XBAR(I)=0.0
S(I)=0.0
DO 11 J=1,N
XBAR(I)=XBAR(I)+X(J,I)
11 S(I)=S(I)+X(J,I)**2
XBAR(I)=XBAR(I)/N
10 S(I)=SQRT(S(I)/N-XBAR(I)**2)
WRITE(6,6)(XBAR(J),J=1,M)
6 FORMAT(6H0MEANS/(8F15.2))
WRITE(6,7)(S(J),J=1,M)
7 FORMAT(20H0STANDARD DEVIATIONS/(8F15.2))
WRITE(6,5)
DO 15 I=1,M
DO 15 J=1,N
15 X(J,I)=X(J,I)-XBAR(I)
DO 16 I=1,M
DO 17 J=1,M
V(J)=0.0
D(J)=0.0
B(J)=0.0
DO 14 K=1,N
V(J)=V(J)+X(K,I)*X(K,J)
B(J)=B(J)+X(K,I)**2
14 D(J)=D(J)+X(K,J)**2
17 T(J)=V(J)/SQRT(B(J)*D(J))
16 WRITE(6,8)I,(T(J),J=1,M)
8 FORMAT(4H0ROWI3/(10F12.5))
CALL EXIT
END

```

```

    DIMENSION X(200,10),XBAR(10),S(10),V(10),R(4),B(10),D(10),T(10),
    1Z(200,2),STD(2),U(10),Y(121),M1(200)
    M=8
    WRITE(6,5)
5  FORMAT('1'//)
    DO 2 I=1,200
        READ(5,3)L,(X(I,J),J=1,M)
3  FORMAT(I3,F9.3,2F4.0,F6.0,3F5.0,F4.0)
        IF(L)12,13,12
12 WRITE(6,9)L,(X(I,J),J=1,M)
9  FORMAT(5H0TOWNI4/(F21.3,F11.0,F13.0,F20.0,F12.0,F13.0,F17.0,F14.0
    1))
        X(I,8)=X(I,5)+X(I,6)+X(I,8)
2  X(I,9)=X(I,5)+X(I,6)
13 N=I-1
    M=M+1
    WRITE(6,5)
    J=N
    DO 31 I=1,M
        T(I)=0.0
        S(I)=10000.
        DO 31 L=1,J
            IF(T(I)-X(L,I))32,37,37
32 T(I)=X(L,I)
        GO TO 31
37 IF(X(L,I))31,31,39
39 IF(X(L,I)-S(I))36,31,31
36 S(I)=X(L,I)
31 CONTINUE
        READ(5,41)DOT,BLANK,I1,I2
41 FORMAT(2A1,2I1)
        N=0
        DO 50 I=1,J
            IF(X(I,I1).EQ.0.0.OR.X(I,I2).EQ.0.0)GO TO 50
            N=N+1
            Z(N,1)=X(I,I1)
            Z(N,2)=X(I,I2)
50 CONTINUE
        IF(N-2)53,53,52
52 DO 70 I=1,2
            XBAR(I)=0.0
            STD(I)=0.0
            V(I)=0.0
            D(I)=0.0
            R(I)=0.0
            B(I)=0.0
70 U(I)=0.0
        DO 71 I=1,2
            DO 72 L=1,N
22 XBAR(I)=XBAR(I)+Z(L,I)
71 XBAR(I)=XBAR(I)/N
            DO 73 I=1,2
                DO 73 L=1,N
73 Z(L,I)=Z(L,I)-XBAR(I)
            DO 74 I=1,N
                V(1)=V(1)+Z(I,1)*Z(I,2)
                V(2)=V(2)+Z(I,1)**2
74 R(1)=R(1)+Z(I,2)**2

```

```

      R(2)=V(1)/SQRT(V(2)*R(1))
      WRITE(6,5)
      WRITE(6,51)R(2)
51  FORMAT(' PRODUCT MOMENT CORRELATION COEFFICIENT = ',F7.4//)
      R(4)=V(1)/V(2)
      R(3)=XBAR(2)-R(4)*XBAR(1)
      IF(R(4))56,57,57
56  WRITE(6,58)(R(I),I=3,4)
58  FORMAT(' REGRESSION EQUATION IS      Y = ',F8.2,F8.2,' X'//)
      GO TO 60
57  WRITE(6,59)(R(I),I=3,4)
59  FORMAT(' REGRESSION EQUATION IS      Y = ',F8.2,' +',F8.2,' X'//)
60  CONTINUE
      U(1)=(R(1)-(V(1)**2/V(2)))/(N-2)
      WRITE(6,62)U(1)
62  FORMAT(' MEAN SQUARE DEVIATION FROM REGRESSION = ',F12.4//)
      U(2)=SQRT(U(1))
      WRITE(6,63)U(2)
63  FORMAT(' STANDARD DEVIATION FROM REGRESSION = ',F10.4//)
      N=N-2
      WRITE(6,64)N
64  FORMAT(' DEGREES OF FREEDOM = ',I6//)
      B(1)=U(1)/V(2)
      WRITE(6,65)B(1)
65  FORMAT(' VARIANCE OF DISTRIBUTION = ',F10.4//)
      B(2)=(V(1)/V(2))/(SQRT(U(1)/V(2)))
      WRITE(6,66)B(2)
66  FORMAT(' T VALUE = ',F10.4//)
C.....
C SUBPROGRAM TO PLOT SCATTER DIAGRAM
C FOLLOWING TERMINATION CARD FOR DATA DECK
C COLUMN ONE      *
C COLUMN TWO      (BLANK)
C COLUMN THREE     (HORIZONTAL AXIS - COLUMN OF X ARRAY)
C COLUMN FOUR      (VERTICAL AXIS - COLUMN OF X ARRAY)
      DO 47 N=1,41
47  Y(N)=S(I1)+(N-1)*(T(I1)-S(I1))/40.0
      DO 55 N=1,4
      DO 48 I=1,41
      M1(I)=Y(I)/10.0**(4-N)
48  Y(I)=Y(I)-10.0**(4-N)*M1(I)
      IF(N-1)49,54,49
54  WRITE(6,61)(M1(I),I=1,41)
61  FORMAT('1',I7,40I3)
      GO TO 55
49  WRITE(6,38)(M1(I),I=1,41)
55  CONTINUE
      WRITE(6,35)
35  FORMAT(' .....
1.....
2.....')
      DO 40 L=1,J
      M1(L)=-1
      IF(X(L,I1).EQ.0.0.OR.X(L,I2).EQ.0.0)GO TO 40
      M1(L)=(X(L,I2)-S(I2))/(T(I2)-S(I2))*120.0
40  CONTINUE
      DO 42 L=1,121
      DO 45 I=1,121

```

```

45 Y(I)=BLANK
   I=121-L
   DO 43 K=1,J
     IF(M1(K)-I)43,44,43
44 N=(X(K,I1)-S(I1))/(T(I1)-S(I1))*120.0+1.0
   Y(N)=DOT
43 CONTINUE
   N1=T(I2)-(L-1)*((T(I2)-S(I2))/120.0)
42 WRITE(6,46)N1,(Y(N),N=1,121),N1
46 FORMAT(I6,'.',121A1,'.',I4)
   WRITE(6,35)
   DO 67 N=1,41
67 Y(N)=S(I1)+(N-1)*(T(I1)-S(I1))/40.0
   DO 69 N=1,4
   DO 68 I=1,41
     M1(I)=Y(I)/10.0**(4-N)
68 Y(I)=Y(I)-10.0**(4-N)*M1(I)
69 WRITE(6,38)(M1(I),I=1,41)
38 FORMAT(I8,40I3)

```

```

C.....
   N=J
   DO 10 I=1,M
     XBAR(I)=0.0
     S(I)=0.0
     DO 11 J=1,N
       XBAR(I)=XBAR(I)+X(J,I)
11 S(I)=S(I)+X(J,I)**2
     XBAR(I)=XBAR(I)/N
10 S(I)=SQRT(S(I)/N-XBAR(I)**2)
     DO 15 I=1,M
       DO 15 J=1,N
15 X(J,I)=X(J,I)-XBAR(I)
     DO 16 I=1,M
       DO 17 J=1,M
         V(J)=0.0
         D(J)=0.0
         B(J)=0.0
         DO 14 K=1,N
           V(J)=V(J)+X(K,I)*X(K,J)
           B(J)=B(J)+X(K,I)**2
14 D(J)=D(J)+X(K,J)**2
17 T(J)=V(J)/SQRT(B(J)*D(J))
16 WRITE(6,8)I,(T(J),J=1,M)
   8 FORMAT(4HOPQW13/(10F12.5))
53 CALL EXIT
   END

```

APPENDIX C

THE MEASUREMENT OF DISPERSED PATTERN OF SETTLEMENT

Distance to the nearest neighbour for each of the 147 central places as measured on Figure 7 ($1/6$) = 1)

0.6	1.4	1.7	2.0	2.2	2.5	3.0
0.6	1.4	1.7	2.0	2.2	2.5	3.0
0.8	1.4	1.7	2.0	2.2	2.5	3.0
0.8	1.5	1.7	2.0	2.2	2.5	3.1
0.8	1.5	1.7	2.0	2.2	2.5	3.2
0.8	1.5	1.7	2.0	2.2	2.5	
1.0	1.5	1.7	2.0	2.2	2.5	
1.0	1.5	1.7	2.0	2.2	2.5	
1.0	1.5	1.7	2.0	2.2	2.5	
1.0	1.5	1.8	2.0	2.3	2.5	
1.0	1.5	1.8	2.0	2.3	2.5	
1.0	1.5	1.8	2.0	2.3	2.5	
1.1	1.5	1.8	2.0	2.4	2.5	
1.1	1.6	1.8	2.0	2.4	2.5	
1.1	1.6	1.9	2.1	2.4	2.6	
1.1	1.6	1.9	2.1	2.4	2.6	
1.3	1.6	1.9	2.1	2.4	2.7	
1.3	1.6	1.9	2.1	2.4	2.8	
1.4	1.6	1.9	2.1	2.4	2.8	
1.4	1.6	2.0	2.1	2.5	2.8	
1.4	1.6	2.0	2.1	2.5	2.8	
1.4	1.6	2.0	2.1	2.5	3.0	
1.4	1.7	2.0	2.2	2.5	3.0	

[illegible]

APPENDIX D

QTY	DESCRIPTION	UNIT	PRICE	TOTAL
4	SPORTING GOODS			
1	3 FLORIST			
1	1 HOSPITAL			
2	2 CHILDREN'S WEAR			
1	1 CHILDREN'S SHOES			
3	3 DAIRY AND POULTRY			
4	4 PHOTOGRAPHY			
6	6 TIRES (VULCANIZED)			
4	4 PAINTS			
2	2 STATIONARY			
2	2 EGG GRADING			
5	5 DRY CLEANERS			
1	1 GENERAL MERCHANDISE			
5	5 HATCHERY			
1	1 DRY GOODS			
1	1 VARIETY STORE			
2	2 POULTRY PACKERS			
1	1 WOODWORKING			
1	1 EQUIPMENT RENTAL			
7	7 EXCAVATION CONTRACTOR			
3	3 PAINTING & DECORATING			
2	2 GREENHOUSE			
1	1 UPHOLSTERY			
1	1 GIFT SHOP			
1	1 WELL DIGGING			
1	1 CHARTERED BUS			
1	1 CROP DUSTING			
2	2 AUTO PARTS			
1	1 TOBACCO WHOLESALING			
2	2 MONUMENTS			
3	3 FRUIT WHOLESALING			
2	2 DEPARTMENT STORE			
1	1 CANVAS PRODUCTS			
2	2 STORAGE			
1	1 FARM SUPPLIES			
3	3 MACHINE SHOP			
1	1 SIGNS			
2	2 MEAT PACKERS			
2	2 TAXI			
1	1 OIL FIELD CONSTRUCTION			
1	1 BOY'S WEAR			
1	1 BOAT REPAIR			
1	1 TRAILERS			
1	1 PLUMBING SUPPLIES			
1	1 AVIATION			
1	1 RADIATOR REPAIR			
4	4 WELDING			
3	3 AUTO ACCESSORIES			
1	1 BOAT BUILDING			
2	2 OIL COMPANY			
1	1 ORNAMENTAL IRON			
3	3 AUTO WRECKERS			
3	3 REFRIGERATION SERVICE			
2	2 RETAIL TOBACCO			
1	1 ELECTRIC MOTOR REPAIR			
1	1 LANDSCAPING			
3	3 BOTTLING COMPANY			
2	2 TOURIST CAMP			
1	1 JANITORIAL SERVICE			
2	2 WHEEL ALIGNMENT			
1	1 IRON FOUNDRY			
1	1 MAGAZINES			
3	3 MUSICAL APPLIANCES			
2	2 PLATE GLASS			
1	1 SCRAP IRON			
2	2 WELDING SUPPLIES			
1	1 WOOLEN PRODUCTS			
5	5 WHOLESALE GROCERY			

- W MACHINE SHOP
- - SIGNS
- 2 MEAT PACKERS
- 2 - 0 2 TAXI
- 5 2 - OIL FIELD CONSTRUCTION
- 2 < BOY'S WEAR
- 3 < BOAT REPAIR
- 0 - TRAILERS
- 2 < PLUMBING SUPPLIES
- - AVIATION
- - RADIATOR REPAIR
- 4 WELDING
- W AUTO ACCESSORIES
- BOAT BUILDING
- 2 OIL COMPANY
- ORNAMENTAL IRON
- W AUTO WRECKERS
- W REFRIGERATION SERVICE
- 2 RETAIL TOBACCO
- ELECTRIC MOTOR REPAIR
- LANDSCAPING
- W BOTTLING COMPANY
- 2 TOURIST CAMP
- JANITORIAL SERVICE
- 2 WHEEL ALIGNMENT
- IRON FOUNDRY
- MAGAZINES
- W MUSICAL APPLIANCES
- 2 PLATE GLASS
- SCRAP IRON
- 2 WELDING SUPPLIES
- WOOLEN PRODUCTS
- W WHOLESALE GROCERY
- WHOLESALE + RETAIL PAINT
- TANK COMPANY
- PROPANE
- SCHOOL SUPPLIES
- SAW SHARPENER
- 2 ROOFING
- 4 CONCRETE
- MILL WORKING
- 2 MANUFACTURING FURNITURE
- 2 WATER SOFTENER
- WHOLESALE OF MUSICAL INST.
- WHOLESALE AUTO PARTS
- PUMP REPAIR
- W OPTICAL LENS
- TYPEWRITER REPAIR
- TOYS + HOBBY CRAFT
- 2 DRAPERS
- TRAILER COURT
- OFFICE SUPPLIES
- WHOLESALE + RETAIL SEEDS
- HIDE + FUR
- SEED MAIL ORDER
- WHOLESALE TIRES
- GAS COMPANY
- SHOE MANUFACTURING
- DETERGENTS
- USED AUTO
- MOTOR CARRIER
- BUSINESS MACHINES
- 2 WASHING MACHINE REPAIR
- FISH + BUTCHER SUPPLIES
- USED FURNITURE
- NOVELTY STORE

[illegible]

BROOKDALE	2	2	1	1	2R 51	1	a	3	1		
TILSTON	2	3	1	1	1R 19	1		a	a	1	
GOODLANDS	2	3	1	1	1R 28	1		1		1	1
GAISWALD	1	a	3	1	1	1		1		2	1
CRANDALL	2	1	1	1	2R 31	2	1	1	a	a	1
MATHER	2	2	1	1	1			a	a	1	
BEULAH	1	2	1	1	1R 11	1	1				
SOLSGIRTH	3	2	1	1	1R 17	1					
LYLETON	a	a	2	1	1	3	1	1		1	1
NINGA	a	1	3	1	1					1	1
BASSWOOD	1	3	1	1	1R 24	1	1	1		1	
NESBITT	1	2	1	1	1R 12	2			1		
RIDING MOUNTAIN	2	1	1	1	1	3	a			1	1
CARDALE	1	3	1	1	1R 14	a		a	1	1	1
VISTA	a	2	2	1	1					a	1
NEELIN	1	2	1						1	1	
HOLMFIELD	2	2	1	1	2		1		1	a	b
DECKER	1	2	1	1	abc 3			b	bc 2		
MCDORA	2	2	1	1	1R 21		1	a	a	1	
KEMNAY	1	1	1	1	1	a			a	1	
CROMER	1	1	1	1	a	1	1		a		1
LENORE	1	1	1	1	1R 13	a	1		a	1	1
SINCLAIR	2	2	1	1	1R 21	a	1		a	1	
LAUDER	1	2	1	1	1				a	1	e
MANSON	1	2	1	1	a				a	1	
ISABELLA	1	3	1	1	1R 13	1		b	b	a	1
MARGARET	1	2	1	1	1R 16	a			a	1	
CARROLL	1	2	1	1	1R 12	1					
WELLWOOD	1	1	1	1	2R 26	1					
BIRNIE	2	1	1	1	1						
GLENORA	2	1	1	1	1	1					
JUSTICE	1	1	1	1	2R 24	1		1			
MCCONNELL	1	2	1	1	1				a		
OKNER	1	1	1	1	a	1			a		
HARGRAVE	1	2	1	1	1						
ARROW RIVER	1	1	1	1	1						
SILVERTON	1	3	1	1	1						
HARDING	1	1	1	1	a			a	1		
COULTER	1	1	1	1	1						
FRANKLIN	1	2	1	1	1			a	a	1	
WHEATLANDS	1	1	1	1	1			a		1	a
BRADWARDINE	1	1	1	1	1R 19	a	a		b	b	1
GREENWAY	1	1	1	1	1						
BELLEVUE	1	1	1	1	1				1	1	

SOURCES;

1. The main source was Dun and Bradstreet Reference Books, July, 1961
2. The centers with a post office were obtained from the Federal Post Office in Winnipeg.
3. Information on grain elevators was obtained from the Department of Industry and Commerce.
4. The data on Elementary schools and High Schools was obtained from the Department of Education for the Province of Manitoba.
5. The location of Hospitals was derived from the Manitoba Provincial Exchange Telephone Directory.
6. The location of Telephone Exchanges is supplied by the Manitoba Telephone System.

FOOTNOTES;

A. The centers have been arranged in order of increasing number of commercial hydro meters.

B. ^{ef} 5 means Neepawa has 5 Grocery Stores as indicated by e and f, offer additional same premises. Both grocery stores offer the same vice of meat. This is determined by finding the spaces e and f for Neepawa are found.

