2-1947

The Integration of Water Use in Nebraska

G. E. Condra
University of Nebraska-Lincoln

Nebraska Conservation Bulletin

Number 29 February 1947

THE INTEGRATION OF WATER USE IN NEBRASKA

G. E. CONDRA

★ ★ ★

UNIVERSITY OF NEBRASKA

CONSERVATION AND SURVEY DIVISION

NEBRASKA CONSERVATION BULLETIN

NUMBER 29 FEBRUARY 1947

THE INTEGRATION OF WATER USE IN NEBRASKA

BY

G. E. CONDRA

The University of Nebraska

PUBLISHED BY THE UNIVERSITY OF NEBRASKA
CONSERVATION AND SURVEY DIVISION, LINCOLN

The Integration of Water Use in Nebraska*

BY G. E. CONDRA

MR. PRESIDENT, LADIES AND GENTLEMEN:

The subject assigned to me is one of vital interest to most Nebraskans, and especially so to irrigators. It means the multiple use of the available water supply of the state in a program planned to meet the important expanding needs of the state adequately and beneficially without wastage.

Our state differs much from place to place in its topography, rainfall distribution, wind velocity, length of growing season, groundwater supply, and soil characteristics. These differences and conditions environ the plant and animal life and shape the land and water use capabilities.

Mistakes and Progress. Fifty years or more ago, little was known about the physical features, climate and natural resources of the state and a period of trial, mistakes and some progress followed until it was learned that a knowledge of the climate factors, and of the water, soil and other resources was needed for guidance in future development. Then came survey, experimental activity, engineering, education and planning relating to the use of the resources and these services have continued on the up-grade to present time, and the climatic factors; the geology, topography and soils of the land; and the surface waters and the groundwater are now quite well known. In other words, enough is known about the occurrence, extent, availability and quality of our water supply for better integration of its use than could have been made when irrigation began in Nebraska. Also, Nebraskans now know that the water supply is a main factor in the development of the future prosperity and welfare of the state. And, no doubt, you are here primarily to further the conservation of water and soil in irrigation, but do you fully realize that there is a growing need in parts of the state for the integration of gravity irrigation, pump irrigation and sub-irrigation, and a general need for the integration of all land and water use?

* This paper was presented at the Nebraska Irrigation Association meeting held at Holdrege December 5 and 6, 1946, and is reproduced as this bulletin with only slight change.

You know too that the mistakes made in the installation of some irrigation projects have caused bad use of water and soil and that the results of these mistakes now interfere with the proper correlation of water and soil use, and that such mistakes must be avoided in planning future projects.

Let me now by-pass my subject to make preliminary statements on (1) the occurrence of water, (2) the amount of available water, and (3) precipitation water.

Occurrence of Water. Our water resources are in the atmosphere, on the surface of the land, in the soil and subsoil and in the ground below the water table where it is known as groundwater (See reference 3): Terminology Relating to the Occurrence, Behavior and Use of Water in Nebraska.†

Water occurs in the atmosphere as vapor from which come rain, snow and hail which become surface water, soil water or groundwater and returns to the atmosphere by evaporation from land and water surface and from plants, animals and other sources. This is the water circuit (Reference 3).

Surface water originates generally from precipitation and locally from groundwater, as the springs and streams heading in the sandhills. Water, along with some air, occurs in the soil in both gaseous and liquid form, but generally it is capillary water, like that in the subsoil, down to the water table. Groundwater is the saturated zone in the land or ground extending to variable depths below the water table.

Amount of Water. The mean annual precipitation of the state ranges between about 70,000,000 and 100,000,000 acre feet. This, the state's largest renewable resource, is a dominant factor in the life and industry of Nebraska (Reference 5).

The volume of the surface water of the state ranges between 3,000,000 and 6,000,000 acre feet, about half of it being in natural streams and lakes and half in artificial ponds, canals and reservoirs.

The volume of water or moisture in the soil and subsoil varies considerably during the year, ranging between 5,000,000 and 16,000,000 or more acre feet. It is used principally by the native vegetation and cultivated crops.

The amount of groundwater is many times that of the combined surface, soil and subsoil water and several times that of the annual

† References at end of bulletin.

precipitation. The amount of groundwater in the comparatively shallow formations of the state is 950,000,000 acre feet or more. This does not include the deep-seated water.

Our state is endowed with about 1,000,000,000 acre feet of water available for beneficial use. This is more water of its kind and quality than occurs in any state bordering Nebraska.

Precipitation Water. The use of this water supply is not controlled very effectively but progress is being made by the use of agricultural practices that conserve the precipitation water in the soil for beneficial use, as by contour farming, terracing and the use of stubble mulch (References 1 and 2).

It is now known that the amount and time of occurrence of the rainfall do not alone determine the effectiveness of its use, but that the results are influenced by such physical and cultural features as the topography, nature of the soil, and by the use of crops and cultural methods and practices that conserve the water and soil.

There are places in the state where a 30-inch annual precipitation on sandy soils with high rate of infiltration and rapid subdrainage does not respond as beneficially under cultivation as does 16 inches on a soil section that conserves the water making it available for plant growth. So, the duty or effect of water use is variable in the state and consideration of all factors involved should be taken into account in agricultural land and water use, and the wastage of precipitation as runoff, causing soil erosion, should be controlled (References 3 and 5).

So far as possible in the time allotted I will now review the integration of water use in Nebraska under the following headings: (1) Domestic: farm, municipal, industrial; (2) Irrigation: gravity, pump and sub-irrigation; (3) Water Power; (4) Flood Control; (5) Drainage; (6) Navigation; (7) Wild Life and Recreation.*

Farm Use. This refers primarily to the drinking water used in farm homes and for livestock. Most of this water supply is abundant, of good quality, and comes largely from wells, except in a few small areas where the groundwater is scant or too deep for pumping. Most farm water is pumped with wind power and from tubular wells. The water usually is sanitary, but there are too

* The profiles and cuts used in my talk are not reproduced in this report.

many places in the state where the farm wells are not located where the water is free from pollution.

Farmers and well-drillers should know the occurrence of groundwater and the direction of its movement in order to locate wells where there is clean water not moving to the wells from areas polluted from feed lots, cess pools and other sources. This precaution should be observed because the use of contaminated water from unsanitary wells or other unsafe sources may cause sickness and death in the farm homes. Therefore, it is not safe to drink untreated water from unsanitary wells, streams, lakes and irrigation canals. Information on groundwater and location of sanitary wells is available from the Conservation and Survey Division upon request.

Evidently a sanitary water supply is of first importance in the water use on a farm. It is good health insurance for the family and others who may use the water and is not bad for the health of livestock.

At a few places in the state, as on shaly lands, where no groundwater is available for domestic use, runoff from rainfall is impounded in ponds for livestock, and water for home use is spouted from buildings to barrels and cisterns or is hauled from other areas, and at places it is developed by the seepage of pond water to sand and gravel-filled channels located below the ponds.

Municipal Use. Most municipal water of the state, except the treated river water at Omaha, Nebraska City and a few other places, is pumped from groundwater and is potable without treatment. However, some municipal water supplies have become unsanitary the past few years and this has caused the towns and cities to develop safe water supplies adequate for future needs. Among the cities that have made most progress in this line are Seward, Wahoo, Beatrice, Wymore, Fairbury, Alma, McCook, Minden, North Platte, Scottsbluff, Alliance, Norfolk, Grand Island, Fremont, Lincoln, Auburn and Falls City. The Conservation and Survey Division assists municipalities in the solution of their water supply problems.

There is not time for me to review the factors involved in the location of good municipal water supplies. Nor is it necessary, with this group, to discuss the importance of water for municipal use, but I feel free to state that the towns and cities of the state not having adequate supplies of good water should locate and

develop such supplies before the allocation and development for other uses may interfere with future planning for municipal use.

The garbage and sewage disposal of the towns and cities is becoming a problem. Much water is used in sewage disposal from our towns and cities and at most places the result is a filthy nuisance and the pollution of streams and groundwater, sometimes needed for rural water supply. So this feature of municipal water use needs correction, and like at Lincoln and at the Omaha Stock Yards, the sewage should be treated to prevent water pollution and to develop a resource such as fertilizer material.

Industrial Use. Usually the industrial use of water is included with municipal use, because the water requirements are essentially the same. But some industries require water of relatively low temperature like that in Nebraska and not with as much range in temperature as river water. Fortunately, there is much groundwater in Nebraska suitable for industrial use and this condition is a feature of importance in the location of industrial plants. However, some industrial plants produce wastes that pollute groundwater, and, like with city sewage, there is objection to the disposal of these wastes by streams. But, this does not mean that the waste material of treated sewage and the wastes from industrial plants should not be carried away by streams provided they have the discharge capacity to dilute the materials to the point where the streams are not made unfit for other beneficial use. The water priority for most industries is the same as for municipalities and superior to that for water power and irrigation.

Irrigation Use. This use in our state has passed through stages of failure and marked success and is now in the process of evaluation and planning for future development on a more comprehensive scale. You know the history of gravity irrigation in Nebraska relating to water right, districts, construction, flood water storage, operation, administration, federal participation, etc., and you know the value of irrigation and why it should be extended to new areas where the water supplies are available, the soils are suitable, and the cost of installation is economically feasible. Then too, you know that in the past the close relations that exist between gravity, pump and sub-irrigation were not recognized very generally and that these forms of irrigation must be coordinated more closely in future development. If this correlation is

observed in the future there will be better land use and relatively more land can be irrigated from the water supply.

In the early development of gravity irrigation in Nebraska the soil and water resources were not known; canals were made from intermittent streams that had no water when it was needed, and even after dependable water supplies were developed, some canals and laterals were made to land not suited for irrigation. Consequently, some of the projects failed in whole or in part, but with the reservoir storages of flood water and the integration of water power and irrigation, the program expanded with federal financial support to its present stage of development. However, in some gravity irrigation projects not enough thought has been given to the prevention of seepage from reservoirs and canals and to the drainage situation, alkali problem, preparation of land for irrigation, and the conservation of irrigation water. And, due to this lack of forethought and failure to recognize the importance and inter-relations of groundwater, there has been wastage of water, damage to good agricultural land, and less progress in irrigation than had been expected. So we are now looking both backward and forward in irrigation planning and no doubt all of the things enumerated here, and by others, will be taken into account in the construction and operation of the future irrigation projects of Nebraska.

Pump Irrigation. It has taken survey and study to learn some of the essential facts about the occurrence, volume, behavior and quality of groundwater in Nebraska. Several men have served well on the cooperative state-federal water survey the past 17 years and we believe that the results of this work have been beneficial and that the people of the state are now conscious of the fact that there is much ground water in the state, as evidenced by the progress made in pump irrigation, when the record shows that there were about 300 irrigation wells when the survey was started and 6,000 wells now pump for 300,000 acres.

The pump irrigation program has been one of survey, educational service and cooperation with well drillers. There is no law in Nebraska on the allocation and regulation of groundwater use for irrigation, but it is certain that the pump irrigation potentialities should be taken into account in the overall planning of irrigation development because there is much more groundwater than surface water in the state.

Sub-Irrigation. This, which is nature's form of irrigation, covers more than 2,000,000 acres of land in the state, located in the sandhills and in various large valleys. Most, but not all of the sub-irrigation land is sandy, with abundant groundwater, shallow water table, and is in native sod. Much of it is suited for grazing. However, there are places in the state where the groundwater table is at depth of 5 to 20 feet and the soil is suited to cultivation. At these places, alfalfa and other deep-rooting plants, after they are established, draw upon the capillary water above the groundwater and thus perform the irrigation practice, using the groundwater source of supply. However, there should be some pump or gravity irrigation, preferably the latter, on these lands at seeding time.

In the analysis of the inter-relations of gravity, pump and sub-irrigation, the following conclusions are reached.

1. Canals constructed across terraces and uplands, and not lined to prevent seepage, release relatively large amounts of water which recharges the groundwater and lifts the water table too high at places. This condition develops groundwater storage, changes the depth and contour of the water table, and forms seepage areas and return flow at the lower levels. However, the elevated water table on the lower terraces damages the land too much locally for either gravity or pump irrigation use, whereas, where the canal loss is less or water is released to recharge the groundwater to the optimum depth for pump irrigation, or drainage is installed, the result is beneficial for irrigation, both pump and gravity.
2. The excessive loss of water from canals develops seepage areas along the lower valley sides and borders of low terraces and contributes to the formation of alkali. This makes drainage installation necessary, yet in places it is not very effective in removing the alkali from the soils, and may remove groundwater needed for irrigation.
3. At places in present and contemplated irrigation districts the soil is too sandy or gravelly and the water table is too shallow for either pump or gravity irrigation. These areas are now sub-irrigated native prairie. They occur in several valleys of the state and on the hay flats of the sandhills and are not well suited to either gravity or pump irrigation.

4. The sub-irrigated lands having suitable soils and a dependable supply of groundwater for pump irrigation should not be brought under gravity irrigation. However, as noted before, there are places where some supplemental water from gravity irrigation canals would favorably recharge the groundwater for heavy pump irrigation.
5. By the proper drainage control of the excess groundwater in the terraces and slope lands the water table could be held at the optimum depth for pump irrigation and sub-irrigation. This would make a resource of the excess water now retarding the land use at places in the Platte Valley and make the water use beneficial rather than detrimental.
6. The alkali soils in the irrigable areas of the state present an important problem. Their reclamation will require the application of corrective fertilizers, levelling, drainage and suitable agronomic practice.

Irrigation Policy. It should be the policy of the state to develop gravity and pump irrigation as fully and beneficially as possible in the surface drainage valley areas in harmony with the availability and dependability of the surface and groundwater supplies and the accessibility and suitability of the land for irrigation, the excess or surplus water, when there is such, to be used on adjacent areas where irrigation is needed and feasible. The policy should be based on the condition of occurrence, volume, behavior and use capabilities of both surface water and groundwater, and involve the correlation of gravity, pump, and sub-irrigation, with the application of each where it is most suitable and the joint use of gravity and pump irrigation only where they are supplemental.

It will be necessary in carrying this policy into effect in the Loup-Platte-Loess Plain area, where there is much groundwater, to understand the Platte River discharge and reservoir storage, to evaluate the relations that exist between local rainfall, stream flow and groundwater recharge, and to take into account the groundwater source of the Loup rivers, the volume and direction of groundwater movement from the Sandhills to the Loup and Platte rivers and valleys and beyond to the Loess Plains areas, and to construct reservoir storage, classify the irrigability of the land, determine the areas best suited for each kind of irrigation, and develop an overall plan of construction and operation that will make the most beneficial use of the water and soil.

Fortunately, nearly all of the Loup-Platte-Loess Plain area has been covered by the Soil Survey; the streams have been gaged for a number of years, and a large amount of the area has been covered by the Groundwater Survey. Consequently the irrigability of the land, the nature of the water supply, including the groundwater, are fairly well known, but with lack of detail at places, and a comprehensive evaluation of the factors involved in the irrigation of this general region is underway, state and federal agencies cooperating.

The movement of both surface runoff and groundwater is largely to the Platte River and its bordering bottomland and thence down-valley in the stretch of the valley extending from Wyoming to west of Buffalo County, but between this point and south of Bellwood, Butler County, the movement of surface water and of the groundwater in the shallow sands and gravels is down-valley but there is considerable underflow from this stretch of the valley in deeper sands and gravels in buried pre-glacial gravel-filled channels extending southeastward from the Sandhills, to and under the Platte Valley and the Loess Plain south of the Platte. So in this middle course of the Platte Valley the shallow and deeper water-bearing sands carry much groundwater available for domestic and irrigation uses in the valley and the deeper sands and gravels supply water for the same uses in the plains area located south of the Platte. There were 2,507 irrigation wells in this stretch of the Platte Valley January 1, 1947 and more than 300 in the uplands south of the valley. It seems now that some gravity irrigation water will be needed to recharge the groundwater at places in this part of the Platte Valley where there is heavy concentration of wells and pumping from comparatively thin water-bearing sands and gravels.

We are to make a survey this year to determine more exactly the occurrence and width of the old drainage courses known to extend to, under, and beyond the Platte. This will be done by making three closely placed southwest-northeast traverses of test drillings, one located south of the Platte Valley, one north of the Platte Valley and the other in the Sandhill Region where much of the groundwater originates. The survey should supply information needed in evaluating the use capabilities of the groundwater in the old buried channels, and serve also in evaluating

the need for gravity irrigation in the Loup valleys and in this part of the Platte Valley.

In the Loup-Platte area there are two phases of natural water drainage or discharge—surface and subsurface—the one of surface water and the other of groundwater. In much of the Sandhill Region the water table slopes to the streams, the groundwater becoming stream water. However, at places in the so-called hard land areas the surface and ground water zones are separate and distinct, and at places in valleys they come together intermittently, as on and in the flood plain of the Platte, where during the high stages of the river its water moves into and recharges the groundwater of the bordering lands and during the low stages of the river, groundwater of the border land is released to the river. In other words, the local rainfall and the discharge of the Platte, when there is such, build up local groundwater to river level, and the groundwater is withdrawn or removed by slow under-drainage, evaporation, and plant growth in sub-irrigated areas, and by under-drainage, pumping, evaporation and crop use in pump irrigation areas. The mean annual fluctuation of the water table in this part of the Platte flood plain and low terraces is 2 to 5 feet, which is not the local drawdown at wells. Fortunately, there is extensive recharge of groundwater here by underflow from the northwest and intermittent recharge from the river. The amount of recharge from each direction or source should be recognized in overall planning. These release and recharge relations of the two forms of water supply and water movement along the intermittent course of the Platte are features of importance and are fundamentally involved in the integration of water use in the middle course of the Platte Valley.

Evidently it will be possible to develop irrigation more generally and beneficially in the subhumid areas of the state than is generally supposed if the development can be based on a sound policy of water and land use. And there is supporting evidence for the conclusion that by the right use of the surface water and groundwater available in the Loup-middle Platte Valley area, all of the irrigable land here might be covered by gravity, pump and sub-irrigation with a probable surplus for use in adjacent areas.

Water Power. There are about 47 hydro-powers in Nebraska with a combined generating capacity of about 145,900 KW compared with 274,184 KW by the fuel-burning electric plans. The electric hook-up of the state serves many municipalities, industries, and rural electrification on about 40,000 farms of the state (References 3 and 5).

Marked progress has been made in the development of hydropower the past few years in connection with the federally-supported, self-liquidating irrigation-power projects. Two of the power plants, built with funds assessed against irrigation lands in Nebraska and eastern Wyoming, are at Lingle and Guernsey, Wyoming. They light and power the North Platte area of Nebraska. Profits from the operation of these powers are used to liquidate irrigation projects in Scotts Bluff County, Nebraska, and the use of water for power development does not interfere with the supply of water for irrigation because the land at the Guernsey dam and reservoir and along the power canal between Whalen and the power plant near Lingle, Wyoming, is not suited to irrigation, and the priority is for power use. So the dual use of water in this general area is supplemental and beneficial.

The water passing through the Sutherland and Tri-County power plants is diverted from the river, the flow of which is from flood storage at McConaughy and Sutherland reservoirs and carried down-valley in canals with lower gradient than the river thereby reaching high points in the valley sides from which it is dropped to the valley floor at power plants, developing electric current for high line distribution, and delivering the water for down-valley irrigation. These projects give dual and repeat use of water for power and irrigation (Reference 1). The power development in the plants just mentioned has been a factor in the operation, maintenance and liquidation of the irrigation installations.

The two power plants of the Columbus project are located in the more humid part of the state where the preference in water use is for power development rather than for irrigation. And the irrigation on the Platte Valley east of Columbus is by pumping from groundwater recharged in part by return water from these plants.

Electrical energy is of fundamental importance in our state and no doubt the future use of water for irrigation and power development in Nebraska will be based on the conditions and needs of the state, but with preference for irrigation in the subhumid areas

and probably for power in the more humid areas, yet the principle of dual, repeat-use should be applied where it is possible and feasible.

About 290 water powers, most of them for local use, as at pioneer grist mills, have been built in Nebraska, but most of those located on small streams later changed by drainage-flood control have been abandoned, also some that could not compete with larger powers built for the generation of electric current. And, if the plan to develop hydro-plants at the big dams constructed on the Missouri in the Dakotas is consummated, there will be high line distribution of current from these sources to Nebraska and other states.

Flood Control. Nebraska has a flood hazard. Some of the large floods, as in Salt Creek, Republican and Missouri River valleys, have damaged or destroyed land, forest, wild life, farm crops, farm improvements, livestock, highways, railroads and towns and killed a number of people. But ways are known to retard surface runoff, control stream flow and thus minimize and reduce the flooding of low-lying bottomlands. I refer to contour farming, terracing and the re-vegetation of steep slopes of hilly lands where these practices are feasible, and to the straightening of creek and river channels to minimize the flooding and facilitate the rapid removal of flood water. However, these practices, though important, are not sufficient to control the big floods of large rivers on which reservoir storage is the main factor in stream regulation, but there are places where the flood storage is needed for irrigation and other uses and which requires allocation for both flood control and beneficial use.

The plan in the Republican Valley is to integrate flood control, irrigation, power, wild life, and recreational development. The Platte and Niobrara rivers are quite well regulated against the flood hazard except in their lower courses and have irrigation, water power, wild life and recreation developments. The Elkhorn is being studied for flood control and some irrigation. The Loups have irrigation, water power, wild life, and recreational relations and flood problems only in their lower courses. Salt Creek and the Little Nemaha and Big Nemaha have drainage-flood control and no measures for irrigation and power development are contemplated. The Big Blue has a flood problem and is well developed for hydro-power and recreational use and flood control is

being advocated. However, many citizens of the valley are strongly opposed to the big flood control dam recommended by the War Department to be built north of Crete.

Drainage. The purposes of drainage are the opposite of those of irrigation. They are to prevent and correct the damages done by uncontrolled water, i.e. drainage is installed (1) to remove water from temporary lakes located in depressional areas on uplands, as in the area between Seward and Phelps counties, (2) to reduce marsh and lake-levels in the sandhills where such is more beneficial than detrimental, (3) to improve the flood situation in valleys by straightening stream channels and by ditching or tiling the floodable land.

The drainage problems of our state are complicated, involving the topographic, geologic, soil, surface runoff, and groundwater relations, and call for technical engineering. They are involved in the planning of conservation practices in several of the many Soil Conservation Districts of the state, and the administration of the drainage law of the state is vested in the Bureau of Irrigation, Water Power, and Drainage, office of State Engineer, Lincoln.

Navigation. The Missouri is to be controlled by large dams, reservoir storage and channel regulation to develop power, gravity-pump irrigation, flood control and navigation, and evidently this will not conflict with the developments of the tributary streams in Nebraska for irrigation, power, municipal supply and flood control. However, the main objectives in the regulatory control of the Missouri, as they relate to Nebraska are water power, flood and drainage control, wild life conservation, recreation, local pump irrigation, and navigation.

Recreation and Wild Life. Most of the big canals and reservoirs of the hydro-projects of the state contribute to the recreational requirements of the state and to the development of fish and game. In other words, the opportunities for boating, swimming, fishing and hunting are increasing, also the places for picnics and outings.

Summary Conclusion. Now in closing, let me solicit your continued interest in the geological, water, soil and conservation surveys of the Conservation and Survey Division of the University. The Division has engaged in geological and soil surveys for more than 30 years and in groundwater survey and in furthering the development of pump irrigation, and the improvement of domestic water supplies for 17 years. This has been an integrated

program carried on in cooperation with federal agencies, but it will require much additional detailed survey to supply the factual data necessary for local, regional and state development on a sound basis.

The farmers of the state are participating effectively in the integration of soil and water use by the control of soil erosion, the beneficial use of rain where it falls, the preparation of land for irrigation, the effective and efficient use of irrigation water, the improvement of home and stock water supplies, the development of pump irrigation, and by better land use. These things are being put into practice in the Soil Conservation Districts which cover most of the state.

It will require the united interest and support of the people of the state to establish an overall, workable plane for the integration of gravity irrigation, pump irrigation, sub-irrigation, water power, domestic water supply, flood control, navigation, recreational and other worthwhile phases of water use. You have a well grounded experience with the beneficial uses of water and soil and are qualified to further this integration.

Five bulletins that may be of use to you in connection with water and land use are listed herewith. I appreciate the close attention and interest you have shown during my talk. Thanks. (Applause.)

References

1. *Toward Soil Security:* Farmers Bulletin 1864, by Glen K. Kule, U. S. Department of Agriculture, Washington, D. C., 1941.
2. *Drouth, Its Effects and Measures of Control in Nebraska:* Conservation Bulletin 25, Conservation and Survey Division, by G. E. Condra, University of Nebraska, 1944.
3. *Terminology Relating to the Occurrence, Behavior and Use of Water in Nebraska:* Water Survey Bulletin No. 1, Conservation and Survey Division, by G. E. Condra, University of Nebraska, 1944.
4. *Land and Water Conservation Problems of the Missouri River Basin:* Conservation Bulletin No. 26, Conservation and Survey Division, by G. E. Condra, University of Nebraska, 1946.
5. *Industrial Nebraska in Outline:* Bulletin 28, Conservation and Survey Division, by G. E. Condra, University of Nebraska, 1946.