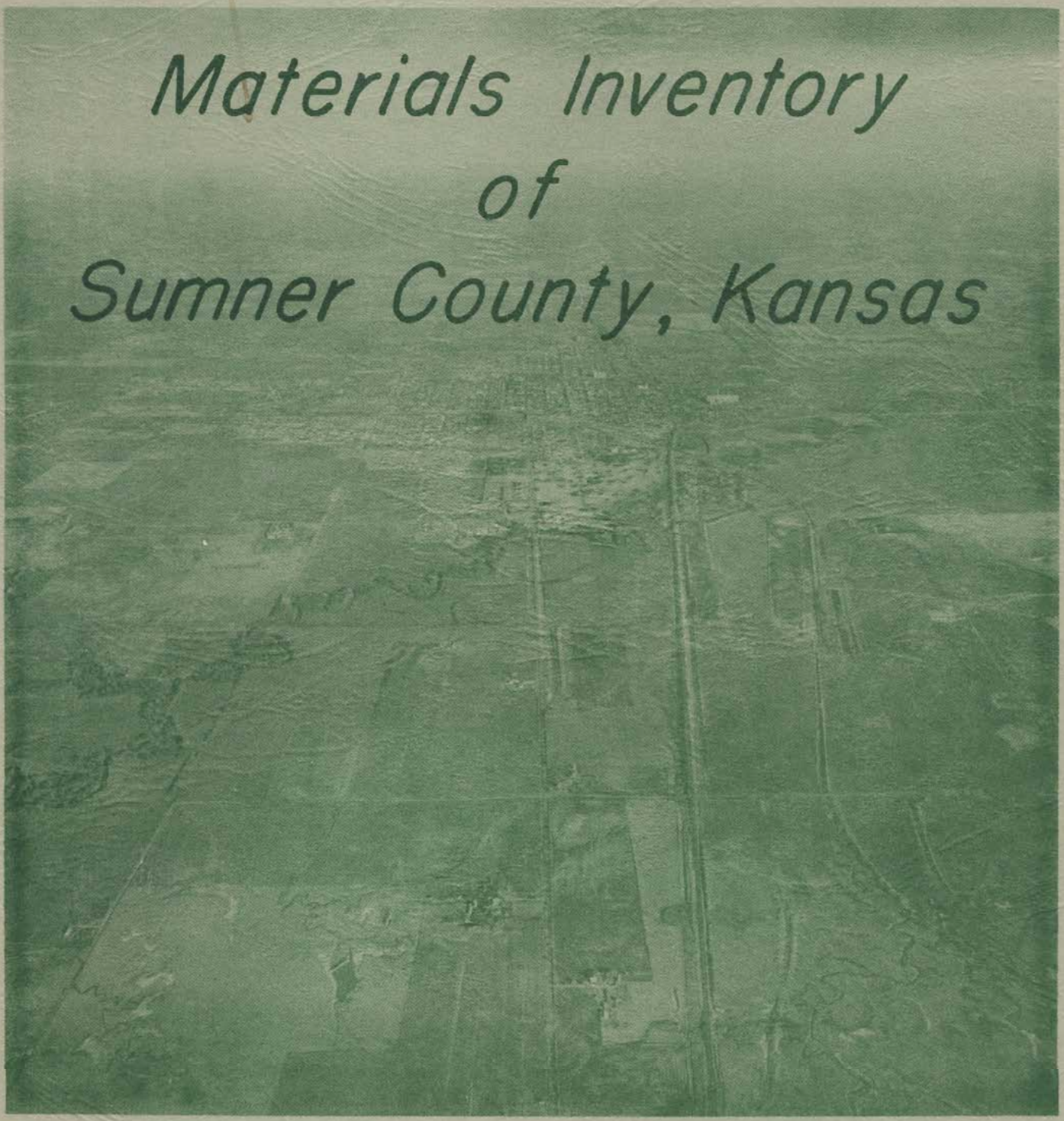
Materials Inventory of Sumner County, Kansas



prepared by

The State Highway Commission of Kansas

in cooperation with

The U. S. Department of Commerce

Bureau of Public Roads

State Highway Commission of Kansas
Research Department - Photronics Department

MATERIALS INVENTORY OF SUMNER COUNTY, KANSAS

by

Gerald Hargadine & Dale R. Johnson
Photogrammetry Section

Prepared in Cooperation with
U. S. Department of Commerce
Bureau of Public Roads

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Materials Inventory Report No. 4

SUGGESTED USE OF THE REPORT

The Materials Inventory of Sumner County is the fourth report of a series of county materials inventories prepared by the State Highway Commission of Kansas in cooperation with the Bureau of Public Roads. The report includes: 1. An introduction which describes the nature of the report and gives general information concerning Sumner County; 2. An explanation of the procedures used in compiling the information contained herein; 3. A brief explanation of the origin of the geologic units that are source beds for construction materials in the county, and a detailed description of the materials which have been produced from these units; 4. County materials maps (Plates I through VI) which show the geographic locations where the various source beds can be found in the county, along with the locations of all open materials sites and prospective materials sites; 5. Appendixes I through IV which contain site data forms for each open materials site and each prospective materials site. Each site data form has a sketch showing the materials site and surrounding landmarks, the name of the landowner, the name of the geologic source bed, and a resume' of all test data available for that site.

When this report is used as a guide for planning an exploration program or making an assessment of the materials resources of Sumner County, the reader may find the following suggestions helpful.

After becoming familiar with the nature of the report, the reader may wish to refer to the section "Construction Materials Resources of Sumner County". In this portion of the report a geologic history of Sumner County is presented which describes the geologic events which led to the deposition of the various source beds and sets forth the geologic nomenclature used throughout the report. The construction materials resources of Sumner County

are also inventoried in this portion of the report. A study of the Construction Materials Inventory will reveal the types of material available in the county, their geologic source beds, the localities where they are found, and a description of their engineering properties.

When the reader has determined which geologic source bed may contain material that will meet his requirements, he should then refer to the county materials maps. From these maps he can find the areas in which this geologic source bed is present, the locations of sites which have produced material from this source, the locations of prospective materials sites in this source bed, and references to site data forms for each open or prospective site.

For example, the reader determines from the study of the Construction Materials Inventory that sand and gravel from the Wisconsinan Terrace Deposits and Recent Alluvium fulfill the materials specifications for a project in the east-central part of the county. The materials map (Plate IV) shows several open pits along the Arkansas River. If the reader is interested in site $\frac{\text{SG 34}}{\text{Qal}}$ he refers to Appendix II where detailed information about this particular site is given on a site data form. This information will enable him to plan his exploration program in an orderly fashion.

PREFACE

This is one of a series of county construction materials reports compiled as a product of the Highway Planning and Research Program, Project 64-6, "Materials Inventory by Photo Interpretation", a cooperative effort between the Bureau of Public Roads and the State Highway Commission of Kansas financed by Highway Planning and Research funds. The materials inventory program was initiated to provide a survey of all existing construction materials in Kansas on a county basis to help meet the demands of present and future construction needs.

The objectives of the program are to map and describe all materials source beds in the respective counties and correlate geological nomenclature with the materials source beds for classification purposes. The program does not propose to eliminate field investigations, but it should substantially reduce and help to organize field work.

Previous to this time, no extensive or county-wide materials investigation had been completed in Sumner County. Several geologists have presented reports on strata which outcrop in Sumner County. Two reports which are particularly useful are Frye and Leonard, "Pleistocene Geology of Kansas" (1952), and Walters, "Geology and Ground-Water Resources of Sumner County" (1957). In addition, several preliminary soil surveys have been made and centerline profiles prepared for road design purposes by the State Highway Commission of Kansas along the major highways that traverse Sumner County; however, available information on materials suitable for construction purposes has been very meager.

Aggregate quality test results, pertinent information pertaining to materials produced, and geologic data on Sumner County used in this report were supplied

by the Materials Department and the Geology Section of the Design Department. The report was prepared under the guidance of J. D. McNeal, Engineer of Research, the project leader, R. R. Biege, Jr., Engineer of Aerial Surveys and Photogrammetry Section, and A. H. Stallard of the Photogrammetry Section. Appreciation is extended to L. G. Dale, Sumner County Engineer, for verbal information on construction materials in the area.

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ABSTRACT

The construction material resources of Sumner County are restricted to thick shale formations and unconsolidated terrace deposits which are found throughout the county.

The Wellington and Ninnescah Shale Formations provide the local townships with an economical source of surfacing material which is suitable for use on lightly traveled rural roads. These surface courses must be replaced quite often because they are easily eroded by wind and water; however, the high cost of more durable material makes it feasible to utilize these silty shales.

The Nebraskan Terrace Deposits contain fine to medium-grained sand which is contaminated with highly plastic clay and silt. Material from this source bed has not been extensively used for highway construction in Sumner County because of the expensive processing necessary to remove the objectionable plastic material. If new construction procedures make it possible, the abundant supply of material available in these deposits will, perhaps, be utilized in the future due to the scarcity of higher quality aggregates.

The Kansan or Illinoisan Terrace Deposits are a source of clay-bound sand and gravel. The clay, which has a high plastic index, must be removed before material from these deposits can be used in bituminous construction; however, pit run material is used for light type surfacing on many lightly traveled rural roads.

The Wisconsinan Terrace Deposits and the Recent Alluvium provide the best source of concrete and bituminous construction material in Sumner County. The deposits of this age, along the Chikaskia River, are composed of fine to medium sand and limestone gravel while those found along the Arkansas and Ninnescah Rivers are made up of medium to coarse sand and arkosic gravel. Some dry pit production is found along the Chikaskia River, but the Wisconsinan and Recent deposits found in the Ninnescah and Arkansas River valleys must be recovered by pumping operations because they lie below the water table.

The sand dunes which are located along the Arkansas and Chikaskia Rivers are comprised of fine sand. This material is often utilized in Sumner County as mineral filler for bituminous course construction. These deposits also provide a possible source of aggregate for asphalt stabilized or water bound base course construction on roads which have light wheel loadings.

INTRODUCTION

The purpose of this report is to present information concerning the availability, location, and nature of deposits of materials for use in highway construction and similar projects in Sumner County and to provide a guide for materials prospecting in the county.

Scope

This investigation includes all of Sumner County. All geological units and deposits that are considered a construction material source are mapped and described. The term construction materials, as used in this report, includes all granular material suitable for bituminous and concrete construction on highway projects. Mineral filler of high quality is included in the term.

Nature of the Report

Because all materials source beds are the product of geologic agents, the materials inventory program is based largely on the geology of the county being investigated. The use of geology as the basis of the materials inventory enables one to ascertain the general engineering properties of the material source unit and to identify and classify each source bed according to current geologic nomenclature. By adapting geologic nomenclature to material inventories, a uniform system of material source bed classification is established. However, the quality of material that can be produced from a given source bed may vary from one county to another, especially when dealing with unconsolidated deposits. In most cases, the geologic classification attached to unconsolidated deposits denotes age and not material type.

Therefore, two deposits which were laid down during the same time period, but located in different parts of the state, may have the same geologic name or classification but may vary in composition because of different parent material. The sorting and gradation of materials present in either deposit are greatly affected by the mode of deposition and the carrying capacity or energy of the depositing agent.

Consolidated geologic units, such as limestone, are usually characterized by more consistent engineering qualities throughout a given county; however, a change in material quality and thickness may be noted in some areas because of variations in local depositional environments and weathering conditions.

In essence, the geology of the county provides a basis for mapping material source beds and a criteria for evaluating the general qualities of the material.

The mapping of various geologic units is accomplished on aerial photography of the county. Because of their continuous nature, most consolidated geologic units can be mapped with a minimum amount of field checking. Unconsolidated deposits of sand and gravel are less extensive and more erratic, but they can be located on aerial photographs by having a knowledge of the geology of the county and by interpreting significant terrain features that are discernible on the aerial photographs.

By knowing the mode of deposition, source bed, geological age, type of landform of a particular material site, and the results of the quality tests completed on samples obtained from similar deposits, one can derive general information concerning the material in prospective sites. Consequently, prospective sites can be selected for development on the basis of the general merits of the material.

General Information

Sumner County has an area of 1,183 square miles and a population of 25,704 according to the 1960 census. It lies in the Central Lowland physiographic province and is bounded by parallels 37° 00' and 37° 29' north latitude and meridians 97° 09' and 97° 48' west longitude.

Sumner County is located in the first row of counties north of the Kansas-Oklahoma border and is about midway between the east and west borders of Kansas. The county is bordered on the east by Cowley County, on the north by Sedgwick County, on the west by Kingman and Harper Counties, and on the south by Grant and Kay Counties in Oklahoma.

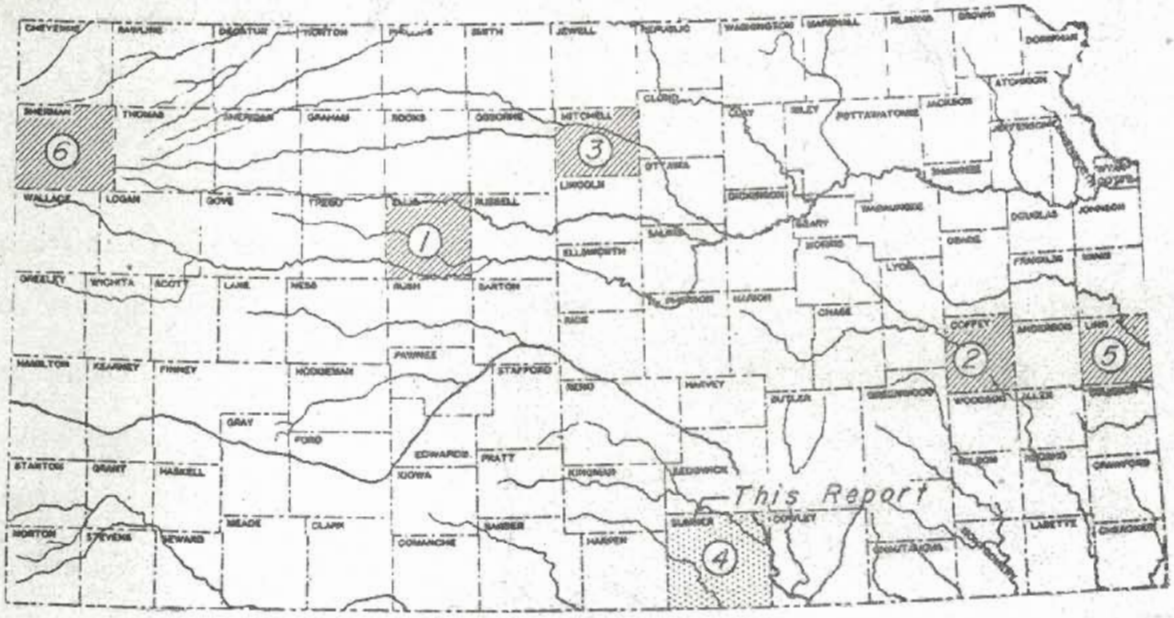


Figure 1. Index map of Kansas showing the location of Sumner County along with the report number and location of reports published or in process.

The land surface is a gentle rolling plain sloping to the southeast. The county is drained by the Arkansas, Ninnescah, and Chikaskia Rivers and their major tributaries. The Arkansas and Ninnescah Rivers flow through and

join together in the northeast corner of the county. Slate Creek flows from northwest to southeast through the center of the county and empties into the Arkansas River out of the county. The Chikaskia River and Bluff Creek flow through the southwest corner of the county and into Oklahoma.

Sumner County is served by lines of the Atchison, Topeka and Santa Fe Railroad; the Chicago, Rock Island and Pacific Railroad; the Missouri Pacific Railroad; and the Midland Valley Railroad. The county is traversed by US-81 highway which extends north-south through Wellington to South Haven; thence west to Caldwell and south from Caldwell into Oklahoma. US-160 extends east-west across the county through the City of Wellington. US-166 extends from South Haven east across the county line. US-177 extends from South Haven south through Hunnewell; thence into Oklahoma. The county is also served by State Highways 2, 15, 42, 44, 49, 53, and 55. The Kansas Turnpike traverses the county approximately parallel to US-81 running from 2 1/2 to 4 1/2 miles east of that route. The county is served by a well developed system of secondary roads except in areas where it is necessary to cross the Arkansas River, Ninnescah River, Slate Creek, or the Chikaskia River.

PROCEDURES

The investigation for this report was carried out essentially in four phases as follows: First, research and review of available information; second, photo interpretation; third, field reconnaissance; and fourth, final correlation of data, map compilation and report writing. With the exception of the first, the phases of this investigation were not completed as separate operations but were completed contemporaneously as each section of the report required. A detailed discussion of the procedures employed in each phase is included in this section of the report.

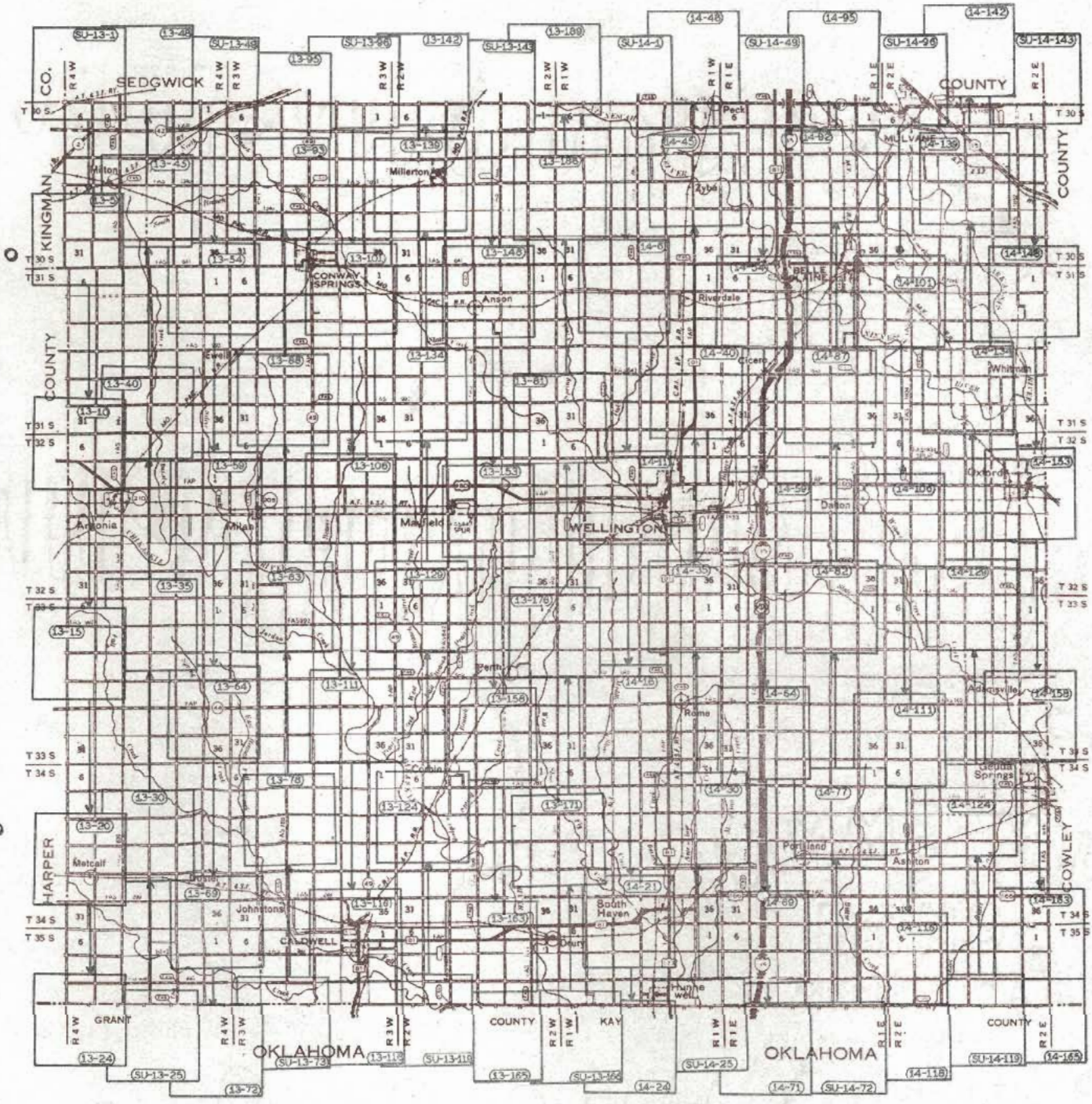


Figure 2. Aerial photographic coverage map. The numbers which are in brackets indicate photograph numbers on flights taken by the Photogrammetry Section of the State Highway Commission of Kansas in September and October, 1963. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

Research of Available Information

All available data and information pertaining to the geology, soils, and construction materials of Sumner County were reviewed. The general geology of the county, relative to construction materials, was determined. During this process, the results of quality tests already completed on samples taken in Sumner County were correlated with the various geologic units and deposits present in the county.

Photo Interpretation

The second phase of the investigation consisted of study and interpretation of aerial photographs taken by the State Highway Commission of Kansas at a scale of 1:24,000 (1" represents 2000'). Figure 2 (page 5) is a photographic coverage map of Sumner County on which index numbers have been placed to indicate the actual area covered by individual photos.

Initially, the whole county was studied on aerial photographs. During this process, all open material sites which have been sampled and tested were located on the aerial photographs and on a cronar base map of the county. The locations of all open material sites which had not been sampled or reported were also transferred to the base map. All materials sites were then correlated with the geology of the county. The geologic source beds that were discernible on aerial photographs were mapped and classified on the photos. Figure 3 (page 7) illustrates this procedure. This information was then transferred to the base map. Prospective sites were tentatively selected on the basis of the geology of the county and the aerial photographic pattern elements.

Figure 3 is a portion of an aerial photograph taken over west central Sumner County showing a portion of the Chikaskia River and its associated deposits. When viewed stereoscopically, the boundaries between the

different deposits are easily recognized. An abrupt break in the terrain marks the division between the Recent Alluvium and the Wisconsinan terraces. The Wisconsinan terraces can be distinguished from the high upland areas by the difference in elevation and by the sparse drainage

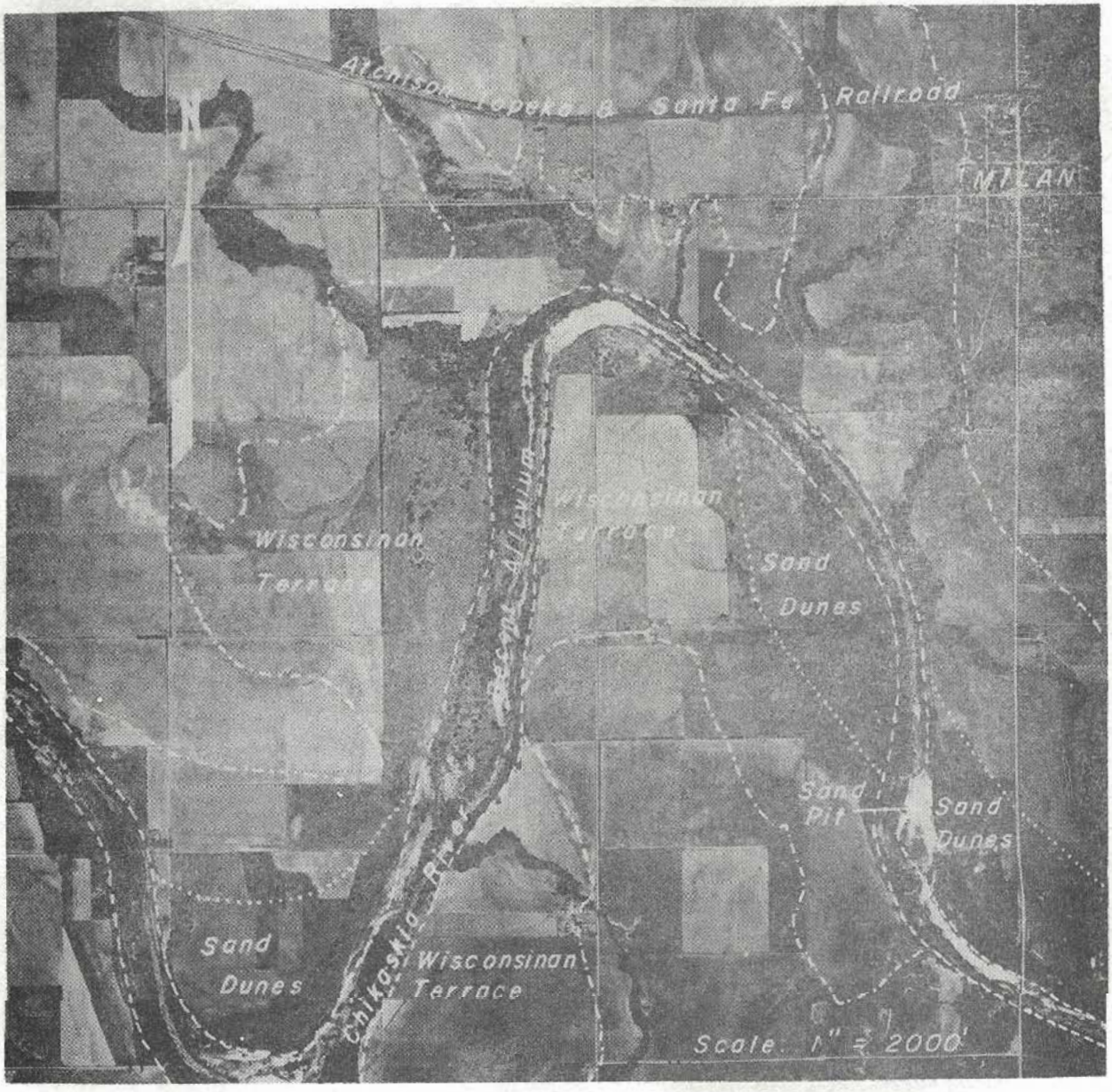


Figure 3. A portion of the Chikaskia River and its associated deposits of unconsolidated material in west central Sumner County.

patterns they exhibit. The sand dunes can be detected by their uneven surfaces and by the mottled appearance they display on the photographs.

After an initial field check, the mapping process was completed and a more detailed description of the geological source units could be written. The quality of the material that might be produced from this particular source bed was, in most cases, ascertained by correlating the results of quality tests with the geological unit from which the test samples were obtained and by field study of the producing unit. The general description of the material should be used as a guide in selecting geologic units for production purposes when planning an exploration program. A more detailed sampling and testing program will have to be accomplished for production purposes.

Field Reconnaissance

As mentioned previously, a field reconnaissance of the county was conducted after the first study of the aerial photographs had been completed. This enabled the photo interpreters to examine the material with which he was working, to verify doubtful mapping situations, and to acquaint himself better with the geology of the county. All open sites were inspected to verify the geologic classification. Limited exploratory drilling was accomplished during this phase of the work and during a second field check when a representative number of the prospective sites was field checked.

Map Compilation and Report Writing

The fourth phase consists of the final correlation of all new information gathered during the investigation to previously existing information, writing the report, and the final compilation of site data forms and county construction materials maps.

The Sumner County materials map was divided into six sections, approximately equal in area (Plates I through VI). Each designated plate represents a specific portion of Sumner County.

Only geologic units or deposits that contribute to the construction material resources of Sumner County were mapped. The map units representing material source beds are based primarily on geologic age. In general, the engineering characteristics of material deposited during each geologic age are fairly consistent throughout the county. For example, all material found in deposits of Nebraskan age display the same gradation and quality properties but display vastly different qualities than material found in deposits of Wisconsinan age.

All existing and prospective sites are identified on the county materials map by appropriate designations and symbols. The site symbol will indicate the status of the materials site to the user of this report; that is, whether it is a prospective site or an open site, and whether it has been sampled or not. The site designation will convey to the reader the type of material which can be found at the location, the estimated quantity of material, the number of the corresponding data sheet for that site, and the geologic age of the source bed and formation name.

The map legend associated with each plate explains all letter and map symbols used in the site designations.

To furnish the user of the report with all available information, a data sheet was compiled for each material site depicted on the materials maps by appropriate designations and symbols. The site data forms are included as Appendixes I through IV in this report. Appendix I contains site data forms for all sites depicted on the Sumner County materials maps that are open, but which have not been tested by the Kansas Highway Commission while Appendix II contains site data forms for all sites shown on the materials map as Open site; sampled. Test data is presented on the site data forms for each site in this appendix. Appendix III contains a site data form for

each site depicted on the materials map as a prospective site; sampled. Test data is presented on the site data form for each site which is included in this appendix. Appendix IV contains site data forms for sites which are shown on the materials map as being a prospective site; not sampled.

Geologic data is presented on each site data sheet to facilitate future correlation. To aid further in determining the type of material which should be expected in untested sites, references are made to nearby locations where test results on samples from the same source bed are available.

A sketch of each site was drawn illustrating major cultural and natural features of the immediate area to help locate the exact site in the field.

Landowner information is presented for each materials site as it is listed in the Sumner County Register of Deeds office.

The text of the report was completed by presenting the geologic history of the county as it pertained to the various material source beds present, a general description of the available material, and a general description of geologic units which, in the past, have displayed unsound engineering properties.

CONSTRUCTION MATERIAL RESOURCES OF SUMNER COUNTY

Geologic History of Sumner County

This portion of the report is intended to provide the layman with a general knowledge of the geologic history of Sumner County. The information contained herein is admittedly general, and from the geologists standpoint incomplete; however, for the purposes intended, it is considered adequate.

Most people tend to think of geologic time in terms of man's generations, or at best, in terms of hundreds of years. Figure 4 (page 12) is a geologic

timetable acquired from the State Geological Survey of Kansas, which shows the divisions of geologic time and the approximate length of each. It should be noted that most time periods represent several million years. To further understand the events which have taken place, it is necessary for the reader to realize that climatic and geographic conditions have been vastly different from those which exist at the present time.

The rocks exposed at the surface in Sumner County are only a few hundred feet in thickness. From these surface exposures, the geologic history of the near-surface deposits may be interpreted; however, the history of older deposits must be studied through the use of drill-hole logs and samples obtained during exploration for oil and gas.

Sumner County, like the remainder of Kansas, is underlain by igneous and metamorphic rocks of Pre-Cambrian age. Early in the Paleozoic Era, these basement rocks were overlain by sediments which were deposited when the sea invaded the area during the Cambrian and Ordovician Periods. The lack of Silurian and Devonian rocks in the subsurface of this area indicates that if any sediments were deposited during these periods, they were removed by erosion prior to the deposition of Mississippian rocks.

Drill logs reveal that Mississippian deposits overlie the eroded surface of Cambrian and Ordovician rocks in the area that includes Sumner County. After the deposition of the Mississippian rocks, data indicates that the area was again uplifted and the upper portion of the Mississippian deposits was severely eroded.

During the Pennsylvanian Period and the early part of the Permian Period beds of limestone, dolomite, shale, sandstone and coal were deposited. After the deposition of the Wellington Shale Formation, thick red silty shales were deposited by sluggish streams or in temporary lakes on a broad

ERAS	PERIODS	ESTIMATED LENGTH IN YEARS*	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE)	1,000,000	*Glacial drift; river silt, sand, and gravel; dune sand; wind-blown silt (loess); volcanic ash.*	Water, agricultural soils, sand and gravel, volcanic ash.
	TERTIARY	59,000,000	*River silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.*	Water, sand and gravel, volcanic ash, diatomaceous marl.
MESOZOIC	CRETACEOUS	70,000,000	*Chalk, chalky shale, dark shale, varicolored clay, sandstone, conglomerate. Outcropping igneous rock.*	Ceramic materials; building stone, concrete aggregate, and other construction rock; water.
	JURASSIC	25,000,000	*Sandstones and shales, chiefly subsurface.*	
	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN	25,000,000	*Limestone; shale; evaporites (salt, gypsum, anhydrite); red sandstone and siltstone; chert; some dolomite.*	Natural gas; salt; gypsum; building stone, concrete aggregate, and other construction materials; water.
	PENNSYLVANIAN	25,000,000	*Alternating marine and non-marine shale, limestone, and sandstone; coal; chert.*	Oil, coal, limestone and shale for cement manufacture, ceramic materials, construction rock, agricultural lime, gas, water.
	MISSISSIPPIAN	30,000,000	*Mostly limestone, predominantly cherty.*	Oil, zinc, lead, gas, chat and other construction materials.
	DEVONIAN	55,000,000	*Subsurface only. Limestone, black shale.*	Oil
	SILURIAN	40,000,000	*Subsurface only. Limestone.*	Oil
	ORDOVICIAN	80,000,000	*Subsurface only. Limestone, dolomite, sandstone, shale.*	Oil, gas, water.
	CAMBRIAN	80,000,000	*Subsurface only. Dolomite, sandstone.*	Oil
PRE-CAMBRIAN	(Including PROTEROZOIC and ARCHEOZOIC ERAS)	1,600,000,000 +	*Subsurface only. Granite, other igneous rocks, and metamorphic rocks.*	Oil and gas.

(Not scaled for geologic time or thickness of deposits)

*Committee on Measurement of Geologic Time, National Research Council

State Geological Survey of Kansas

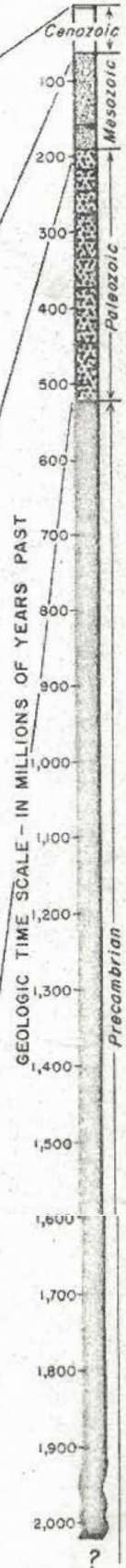


Figure 4. Geologic timetable.

nearly flat, alluvial plain. Erosion has removed all of the red silty shales in Sumner County except a portion of the Ninnescah Shale Formation.

In Kansas, the Mesozoic Era is represented by a few Triassic and Jurassic rocks which are found mostly in the subsurface in the western one-fifth of the state. Rocks of Cretaceous age exist at the surface or in the subsurface in western and central Kansas. Central Kansas, including Sumner County, was probably a landmass during the Triassic and Jurassic Periods and no deposits of these periods are found in this area. Presumably the sea made its final invasion of the area during the Cretaceous Period since deposits of this age are found in the neighboring counties of Barber, Pratt, and Stafford. Any sediments which were deposited in Sumner County, during this period have been removed by subsequent erosion, because no Cretaceous rocks are found in the county.

The uplift of the Rocky Mountains marked the end of the Mesozoic Era and ushered in the Cenozoic Era. Erosion of the area, which is now Sumner County, continued throughout the early part of the Tertiary Period. Late in Tertiary (Pliocene) time, streams carrying debris from the newly formed Rocky Mountains began to aggrade their channels in western Kansas. A thick blanket of alluvial material (Ogallala Formation) was deposited over the eroded bedrock surface of the western part of the state. It is probable that some alluvial material was deposited in Sumner County only to be removed by later erosion.

The Pleistocene Series of the Quaternary Period represents a time of repeated glacial and interglacial cycles. Figure 5 (page 14) is a geologic timetable which indicates the division of the Quaternary Period and the approximate length of each division. The glacial stages (Nebraskan, Kansan, Illinoisan, and Wisconsinan) represent the advance and initial retreat of the glaciers. The three interglacial stages (Aftonian, Yarmouthian, and

Sangamonian) represent times of relative geologic stability. Only two glaciers, the Nebraskan and the Kansan, reached Kansas during this period. Glacial activity in Kansas was restricted to the northeastern portion of the state. This sequence of glaciation which occurred during this time has played a controlling role in the development of Pleistocene nomenclature and in the classification of Pleistocene deposits throughout the state. The geologic history of the Pleistocene series as it is discussed here is based chiefly on a report by Frye and Leonard (1952).

Division of Quaternary Period				
Period	Series	Stage	Estimated length of stage duration in years.	Estimated time in years elapsed to present.
Quaternary	Pleistocene	Recent		10,000
		Wisconsinan Glacial	45,000	55,000
		Sangamonian Interglacial	135,000	190,000
		Illinoisan Glacial	100,000	290,000
		Yarmouthian Interglacial	310,000	600,000
		Kansan Glacial	100,000	700,000
		Aftonian Interglacial	200,000	900,000
		Nebraskan Glacial	100,000	1,000,000

Figure 5. Geologic timetable of the Quaternary Period.

As the Nebraskan glacier started to accumulate, central Kansas was an erosional plain with subdued relief. Broad alluviated valleys were joined with alluviated tributaries which were filled to shallow depths with material of local origin. A major stream flowed south across Kansas through Sumner County. As the glacier moved southward, the streams in Kansas deepened their valleys. This was probably due to eastern tilting of the area. The retreat

of the glacier resulted in smaller volumes of water. This, in turn, caused the streams to aggrade their channels. In Sumner County, deposits consisting of sand and gravel from the Ogallala Formation and red silts and clays from Permian bedrock were laid down along the major streams. A remanent of these deposits now blankets approximately thirty square miles in the northwestern corner of the county. These deposits are overlain by the silts and clays which make up the present day soil in that area. These deposits are referred to later in this report and shown on the county materials map as Nebraskan Terrace Deposits.

As the Kansan glacier retreated, melt water began to flow through Sumner County from two sources. Immense quantities of water from the continental glacier to the north flowed southward through the now abandoned McPherson channel. In Sumner County, this drainage was joined by water from the Rocky Mountains flowing down a newly established Arkansas River drainage system. This huge volume of water resulted in a deepening of the stream channels and the removal of most of the Nebraskan deposits. Later, the retreat of the glacier resulted in deposition of sand and gravel from the Rocky Mountain area and silt and clay from local sources. These deposits are represented in Sumner County by very broad terraces overlying the Permian bedrock. Such terraces are located adjacent to the present day stream valleys. Younger Pleistocene deposits of Illinoisan and Recent age have overlain and become mixed with the Kansan deposits.

The terminus of the Illinoisan glacier was located in southern Illinois; however, due to climatic conditions associated with its existence, important events in the geologic history of Sumner County occurred. In Harvey and McPherson Counties, the McPherson valley was abandoned, resulting in the diversion of the Smoky Hill River drainage

from the Arkansas to the Kansas River. Sediments similar to those of Kansan time were carried eastward along the remaining Arkansas drainage system. These sediments overlaid and became mixed with the Kansan deposits and are indistinguishable from them. The combined Kansan and Illinoisan deposits are referred to in this report and shown on the county materials map as Kansan or Illinoisan Terrace Deposits.

The advance of the Wisconsinan glacier, like that of the Illinoisan, stopped several hundred miles from Kansas. By the beginning of Wisconsinan time, the drainage system of Kansas was similar to that which exists today. In Sumner County the Arkansas, Ninnescah, and Chikaskia Rivers, as well as the major creeks, were cutting wide valleys into the Permian bedrock. Late in this age these valleys were filled with alluvial material. The valleys of the Arkansas, Ninnescah, and Chikaskia Rivers were filled with material composed, chiefly, of sand and gravel while the smaller valleys were filled with locally derived silt and clay. This material now underlies the present-day stream valleys, and is covered by a thin layer of sand, silt, and clay of more recent origin. Deposits of this material are referred to in this report and shown on the county materials map as Wisconsinan Terrace Deposits.

The Recent Age represents the time which has elapsed since the last retreat of the Wisconsinan glacier. Throughout this time period, climatic conditions have been similar to those which exist today. Some wind erosion and deposition is evidenced by the sand dunes which occur along the banks of the rivers that traverse Sumner County. These deposits are shown on the county materials map and are referred to later in this report as Sand Dunes. The major streams have developed their present channels during this time. While so doing they have reworked older Pleistocene deposits, mainly

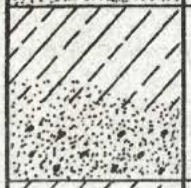
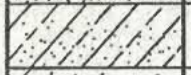
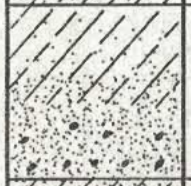
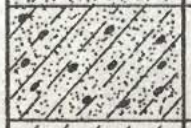
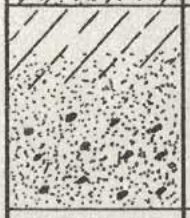
those of Wisconsinan age, and redeposited this material in their stream beds. These reworked deposits consist of sand and gravel and are referred to in this report and shown on the county materials map as Recent Alluvium. This period of geologic stability has also resulted in the formation of the soil mantle which covers the Permian bedrock and older Pleistocene deposits in Sumner County.

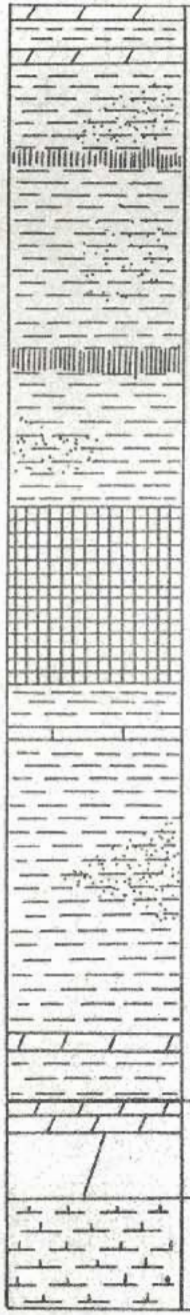
Construction Materials Inventory

This section of the report inventories the construction materials resources in Sumner County. Only geologic units which are producers or are considered to be potential materials sources are discussed in this section of the report. Figure 6 (pages 18 and 19) is a generalized geologic column of the surface geology in Sumner County which illustrates the relative stratigraphic position of each geologic source bed. The county materials map which is divided into six equal portions, Plates I through VI, shows the geographic areas where construction materials source beds are exposed or near the surface.

Figure 7 (page 20) tabulates the results of gradation and quality tests performed on construction material taken from the Nebraskan Terrace Deposits, the Kansan or Illinoisan Terrace Deposits, and the Wisconsinan Terrace Deposits and Recent Alluvium found in the Arkansas River valley. In general, material with the same basic engineering characteristics can be found throughout each source bed.

A tabulation of the various types of material available in Sumner County is shown in Figure 8 (page 21). The source beds from which each material type can be produced are listed along with the page number upon which the engineering characteristics of each of these geologic source beds are described. The reader is reminded to study these descriptions thoroughly

Graphic Legend	Thick-ness	System	Stratigraphic Units: Series	Stratigraphic Units: Formations and Members	Generalized Description	Construction Materials
	0'-25'	Quaternary	Pleistocene	Dune Sand	Sand, fine, well-sorted, tan.	Material for sub-base Filler sand
	0'-75'			Alluvium	Basal part consists of coarse sand and gravel grading upward into fine sand and silt.	Concrete aggregate Road surfacing material
	0'-20'			Pleistocene-Recent Undifferentiated	Clay, silty, tan-brown with minor amounts of sand and gravel.	
	0'-75'			Wisconsinan Terrace Deposits	Coarse sand and gravel grading upward into fine sand and silt.	Concrete aggregate Road surfacing material
	0'-90'			Kansan or Illinoisan Terrace Deposits	Siliceous silt, sand, and gravel with red-brown clay matrix.	Road surfacing material
	0'-90'			Nebraskan Terrace Deposits	Chiefly fine and medium sand with minor amounts of coarse sand and arkosic gravel. Upper part is silt and red sandy clay.	Road surfacing material
	0' - 250'	Permian	Lower Permian	Ninnescah Shale Formation	Reddish-brown silty shale containing many thin beds of siltstone. Gray-green spots are commonly found scattered throughout the formation.	Surfacing material for township roads



0' to 650'		Wellington Shale Formation	Mostly gray to greenish-gray and maroon shale with discontinuous silty shale zones, gypsum stringers and dolomitic limestone beds. A bed of impure dolomitic limestone of widespread occurrance is stratigraphically located approximately 35 feet above the base of the formation which has been termed the Hollenberg Limestone Zone. The middle portion of the Wellington contains the Hutchinson Salt Member. The fossil insect-bearing Carlton Limestone Member occurs a short distance below the salt. The Milan Dolostone Member, which consists of three beds of dolomitic limestone interbedded with grayish-green shales marks the top of the Wellington Formation.	Surfacing material for township roads.
0' to 15'	Nolans Ls.	Herington Limestone Member	Limestone, dolomitic, light gray, shaly in the upper portion, massive and blocky in the lower portion.	
7' ±	Nolans Ls.	Paddock Shale Member	Shale, calcareous, light gray.	

Figure 6. Generalized geologic column of the surface geology in Sumner County.

Location	Material Type	3/4	3/8	4	8	16	30	50	100	Wash	G.F.	P.I.	L.L.	Sp.Gr.	Wt/Cu.Ft.	Wear	Soundness	Source of Data
SOURCE OF MATERIAL: Nebraskan Terrace Deposits																		
SW ¼, Sec. 33, T30S, R3W	Sandy Clay Loam	1	3	9	26	51	79	97	100	8	3.66	25	42	-	-	-	-	Average of 14 test holes.
NW¼, Sec. 4, T31S, R3W	Sandy Clay Loam	T	1	4	11	23	42	70	78	21	2.29	13	25	-	-	-	-	Average of 15 test holes.
SOURCE OF MATERIAL: Kansan or Illinoisan Terrace Deposits																		
NW ¼, Sec. 25, T32S, R1W	Sand-Gravel	1	5	11	19	33	58	81	86	11	2.94	9	22	-	-	-	-	Average of 17 test holes.
E ½ Sec. 9, T34S, R2W	Sand-Gravel	0	5	18	47	73	85	91	92	8	4.11	-	-	-	-	35.8	0.97	1 Sample
NE ¼, Sec. 19, T33S, R2W	Sand-Gravel	0	2	6	14	40	86	96	97	2	3.41	-	-	2.56	107.4	34.0	0.98	1 Stockpile Sample
SE ¼, Sec. 30, T34S, R2W	Sand-Gravel	0	2	7	16	35	66	84	86	12	2.96	25	47	2.59	104.7	34.2	0.97	Average of 8 test holes.
SW ¼, Sec. 29, T33S, R2W	Sand-Gravel	2	5	10	21	42	74	93	98	6	3.45	5	19	2.60	111.9	31.4	0.99	Average of 10 test holes.
NW ¼, Sec. 15, T33S, R2W	Sand-Gravel	1	2	8	20	40	67	82	86	13	3.06	-	-	2.55	98.8	38.2	0.99	1 Quality Sample
SE ¼, Sec. 18, T33S, R2W	Sand-Gravel	0	1	6	19	42	71	87	92	7	3.18	-	-	2.51	95.5	32.6	0.98	1 Quality Sample
Sec. 8, T35S, R2W	Fine Sand	0	0	0	0	1	1	19	87	6	1.08	-	-	2.58	101.0	35.2	0.98	1 Quality Sample
Sec. 22, T34S, R2W	Sand-Gravel	0	2	4	11	26	57	85	91	9	2.76	-	-	2.58	101.0	35.2	0.98	1 Quality Sample
NE ¼, Sec. 31, T34S, R2W	Sand-Gravel	0	3	8	19	39	74	87	89	11	3.19	17	35	2.58	101.6	33.8	0.98	1 Quality Sample
SE ¼, Sec. 30, T34S, R2W	Sand-Gravel	0	3	9	24	50	81	93	95	5	3.55	25	47	2.59	104.7	34.2	0.97	1 Quality Sample
SOURCE OF MATERIAL: Wisconsinan Terrace Deposits and the Recent Alluvium in the Arkansas River Valley																		
NE ¼, Sec. 1, T30S, R1E	Sand-Gravel	0	3	12	36	69	84	94	98	1	3.96	-	-	2.60	112.4	30.6	0.98	1 Stockpile Sample
SE ¼, Sec. 1, T30S, R1E	Sand-Gravel	0	2	11	32	67	90	97	99	1	3.98	-	-	2.62	113.5	35.4	0.99	1 Sample
NW ¼, Sec. 7, T30S, R2E	Sand-Gravel	0	2	11	35	73	93	98	99	0	4.21	-	-	2.62	111.0	35.1	0.98	1 Pit Run Sample
NW ¼, Sec. 3, T31S, R2E	Sand-Gravel	0	1	6	20	42	76	94	99	1	3.38	-	-	2.61	114.6	34.4	0.97	1 Stockpile Sample
NE ¼, Sec. 13, T32S, R2E	Sand-Gravel	0	7	18	31	52	73	89	96	2	3.66	-	-	2.62	114.4	32.2	0.99	1 Pit Run Sample
NE ¼, Sec. 36, T32S, R2E	Sand-Gravel	0	2	10	35	73	87	91	93	6	3.91	-	-	2.62	105.8	34.2	0.98	1 Quality Sample

Figure 7. Results of tests completed on samples taken from the Nebraskan Terrace Deposits, Kansan or Illinoisan Terrace Deposits, and the Wisconsinan Terrace Deposits and the Recent Alluvium in the Arkansas River valley.

when making a preliminary assessment of the construction materials resources of the county. To further aid in making this assessment, the locality where each of the geologic source beds is located is also shown in this figure.

Material Type	Geologic Source	Description	Locality where available
Shale	Wellington Shale Formation	Page 21	Eastern 2/3 of the county
	Ninnescah Shale Formation	Page 23	Western 1/3 of the county
Sand	Nebraskan Terrace Deposits	Page 24	Northwestern corner of the county
	Wisconsinan Terrace Deposits	Page 26	Along the Arkansas, Ninnescah, & Chikaskia River valleys
	Recent Alluvium	Page 26	Along the Arkansas, Ninnescah, & Chikaskia River valleys
	Sand Dunes	Page 27	Along the Arkansas and Chikaskia River valleys
Sand & Gravel	Kansan or Illinoisan Terrace Deposits	Page 24	Very broad terraces along the major stream valleys
	Wisconsinan Terrace Deposits	Page 26	Along the Arkansas, Ninnescah, & Chikaskia River valleys
	Recent Alluvium	Page 26	Along the Arkansas, Ninnescah, & Chikaskia River valleys
Mineral Filler	Sand Dunes	Page 27	Along the Arkansas and Chikaskia River valleys

Figure 8. A recapitulation of the construction materials types and their availability in Sumner County.

Permian System, Lower Permian Series
Wellington Shale Formation

The Wellington Shale Formation, as used in this report, includes all of the beds between the Nolans Limestone Formation below and the Ninnescah Shale Formation above. The lower portion of the formation consists of gray

to greenish-gray silty shale and includes several discontinuous limestone and dolomitic limestone beds. The middle portion of the Wellington Formation contains the Hutchinson Salt Member. These subsurface salt deposits have their greatest thickness in the northwest corner of the county, but this thickness probably does not exceed 150 feet. The upper portion of the formation consists of gray to greenish-gray silty shale with intermittent dolomitic limestone beds. The Wellington has an approximate total thickness of 650 feet in Sumner County. This formation underlies all of the county except for a small area in the Arkansas River valley at the Sumner-Cowley County line. The Ninnescah Shale Formation overlies the Wellington in the western one-third of the county, restricting the exposure area to the eastern two-thirds of Sumner County. Exposures can be found in this area where streams have removed the overlying Pleistocene deposits.

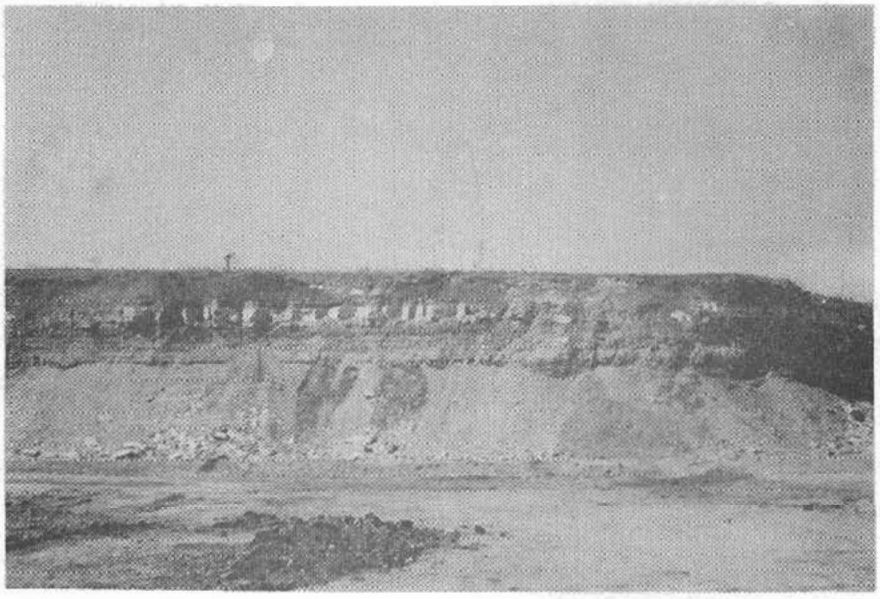


Figure 9. An exposure of the Wellington Formation showing a dolomitic limestone bed and several feet of the gray silty shale. This exposure is located in the SE 1/4, Sec. 27, T32S, R1W.

Townships have found the Wellington Shale to be an economical source of surfacing material for low traffic volume roads. The shale from this formation is spread on the road to a depth of approximately six inches. When compacted this material forms a hard mat which is nearly impermeable to water. Due to wind and water erosion, the life of the shale surface courses is short when compared to base courses constructed of suitable granular material. Attempts to correct this failure by applying asphalt surface treatment have not succeeded because the asphalt will not penetrate the shale.

Inasmuch as the uses for the shales and limestones of the Wellington Formation are limited and exposures are nearly unlimited, it has not been shown on the county materials map.

Ninnescah Shale Formation

The Ninnescah Shale Formation overlies the Wellington Shale Formation in the western one-third of Sumner County. Exposures of this formation are abundant in this area where streams have eroded away the overlying Pleistocene deposits. These exposures are easily distinguished from those of the Wellington Shale by the difference in color. The Ninnescah Shale Formation is generally composed of red-brown silty shale with many discontinuous beds of calcareous siltstone. Many of the beds in this formation have scattered gray-green spots and veinlets of gypsum.

Material from the Ninnescah Formation has also been used by the townships for surfacing low traffic volume roads. In general, material from this source has the same engineering characteristics as material taken from the Wellington Formation. Even though shale from this formation is not entirely satisfactory as a surfacing material, economic factors make its use feasible.

Because the uses for shales of the Ninnescah Shale Formation are limited and the exposures are abundant, it has not been included on the county materials map.

Quaternary System, Pleistocene Series
Nebraskan Terrace Deposits

Silt, sand, and gravel, comprising the Nebraskan Terrace Deposits, blanket approximately 30 square miles of northwestern Sumner County. According to Walters (1961, page 60), the maximum known thickness of these deposits is 90 feet. The lower part of the Nebraskan deposits consists primarily of fine to medium sand with minor amounts of coarse sand and arkosic gravel. The upper part of these deposits is made up of silt and red sandy clay.

Tests performed on material taken from these terrace deposits (See Figure 7, page 20) illustrate the gradation characteristics which one should expect for material taken from this source bed. A plastic index range of 13 to 25 was noted on samples tested. This high plasticity is considered to be characteristic of the material found in the Nebraskan deposits.

Material from these sources can probably be used in highway construction if it is properly processed; however, the lack of adequate water supplies for washing operations will make the processing expensive to accomplish.

Kansan or Illinoisan Terrace Deposits

The Kansan or Illinoisan Terrace Deposits are found in very broad terraces located adjacent to the present day stream valleys. These terraces are extremely difficult to differentiate from more recent Pleistocene deposits or from the featureless topography formed by the underlying shales; therefore, the geographic extent of these deposits was mapped on the basis of elevation. The areas delineated on Plates I through VI represent the portion of Sumner County where deposits of this age are most apt to be located.

The Kansan or Illinoisan Terrace Deposits consist mainly of clay and silt with lenses of sand and arkosic gravel. These deposits range in depth from 0 to 90 feet in Sumner County. They are overlain by a thin layer of younger silt and clay, but overburden should not exceed five to ten feet in most instances. When investigating prospective areas, it should be kept in mind that the lenses of sand and gravel may pinch out or change character in a few feet of horizontal distance.

Figure 10. A close-up view of material in a Kansan or Illinoisan Terrace Deposit. This material consists of silt, clay, sand, and gravel.

Figure 7 (page 20) also contains a summary of the results of tests performed on material taken from this source bed. These tests indicate that material from these terrace deposits is generally of good quality; however, the plastic index ranges from 5 to 25. This high plastic index is the result of the large percentage of silt and clay which contaminates these sand and gravel deposits. This undesirable material can be removed by proper processing, but the lack of water at most pit locations makes the processing operations difficult.

Wisconsinan Terrace Deposits and Recent Alluvium

Wisconsinan Terrace Deposits and Recent Alluvium are discussed under the same general heading because in most instances the major constituents of the alluvium have been derived from the older terrace deposits. Deposits of this age, located in the Arkansas and Ninnescah River valleys, consist of medium to coarse sand and arkosic gravel, while deposits found in the Chikaskia River valley are made up of fine to medium sand with minor amounts of limestone gravel. These deposits vary in thickness from 0 to 75 feet. At most pit locations, the material from this source is recovered by pumping operations because these deposits lie below the water table in Sumner County.

Figure 11. Pumping operations taking material from the Recent Alluvium in NE 1/4, Sec. 36, T32S, R2E. Note the high water level and lack of overburden.

Figure 7 (page 20) tabulates the results of tests performed on material taken from deposits of this age in the Arkansas River valley. No test results are available on material taken from the Ninnescah River valley and only one

site in Chikaskia River valley has been sampled. (See site data sheet $\frac{SG+40}{Qal}$ in Appendix II, Page 74).

Wisconsinan Terrace Deposits and Recent Alluvium, especially those which are located in the Arkansas River valley, are the best source of materials for highway construction in Sumner County. Material from these sources is generally high in quality and the abundant water supply at most pit locations makes the removal of undesirable material relatively easy and inexpensive.

Sand Dunes

Deposits of fine dune sand are abundant along the Chikaskia River, and a few are found along the Arkansas River. Some of these deposits contain material suitable for use as mineral filler in bituminous mixtures; however, particles of silt and clay contaminate some of these deposits resulting in a high plastic index. This contamination makes the material from these particular pits unsuitable for this use.

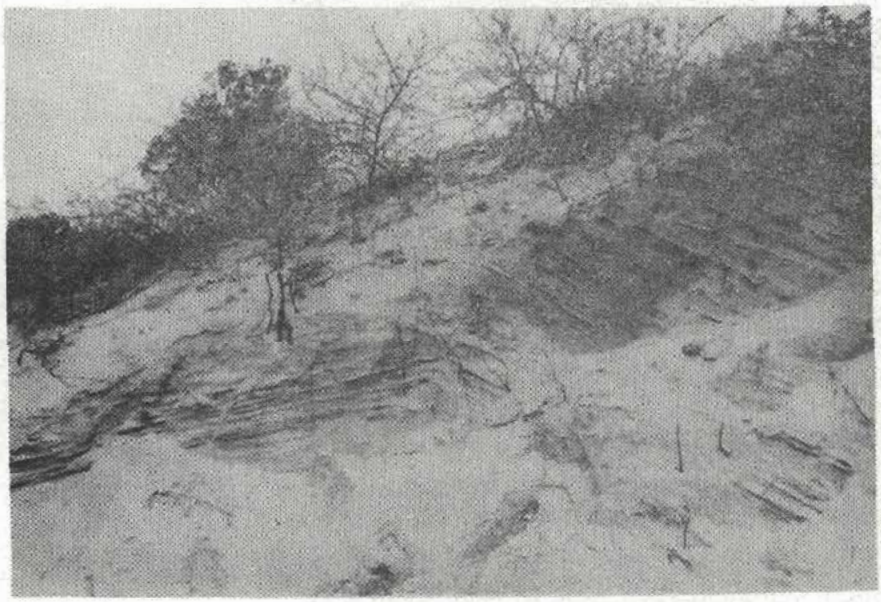


Figure 12. A dissected sand dune in SW 1/4, Sec. 6, T30S, R2E. Note the uniform grain size.

In the areas where dune sand is available, its use in water or asphalt stabilized base course construction should be considered. Because of the fine grading and the uniform grain size of this material, it will not develop sufficient shear strength to accommodate heavy wheel loadings. In spite of this fact, material similar to that found in Sumner County has been used in other sections of Kansas on roads on which wheel loadings are limited. Under these conditions this fine sand has proven to be an economical source of construction material.

Geo-Engineering

Materials Usage Considerations

It is probable that nearly all of the geological units which are exposed in Sumner County have been used at some time in the construction of highway embankment or subgrades; however, many of those which exist, such as the Wellington Shale or any of the highly plastic clay soils, are not recommended for subgrade or shoulder construction due to their shrinkage and swell characteristics. Such materials may be useful for slope protection because of their resistance to erosion, but if the development of a turf is desired, they should be avoided. If used for embankment construction, they should be placed in the lower portion, but consideration must also be given to the height of such fills in order that the shear strength of the materials are not exceeded by the weight from above. A thorough investigation of the shear values of the proposed materials should be made before usage in highway or dam construction is contemplated.

Pollution of Water Resources

The water resources of Sumner County contain a rather wide range of dissolved chemical constituents according to a ground water report by

Walters (1961). Predicated on such findings, it is recommended that caution be exercised in certain areas in the use of water in which sulfate or chloride concentrations are a consideration such as in Portland Cement concrete. The Wellington Shale, for example, yields only small quantities of water (because of its impermeable nature) which are often highly mineralized due to the presence of gypsum ($CaSO_4$) and salt (NaCl) zones in the unit. In the area west of Belle Plaine, highly saline water has been reported as coming from the Hutchinson Salt Member in the Wellington Formation, and it is presumed to be the source of pollution of the water in the overlying Wisconsinan Terrace Deposits and the Recent Alluvium of the Ninnescah River valley. In general, the water from the Wellington may vary in mineral content from one area to another, depending on the minerals in the shale.

Like the Wellington, the Ninnescah Shale Formation yields only small amounts of ground water and in certain localized areas of the county, the water produced from this unit has been reported to be strongly mineralized.

The Nebraskan Terrace Deposits, on the other hand, yield moderate quantities of good water and to the knowledge of the authors, no pollution has been reported in water being produced from this formation; however, local contamination of such sources may occur and an initial analysis of the water is recommended.

The Kansan or Illinoisan Terrace Deposits also yield moderate supplies of water of good quality except when polluted by oil field brine.

The largest sources of good quality water in Sumner County are those associated with the Wisconsinan Terrace Deposits and Recent Alluvium along the Arkansas and Ninnescah Rivers; however, pollution may also occur in certain areas from oil field brine, sewage, or solutioning of the Hutchinson Salt Member of the Wellington Shale as previously mentioned.

Possible Hydrology Problems In Road Construction

Nearly all of the geologic units which are exposed in Sumner County have properties which could contribute to ground water problems in road construction when encountered under adverse conditions. It is beyond the scope of this report to make specific recommendations; however, the undesirable characteristics of certain formations are briefly discussed herein to familiarize the reader with their existence. Detailed surface investigations should be conducted with these facts in mind to ascertain the extent and severity of ground water problems in any area where a construction project is planned.

The Wellington Shale, as previously described, consists of gray to greenish-gray, silty shale with several discontinuous limy zones which generally carry water during and after periods of heavy rainfall. To prevent subgrade failures, care should be taken to assure proper drainage of any ground water encountered in these zones when intercepted in the construction of a roadbed.

The terrace deposits throughout Sumner County generally consist of combinations of silt, clay, sand and gravel. In some instances, lenses of silt and clay which prevent the downward percolation of water and result in perched or abnormally high water tables, are found interbedded in units of predominantly granular material. Such an occurrence may accentuate the undesirable characteristics of the overlying soil and lead to eventual subgrade failures.

The existence of the water table near the surface may also be found in many locations when crossing the broad alluvial valley of the Arkansas River.

GLOSSARY OF SIGNIFICANT TERMS

Absorption: Determined by tests performed in accordance with A.A.S.H.O. Designation T 85.

Aggrade: To raise the grade or level of (a river valley, a stream bed, etc.), by depositing particles of silt, clay, sand, or gravel.

Alluvium: A deposit of clay, silt, sand, or gravel laid down by flowing water.

Arkosic gravel: Gravel composed of mineral fragments derived from weathered granite.

Dolomitic limestone: Limestone containing $MgCO_3$ (magnesium carbonate).

Geologic period: A unit of geologic time. Mississippian, Pennsylvanian, and Permian are examples.

Geologic unit: This term is used in this report to denote (1.) a geologic formation, (2.) a geologic member, or (3.) an unconsolidated deposit of Pleistocene age.

Gradation factor: The value obtained by adding the percentages of material retained on the 1 1/2", 3/4", 3/8", 4, 8, 16, 30, 50, and 100 sieves respectively and dividing the sum by 100.

Igneous: Rocks produced under conditions involving great heat, as rocks crystallized from molten material.

Liquid limit: Determined by tests performed in accordance with Section Y 4 of the State Highway Commission of Kansas Standard Specifications, 1960.

Open materials site: A pit or quarry which has produced or is producing material suitable for some phase or phases of road construction.

Plastic index: Determined by tests performed in accordance with Section Y 4 of the State Highway Commission of Kansas Standard Specifications, 1960.

Pleistocene Series: Deposits laid down during the Quaternary Period.

Prospective materials site: A geographic location where the geologic conditions are favorable for the discovery of construction material.

Siltstone: A very fine-grained stone composed of silt-sized particles.

Soundness: Determined by tests performed in accordance with Section Y 15 of the State Highway Commission of Kansas Standard Specifications, 1960.

Specific gravity: Determined by tests performed in accordance with A.A.S.H.O. Designation T 84 for sand and gravel and A.A.S.H.O. Designation T 85 for crushed stone.

Stratigraphic position: The vertical position of a geologic unit in relation to other geologic units.

Strength ratio: Determined by tests performed in accordance with A.A.S.H.O. Designation T 71.

Terrace: A plain built up by the deposition of sediments by water located above the present flood plain.

Unconsolidated deposits: Deposits of clay, silt, sand, or gravel. These deposits may be laid down by either wind or water action.

Wash: (Material passing the No. 200 sieve) Determined by tests performed in accordance with A.A.S.H.O. Designation T 11.

Weight per cubic foot: Determined by tests performed in accordance with A.A.S.H.O. Designation T 19-45.

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