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**A PROPOSED DEMONSTRATION CITY FOR THE
OAHÉ IRRIGATION DEVELOPMENT**

BY

FREDERICK DARYL HEJL

**A thesis submitted
in partial fulfillment of the requirements for the
degree Master of Science, Major in Civil
Engineering, South Dakota
State University**

1967

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**A PROPOSED DEMONSTRATION CITY FOR THE
OAHE IRRIGATION DEVELOPMENT**

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

Thesis Advisor

Date

**Head, Civil Engineering
Department**

Date

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TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION	1
II. HISTORICAL REVIEW OF FARM-VILLAGE DEVELOPMENTS	4
III. BRIEF DESCRIPTION OF OAHE IRRIGATION UNIT	7
IV. SITE LOCATION	8
V. PRELIMINARY PLAN	11
VI. ECONOMICS AND MECHANICS OF PLAN	18
VII. DEFENSE FOR A DEMONSTRATION CITY	22
VIII. OBSERVATIONS AND CONCLUSIONS	24
IX. RECOMMENDATIONS	26
LITERATURE CITED	27

LIST OF FIGURES

Figure		Page
1. Topography of Site	9
2. Preliminary Plan for Demonstration City	14

CHAPTER I

INTRODUCTION

Most of the people in this nation now prefer to live in urbanized areas. The American people are now seeking residence in urban areas in order to increase their income and obtain a higher standard of living. It has been estimated that 85 per cent of our population will be living in metropolitan or urban areas by 1980. This means that a large part of our population will be residing on a congested five per cent of the total land area. This imbalance in population and land area is a problem worthy of serious consideration at state and federal levels.

Federal, state, and local governments have recognized this trend and have foreseen some of the problems associated with it. Studies are now being conducted on existing urban developments to solve the present problems and to seek solutions for future difficulties. Studies of demonstration cities are now in progress for the purpose of upgrading the planning and design for these metropolitan complexes. These demonstration cities are to reflect significant improvements in urban and metropolitan developments. However, the major emphasis is being placed on a development pattern for an increased population density which in turn complicates planning and development patterns.

It is believed that existing metropolitan development problems may be greatly alleviated by reducing the migration of the agrarian people to the urbanized areas. If we are to reduce the migration of our agrarian population to urban areas, we must provide them with a higher standard of living and an increased earning capacity. It is the purpose of this thesis to make a rational investigation of a demonstration city designed for the purpose of providing the modern farmer with the desirable features normally associated with urbanized development.

The use of a demonstration city was suggested by Professor Hargett of South Dakota State University for the study and development of a higher standard of living for the modern American farmer. The need for a demonstration city for the farmer is emphasized by the revolutionary changes that have been made in farming equipment and farming methods. These changes have greatly reduced the number of man-hours required to produce and harvest a crop, but commensurate changes in farmers' standards of living have not been made.

Such a city would provide the farmer with a centrally located urban community environment. The grouping of farm residences into this type of environment would make possible greater efficiencies in providing community facilities such as schools, water supplies, fire protection, and transportation. Social advantages would occur through less isolation of farm families. Such a city would also decrease the outmigration of the farm population from South Dakota. This would in turn facilitate a reduction in the growing development problems confronting the metropolitan areas in other states.

A logical place for a demonstration city for the modern farmer is an irrigated area such as the Oahe Unit. Modern farming and irrigation practices greatly increase the productivity of the land. By increasing the productivity of the land it will be possible to greatly increase the density of population in the irrigated areas of the Oahe Unit. These large concentrations of farm families will be seeking a higher standard of living. The use of a demonstration city is recommended for pilot study of the development of economical community facilities for the modern farmers in irrigated areas.

CHAPTER II

HISTORICAL REVIEW OF FARM-VILLAGE DEVELOPMENTS

The concept of forming villages for the agrarian population dates back to the Neolithic period (1). In this period man introduced agriculture and, consequently, created a need for protection of the farm families. Families collected into friendly groups and formed villages in which they enjoyed the advantages of mutual protection. Many of the villages were located on sites offering natural protection, whereas other villages were protected by man-made walls or structures. This pattern was followed by many ancient civilizations (2). This was also typical of the feudal estates of medieval Europe (1-33). Strategic sites were sought for permanent fortifications. Within these strongholds the agrarians found protection.

The first cities evolved out of farm-villages. In lower Mesopotamia the people had achieved such increases in productivity that their farms were beginning to support an urban civilization (3). As the urban population obtained new crafts and skills, it created an organizational form which reappeared in many other early cities (4). The ruling or wealthier class had their main residences in the center of the city. The craftsmen and tradesmen encircled the city center. The poorest urbanites and part-time or full-time farmers lived on the city outskirts. Their scattered dwellings finally blended into the open countryside.

Nevertheless, farm-villages more often than not have been the form of settlement and the residence centers for rural and farm families. They were the predominant type of farm settlement in Europe, Asia, Africa, and South America (5). These farm villages prevailed until the Industrial Revolution and the advent of the modern economic system. They still exist today in various forms and stages of development over eastern Europe and Asia (2-435).

In New England this plan of settlement was followed by the North American pioneer (5). During the early development of New England, all families lived in the village before the settlement was scattered to separate farms. Farm families would have their barns and other buildings near their houses with garden plots nearby. Farther away would be the cultivated fields, and still beyond were the pastures and woodlots. This pattern still prevails in some New England villages.

Best known among farm-village settlements today are the Mormon communities. The Mormons were the only early settlers who carried the pattern west (5-184). Other farm-villages include the Mennonite, Rappist, and Dukhobor settlements (6).

The Westward movement was so rapid that there was little opportunity to establish nucleated villages. Village and town centers soon became centers of business more than social groups or residence centers for farm families. Small-scale business enterprises began to accumulate and social distinctions soon developed between town and country people.

The rural community that exists today throughout the United States consists of separate farmsteads and rural villages. This type of community has generally risen where favorable conditions exist. Primarily, the rural community is made possible by free or cheap land and a state of security sufficient to warrant isolated settlements. However, the early settlers were reconciled to the dangers and lived on the large acreage they had acquired. These conditions did not favor the development of farm-villages.

It is thought that the existing dispersion of American farmers precludes any plan for consolidation or densification. However, it is of interest that a centralized plan is considered when farm families are relocated or when new settlements are contemplated. For example, in the Columbia River settlement project a plan of farm layout was proposed which gave small frontages on the highway and greater depths of fields so as to reduce the distance between the farm families (6).

The most outstanding example of the village type of farm settlement in the United States is in an irrigation farming area. Studies conducted twenty years ago on Utah farm-villages revealed that farmers were tending to give up the village pattern of settlement in favor of settlement of open country (6). The almost universal reason given for moving from village to open country was the greater ease and efficiency with which farm operation and management could be carried on. The results of such a study may be reversed today in view of modern mechanization and vehicular movement.

CHAPTER III

BRIEF DESCRIPTION OF OAHE IRRIGATION UNIT

Oahe Unit is located in the northern part of the eastern half of South Dakota. It is divided into two land areas, namely the Lake Plain Area and the Missouri Slope Area. The Lake Plain Area is comprised of irrigable land mainly in Brown and Spink Counties north of Huron. The Missouri Slope Area is mostly in Sully County north of Pierre.

The plan provides for diversion of water from the existing Oahe Reservoir on the Missouri River to the two land areas. It will provide water mainly for irrigation, municipal and industrial use, fish and wildlife development, and recreational uses. It will eventually irrigate 495,000 acres of land and provide a domestic water supply for 23 towns and cities within and adjoined to the Oahe Unit. It will also provide fish and wildlife developments at 29 locations as well as many recreational areas (7).

On January 5, 1965, the landowners in the Lake Plain Area voted to form the first two irrigation districts: the West Brown Irrigation District and the Spink County Irrigation District. The initial stage of development will be located in these two districts. The 190,000 acres to be developed consist of 48,000 acres in the West Brown Irrigation District, 107,000 acres in the Spink County Irrigation District, and 35,000 acres of land outside the Districts (8).

CHAPTER IV

SITE LOCATION

The primary factors affecting the selection of a site for a demonstration city are listed as follows:

1. The existing modes of transportation should be utilized to a maximum.
2. The site should be well drained and the topography suitable for the development of a city.
3. The city should not consume valuable irrigable farm land.
4. The city should be centrally located within the irrigation area.

A tentative site for the proposed city for the farmer of the Oahe Unit is located in northern Spink County. The city would be built along South Dakota Highway 20, 1.2 miles east of Mellette or 6.6 miles west of Brentford. This would place it approximately half way between the cities of Redfield and Aberdeen. (See Figure 1.)

The site would be adequately served by the transportation modes. It is adjacent to South Dakota Highway 20 and only two miles from United States Highway 281. A line of the Chicago-Milwaukee-St. Paul-Pacific Railroad runs within a mile of the site. A short spur would connect the site directly to the main railroad line.

A topographic map of the site indicates it will be well drained and that the topography is suitable for the development of a

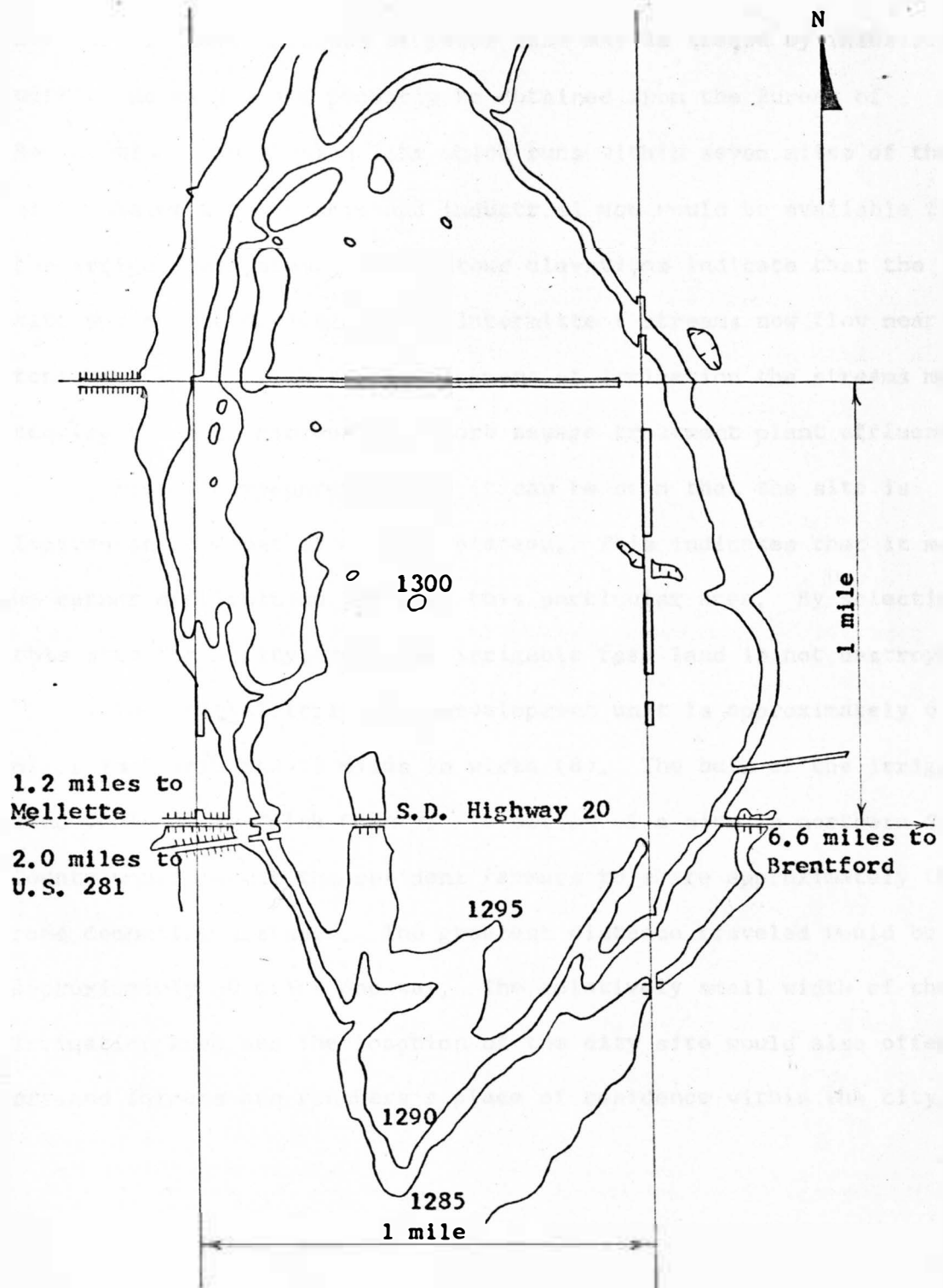


Figure 1.
Topography of Site

city. Public utilities would be easily installed or would be readily available. Large amounts of power that may be needed by industries within the city could probably be obtained from the Bureau of Reclamation transmission line which runs within seven miles of the site. Water for domestic and industrial use would be available from the irrigation system. The contour elevations indicate that the site would also be sewerable. Intermittent streams now flow near the tentative site. With the development of irrigation the streams may acquire flows sufficient to absorb sewage treatment plant effluents.

From the topographic map it can be seen that the site is located on somewhat of a small plateau. This indicates that it may be rather difficult to irrigate this particular area. By selecting this site for a city, valuable irrigable farm land is not destroyed.

The initial irrigation development unit is approximately 66 miles in length and 18 miles in width (8). The bulk of the irrigated land would be in Spink County. Selection of a site in northern Spink County would permit the resident farmers to share approximately the same commuting distance. The greatest distance traveled would be approximately 30 miles one-way. The relatively small width of the irrigation area and the location of the city site would also offer dryland farmers and ranchers a place of residence within the city.

CHAPTER V

PRELIMINARY PLAN

The opportunity to predetermine an optimum population for a demonstration city or farm-village is one of the unique planning features. The optimum population is established by the anticipated economic returns from the irrigated land and the service and industrial functions to be performed by the city. The maximum population is established by determining the number of farm families that can be supported by the farming operations within a given radius of operation. The economy of the demonstration city will then be further strengthened by the service and industrial functions performed by the city.

One of the primary factors to be considered in determining an optimum population for a demonstration city is the school system. The population of the city should be such as to provide an adequate and efficient high school. Elementary school enrollment is not a deciding factor because of the larger enrollment factor. Enrollment factor is the percentage of the total population that is enrolled in school.

According to Conant (9) a high school is of sufficient size if it will release 100 graduates each year. The total enrollment could then be estimated at 300 to 350 students. Assume an enrollment factor of approximately six per cent, which is the factor commonly

used for South Dakota. With the use of these basic planning factors, the population of the demonstration city should be between 5,000 and 6,000.

The commuting distance should have little effect on the minimum size of the city. The farm land should be laid out in a pattern in relation to the number of trips taken by a farmer. The farmer engaged in dairy or livestock enterprises should be given the shortest travel distance. If this pattern is followed, it seems the farmer would be willing to live in the city and travel a distance of approximately 30 miles to a farming or ranching operation.

Consideration was given to the following factors for the preliminary planning of the demonstration city:

1. Traffic movement
2. Residential areas.
3. Central business district
4. Industrial district
5. School locations
6. Recreational facilities
7. Public utilities

The external traffic movement of the city has already been established in the selection of the site. It is the purpose of this section to plan a transportation system within the city in a manner that will enable the system to perform its essential functions with maximum efficiency. In planning for internal traffic movement, the pattern of movement must be worked out in relation to the land-use patterns.

The site selected for the demonstration city covers an area of approximately two square miles or 1,200 acres. This is

considered sufficient area to provide for a city of 5,000 people. Assume an average farm family size of 4.0 people per family. The census (10) figure for this area is slightly higher, but the resident non-farm families will lower this figure. Therefore, the preliminary plan is based on approximately 1,250 families residing in the city.

Residential lots will be of such a size as to be satisfactory to the farm families. A mean lot size of approximately one-half acre is considered adequate for this type of development. Thus, 625 acres would be required for residential lots. Another 30% of residential area or 265 acres will be consumed by streets and right-of-way. This would leave about 310 acres to be used for commercial, industrial, recreational, and school development.

A preliminary diagram of the major street plan and zoning pattern is shown in Figure 2. The major street plan is designed to utilize the existing roadways and minimize the use of additional rights-of-way. With this plan all major traffic is generally in a north-south direction. Intersections with east-west streets occur only at two roadways. The orientation of the street system and the reduction of intersections will permit a more efficient and safer traffic flow.

The preliminary layout of the demonstration city is designed to minimize the commuting distance for the farmers. Zone A residential areas are located along the periphery of the city. This zone is to provide residency for the farm families engaged in full-time farming activities. Farming activities such as dairy farming

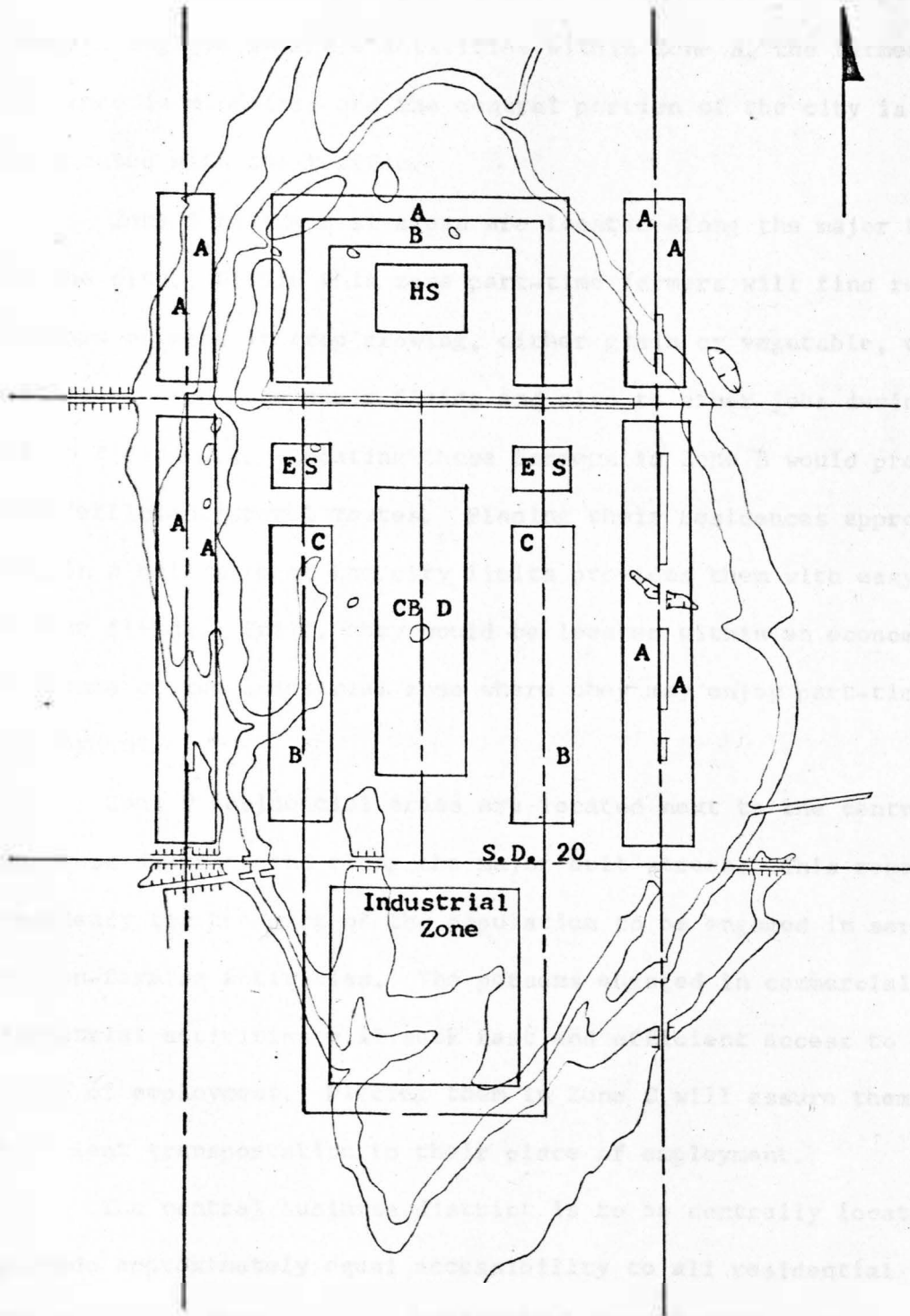


Figure 2.

Preliminary Plan for Demonstration City

and livestock feeding may demand full-time attention. By placing the farmers engaged in these activities within Zone A, the farmer's travel distance is minimized and the central portion of the city is not confronted with the traffic.

Zone B residential areas are located along the major belt street in the city. Within this zone part-time farmers will find residency. Farmers engaged in crop growing, either grain or vegetable, will seek efficient access to their fields and also to other jobs during periods of no field work. Locating these farmers in Zone B would provide them with efficient travel routes. Placing their residences approximately within a half mile of the city limits provides them with easy access to the fields. Still, they would be located within an economical distance of the industrial zone where they may enjoy part-time employment.

Zone C residential areas are located next to the central business district and along the major belt street. This zone provides residency for the part of the population to be engaged in service or non-farming activities. The persons engaged in commercial and industrial activities will seek fast and efficient access to their place of employment. Placing them in Zone C will assure them of efficient transportation to their place of employment.

The central business district is to be centrally located to provide approximately equal accessibility to all residential zones. The maximum distance from a residential area to the central business district is to be approximately one mile. The central business

district is also located so as to provide convenient access to and from the major highways or traffic routes.

The industrial zone is the area of development for industrial, and commercial activities related to agriculture. Farm equipment dealers, potato warehouses, and processing plants, which do not create obnoxious odors, are to be located in this zone to gain three advantages. They would have the benefit of being located adjacent to an existing improved South Dakota Highway 20, thus providing them with an important transportation link. The plants would also be close enough to the residential area to gain the advantage of an adequate labor supply. By separating the industrial zone from the residential zones with Highway 20, the aesthetic features will be protected.

According to the National Park and Planning Commission (11), the maximum service radius for an elementary school is one-half mile and for a high school is one mile. Following this guideline, the preliminary plan of this city indicates the need for two elementary schools. Theoretically, the two schools should be set apart a distance of one mile. This would place one at each end of the city.

However, the high school and the two elementary schools are to be located on the north side of the city. The population density of the city is the greatest in this area. Placing the school zones in this area would minimize the traffic movement.

Adequate recreational facilities are to be provided for the population of this city. Playgrounds for younger children are to be located adjacent to each elementary school to maximize the use

of the school grounds. Likewise, recreational centers for older children and adults are to be incorporated with the high school facilities.

A study of the public utilities serving the city is of extreme importance. City development is limited in many cases by water supply and sewage disposal. The following recommendations are given concerning public utilities.

A report on the Oahe Unit issued by the Bureau of Reclamation (8) states that 17 cities and towns will be provided with a supply of municipal and industrial water. The communities would be required to construct all works to transport the water, treat it, and store it during the nonirrigation season. This demonstration city would be able to obtain its water source from the Unit if the necessary facilities are constructed.

The demonstration city will create two types of sewage wastes, domestic and industrial. The types and amount of wastes will dictate the treatment process. It may be necessary to have processing plants provide their own sewage disposal facilities. Such designs are to be prepared after making a thorough survey of the specific needs for the processing plants.

It should be kept in mind that the preceding paragraphs deal only with a preliminary plan. The preliminary plan reveals the general outline of the city. Further comprehensive investigations are recommended for the detailed design of the demonstration city.

CHAPTER VI

ECONOMICS AND MECHANICS OF PLAN

The primary advantages derived from irrigation in the Oahe Unit are unquestioned. The development of irrigation would broaden the farm income base by stabilizing agricultural production. At the same time, it would provide an opportunity to broaden the overall economic base by increasing the business associated with handling and processing the increased farm products.

Serious consideration should be given to adapting an economy in the Unit that would maximize the economic and social returns. Employment opportunities that provide the Oahe Unit residents with a steady income would yield the greatest economic benefits. Social benefits might be optimized by the establishment of a logical type of land settlement.

The majority of the employment opportunities will be derived from farming of the irrigated land. Employment will be available in the field as well as in industrial and commercial activities. Therefore, careful investigations should be conducted to determine the types of crops that would provide maximum crop yields and maximum employment.

The crops that can be successfully grown in the Oahe area are limited by a relatively short growing season. "Growing season is defined as the period between the last 32° F. temperature in

spring and the first 32° F. temperature in fall." (12). The average growing season in the area of initial development is 135 days (8).

To optimize the use of the erratic length of growing season, a number of crop planting procedures are here proposed. The farming method now practiced under dryland conditions could be retained or two new practices could be tried. Consecutive planting of two crops within a single growing season and planting of cash crops might be feasible. It seems likely that two crops can be grown on the same land in the same growing season. With an average growing season and with the use of commercial fertilizer, the irrigated land should produce a crop yield twice a season. The two crops chosen should be such as to yield a maximum yearly return.

Another plan which may merit thought is the growing of cash crops such as vegetables and sugar beets. Both potatoes and sugar beets have already been proven adaptable to growing under irrigation in this area (12). Other cash crops such as beans, cucumbers, and sweet corn should also be investigated. Larger labor requirements and the lack of moisture have restricted the introduction of truck farming in this area. With the use of irrigation, the growing of these vegetable crops seems feasible.

The establishment of truck farms and the increased production of grain and pasture land would increase the industrial activity of the area. The increased volume of farm products is likely to result in the operation of more agricultural processing facilities within the area. These facilities would probably include meat packing

plants, alfalfa plants, milk processing plants, vegetable canneries, sugar beet processing plants, and potato warehouses (13).

Emphasis should be placed on the introduction of truck farming into the Oahe Unit. Shifting the present agricultural methods to the growing of vegetables and other cannery items, the economy of the area and the state will improve. The larger labor requirements of these crops will create more job opportunities. The Unit and the state would become more self-sustaining in growing these crops.

The large labor requirements in both field and processing plants would create many new opportunities. Depending upon the type of crops or the size of his fields, a farmer could find full-time employment in the fields. He might also seek employment in the processing plants upon the harvesting of the crops. These plants would also provide other members of the farm families with a source of employment.

Food processing plants could be operated at such a scale as to be economically feasible. The plants would provide first for the demands of the Unit and then the state. After satisfying these demands, excess production would be shipped to neighboring areas. The idea is to allow the people of the irrigation area and of the state to be self-sustaining.

Additional job opportunities would also be available in livestock raising, grain farming, and commercial activities. It is estimated that the irrigation of 190,000 acres would provide an opportunity for development of about 500 new farms (8). The majority

of these 500 farm units would require full-time attention. The truck farm units would naturally be seasonal operations. Farm services and other businesses would also create additional employment.

South Dakota, being a highly agricultural state, should adopt a plan to fully utilize its agricultural potential. Only a small amount of the processed food consumed by the people of the state is grown or processed with the state. Meat packing is clearly the dominant sector within processing (14). Most of the other foodstuff bought by consumers is processed, packaged, and labeled in other states. Therefore, it seems that the agricultural methods proposed would be beneficial to the economy of the state.

CHAPTER VII

DEFENSE FOR A DEMONSTRATION CITY

Utilizing the concepts described in the preceding paragraphs, the urbanization of the Oahe Unit seems to be feasible. The establishment of a demonstration city is a logical development pattern in view of current transportation facilities and mechanized farm equipment. It would provide a larger economic base and provide an acceptable standard of living for the farm families. This would, in turn, decrease the outmigration of the farm families and reduce the growing development problems of metropolitan complexes.

The income of the farm families would be raised by providing adequate job opportunities. Farm families would obtain employment as full-time or part-time farmers. Supplementary employment would be provided by processing plants located near the residential area.

The concept of a demonstration city as a residential area for farmers would make possible greater efficiencies in providing community facilities and social advantages. An urban environment would provide the farm families with improved water supply, sanitary facilities, and fire protection. Social advantages would occur through less isolation of the farm families.

Probably the biggest advantage of an urban environment for the farm families would be the improvement of school transportation. The cost of transporting children to school would be reduced

tremendously. With such a demonstration city, the farmer would be commuting to the fields for a few months during the summer instead of his children commuting to school for a period of nine months during the winter.

Farmers and ranchers near Winner, South Dakota, have already recognized the need for improvement of school transportation. They have seen the advantages of living near school facilities. Approximately 35 ranchers have built homes within the city to allow their children to live near the schools and to enjoy the convenience of urban living.

South Dakota has suffered a continual decrease in farm population and, consequently, a decrease in total population. Many farmers would stay on farms if assured of adequate income and a higher standard of living. A demonstration city such as proposed in this thesis is needed as a pilot study as a rational method for the improvement of agricultural development in South Dakota.

CHAPTER VIII

OBSERVATIONS AND CONCLUSIONS

1. The current outmigration of farm families from South Dakota warrants attention.
2. The radius of operation of the modern American farmer has been greatly increased by modern farming equipment and the current facilities for transportation. He is no longer required to live in the immediate vicinity of his farming operation.
3. The source of labor for industrial operations is provided in part by the reduction in man-hours required for modern farming operations.
4. Additional industry is needed in South Dakota to decrease outmigration and improve the economy.
5. The need is apparent for upgrading community facilities and the standard of living for the agrarian people in South Dakota.
6. Many farm families are now supplementing their income with part-time jobs in the nearby cities or towns.
7. Ranchers are now seeking residence in towns and cities in order to simplify the problem of providing school facilities for their children.
8. The development of farm-villages is not a new concept in planning and development. Many of the advantages of farm-village development are reflected in the review of literature.

9. The existing conditions in South Dakota favor a farm-village type of development.
10. A pilot study of a demonstration city is needed for further refinements in the planning and developing of farm-villages for the agrarian people in South Dakota.

CHAPTER IX

RECOMMENDATIONS

1. Studies should be conducted regarding the feasibility of growing two consecutive crops on the irrigated crop land in the Oahe Unit.
2. Studies should be conducted on the adaptability of vegetable crops to the area.
3. It is recommended that a demonstration city be developed to determine the merits and advantages of farm-village living in South Dakota.
4. It is recommended that South Dakota State University seek federal funds for the planning and development of a demonstration city for the agrarian needs in South Dakota.

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