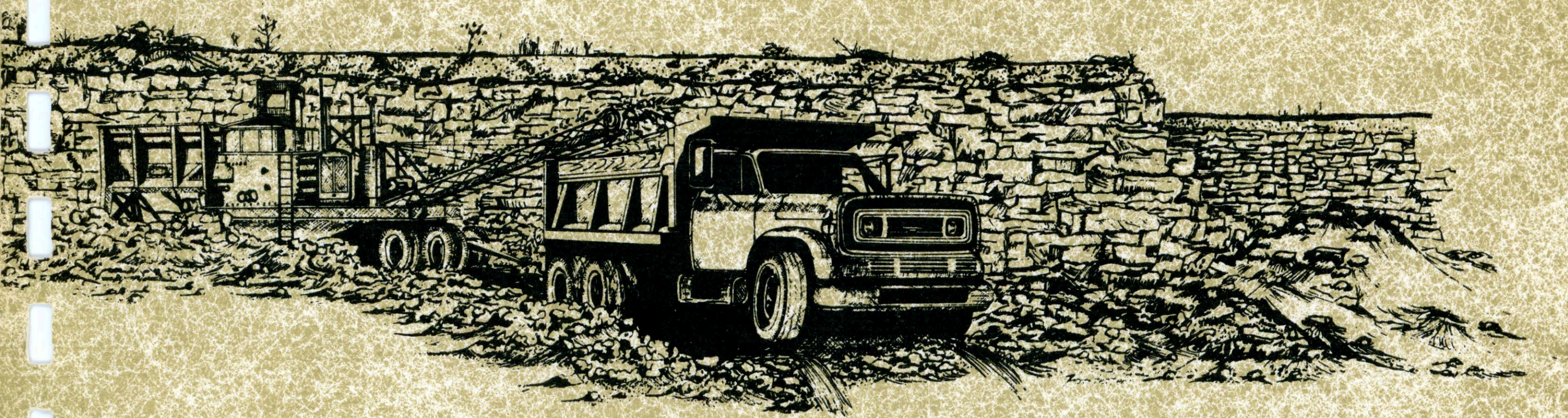
REPORT NO. 32

CONSTRUCTION MATERIALS INVENTORY



COWLEY COUNTY, KANSAS

DEPARTMENT OF TRANSPORTATION KANSAS

Kansas Department of Transportation
Engineering Services Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY

OF

COWLEY COUNTY, KANSAS

by

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Prepared in Cooperation with the
U.S. Department of Transportation
Federal Highway Administration

1978

Construction Materials Inventory Report No. 32

Copies are available from the Planning & Development Department
Kansas Department of Transportation

the WHY?

WHAT?

and HOW?

of This REPORT

This report was compiled for use as a guide for locating construction materials in Cowley County.

> *Construction materials include all granular material, consolidated rock, and mineral filler suitable for use in highway construction.*

Known open and prospective sites, both sampled and unsampled, and all geologic deposits considered to be a source of construction material are described and mapped.

> *Prospective sites are select geologic locations where construction materials may be found.*

The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to locate and evaluate *mapped sites*.

Material found in individually mapped sites represents only a small portion of the construction material resources in the county. Although data used to evaluate the material are based on limited sampling, these can be used to assess the general characteristics of the material source units elsewhere in the county.

Beginning on page 5 is a section explaining the geology of the county. This information (along with the maps, descriptions, and test data) provides the means of evaluating and locating additional construction materials sources in the geologic units throughout Cowley County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN COWLEY COUNTY

TURN TO THE MATERIALS INVENTORY SECTION

See
TABULATION OF CONSTRUCTION MATERIALS
Figure 7, Page 15

for material
BY TYPE
USE COLUMN 1

For Quality
Data
See Figure 17
Page 27

for material
BY INTENDED USE
USE COLUMN 2

for **DESCRIPTION** of material

Column 3 gives page of DESCRIPTION which includes engineering characteristics, approximate locations, and references to materials map.

for **AVAILABILITY** of material

Column 4 gives relative amounts available, general location, and references to materials map.

MATERIALS MAP

SEE PINK SHEET, PAGE 29

Material source units, as well as all open sites, are mapped. Each site is referenced to an individual data form.

SITE DATA FORMS

OPEN MATERIALS SITES; SAMPLED	GREEN SHEET, PAGE 32
OPEN MATERIALS SITES; NOT SAMPLED	GREEN SHEET, PAGE 60
PROSPECTIVE MATERIALS SITES; SAMPLED	GREEN SHEET, PAGE 76
PROSPECTIVE MATERIALS SITES, NOT SAMPLED	GREEN SHEET, PAGE 82

Each site data form includes a map for site location and provides information concerning landownership, material quality (if available), geologic age, and site accessibility.

CONTENTS

PREFACE

This report is one of a series compiled for the Highway Planning and Research Program, "Materials Inventory by Photo Interpretation". The program is a cooperative effort of the Federal Highway Administration and the Kansas Department of Transportation, financed by highway planning and research funds. The objective of the project is to *provide a statewide inventory of construction materials*, on a county basis, to help meet the demands of present and future construction and maintenance needs.

Publications issued by the State Geological Survey of Kansas, concerning Cowley and surrounding counties, provided the basic geologic information used in this investigation. Detailed geologic and soils data were obtained from geologic profiles and soil surveys prepared for use in the design of major highways in the county by the Kansas Department of Transportation.

Appreciation is extended to Mr. Kenneth Watts, P.E., Cowley County Engineer, Roland E. Fry, P.E., Kansas Department of Transportation, Fifth District Materials Engineer, Donald Brison, Gary Koontz and Paul Clark, Geologists, Kansas Department of Transportation and personnel of the Environmental Support and Special Services Sections, Engineering Services Department, Kansas Department of Transportation.

This report was prepared under the guidance of Robert R. Jones, P.E., Engineer of Engineering Services, A. H. Stallard, Chief, Environmental Support Section, and Lewis D. Myers, Geologist III, Environmental Support Section, Engineering Services Department.

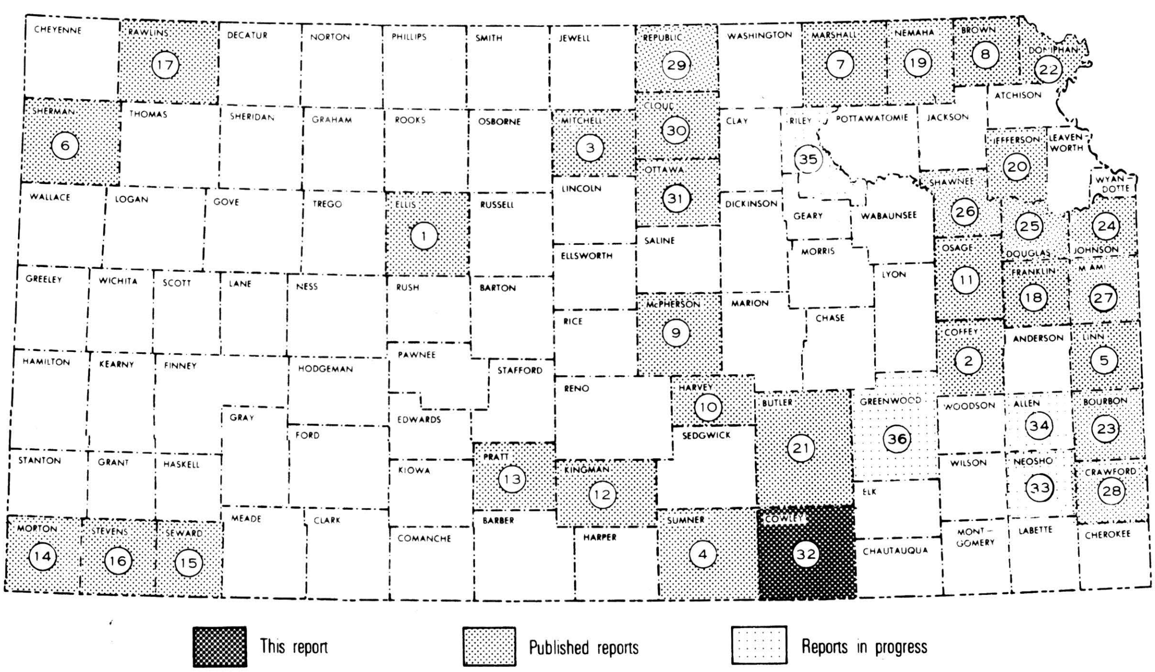


Figure 1. Index map of Kansas showing the location of Cowley County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Cowley County lies within the Central Lowlands physiographic province. Major topographic features include gently sloping upland plains and steep valley walls formed by the erosion of thick limestones and shales along major drainage channels in the Osage Plains section, and an area of relatively low relief within the Arkansas River Lowlands which is underlain by the Wellington Formation.

The Arkansas River and its major tributaries, the Walnut River and Grouse Creek, drain all but the southeastern corner of the county which is drained by Rock, Cedar, and Otter Creeks.

Sources of construction materials in Cowley County are limestones of lower Permian age, limited amounts of chert gravel from Nebraskan-Kansan Terraces which occupy elements of higher topography along the Walnut River, limited tracts of dune sand, limestone and chert gravel from Wisconsinan terraces along the Walnut River, and sand and gravel deposits in the alluvium of the Arkansas River. Limestone aggregate which can be used as light type surfacing on local roads can be produced from almost all of the limestone units exposed in the county.

Moderate to large quantities of water are available in the alluvial and terrace deposits of the Arkansas River; however, in some areas these aquifers have been contaminated by brine from oil wells. Small to moderate quantities of good to poor quality water are available in other stream valleys. Water in these aquifers may be high in bicarbonate and iron. Limited to moderate amounts of water are available from consolidated rock aquifers; however, water from these sources may have a high iron content.

GENERAL INFORMATION SECTION

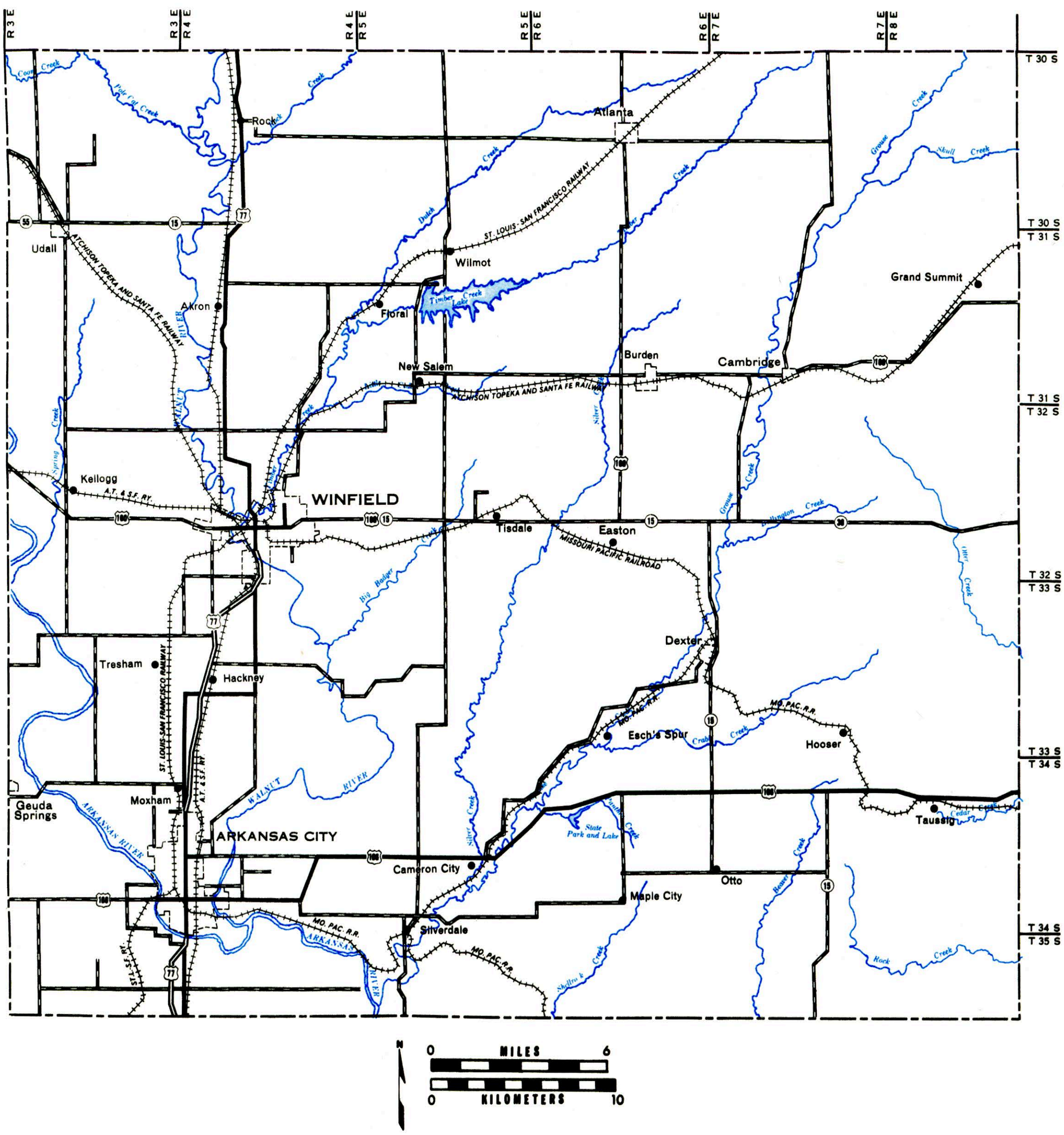


Figure 2. Drainage and major transportation facilities in Cowley County.

FACTS ABOUT COWLEY COUNTY

Cowley County, one of the largest counties in Kansas, is located along the Oklahoma border in south central Kansas and has an approximate area of 1,136 square miles (2942 sq. km.) (figure 1, page v). According to the Kansas State Board of Agriculture, Cowley County had a population of 35,125 in 1976.

Elevations above mean sea level range from a high of 1586 feet (483.4 m) located in the northeastern part of the county in the E½, sec. 33, T30S, R8E, to a low of 920 feet (280.4 m) where Rock Creek exits the county in the NE¼, sec. 9, T35S, R8E.

A primary road system connects all major communities, and a well developed secondary road system provides access to small communities. Figure 2 illustrates major drainage and transportation facilities in the county.

METHODS OF INVESTIGATION

Investigation for and preparation of this report consisted of three phases: (1) research and review of available information, (2) photo interpretation, and (3) field reconnaissance.

Phase One: Relevant information concerning geology, soils, and construction materials of the county was reviewed and the general geology determined. Quality test results of samples taken in Cowley County were then correlated with the various geologic units.

Phase Two: A study and interpretation of aerial photographs taken by the Kansas Department of Transportation at a scale of one inch equals 2,000 feet (1cm = 240 meters) was accomplished. Figure 3 illustrates aerial photographic coverage of Cowley County. Geologic source beds and all open materials sites were mapped and classified on aerial photographs. All materials sites were then correlated with the geology of the county.

Phase Three: This phase was conducted after initial study of aerial photographs. A field reconnaissance was conducted by the author to examine construction materials, to verify doubtful mapping situations, and to acquire supplemental geologic information. Geologic classifications of open sites were confirmed, and prospective sites were observed.

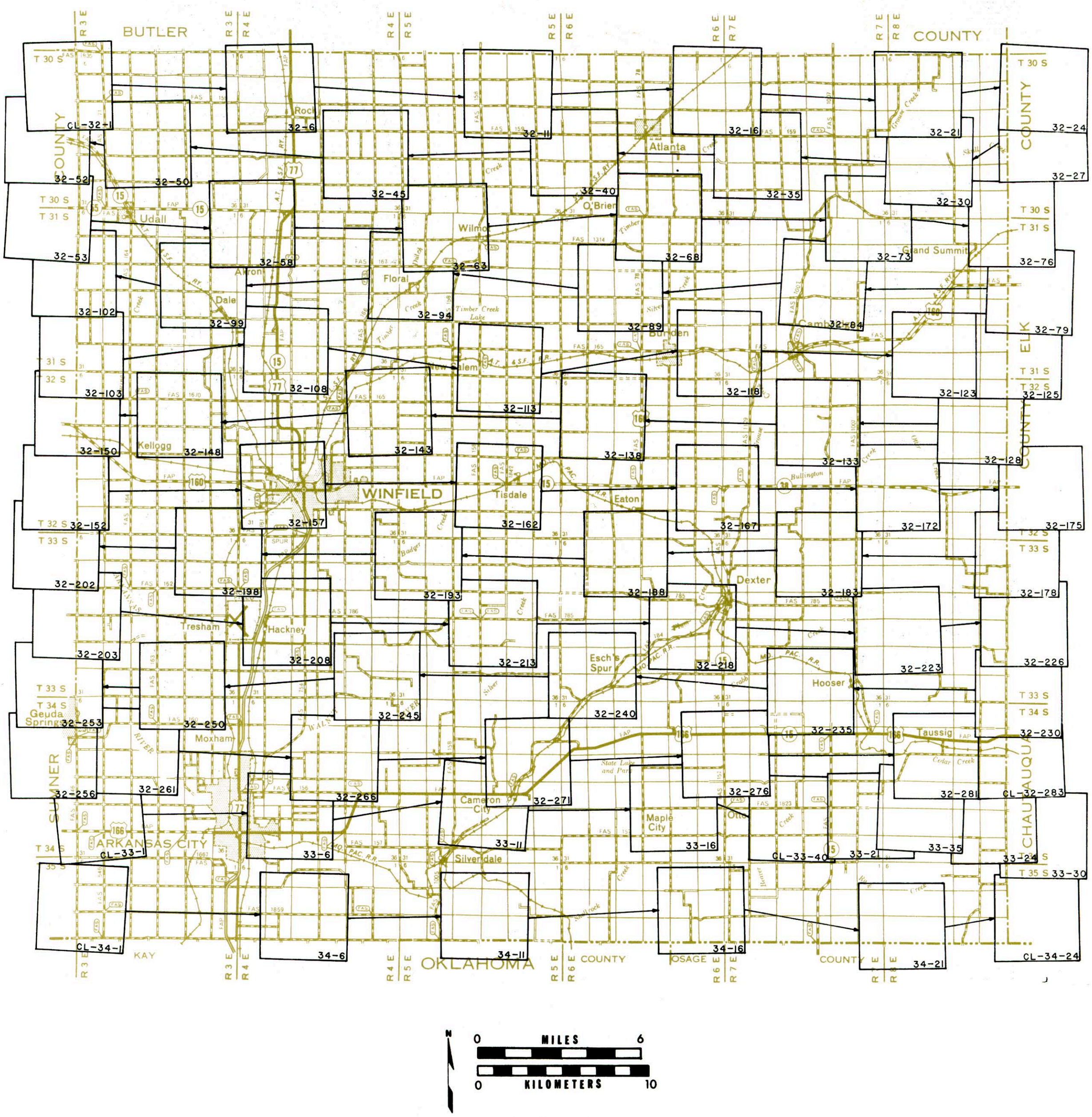
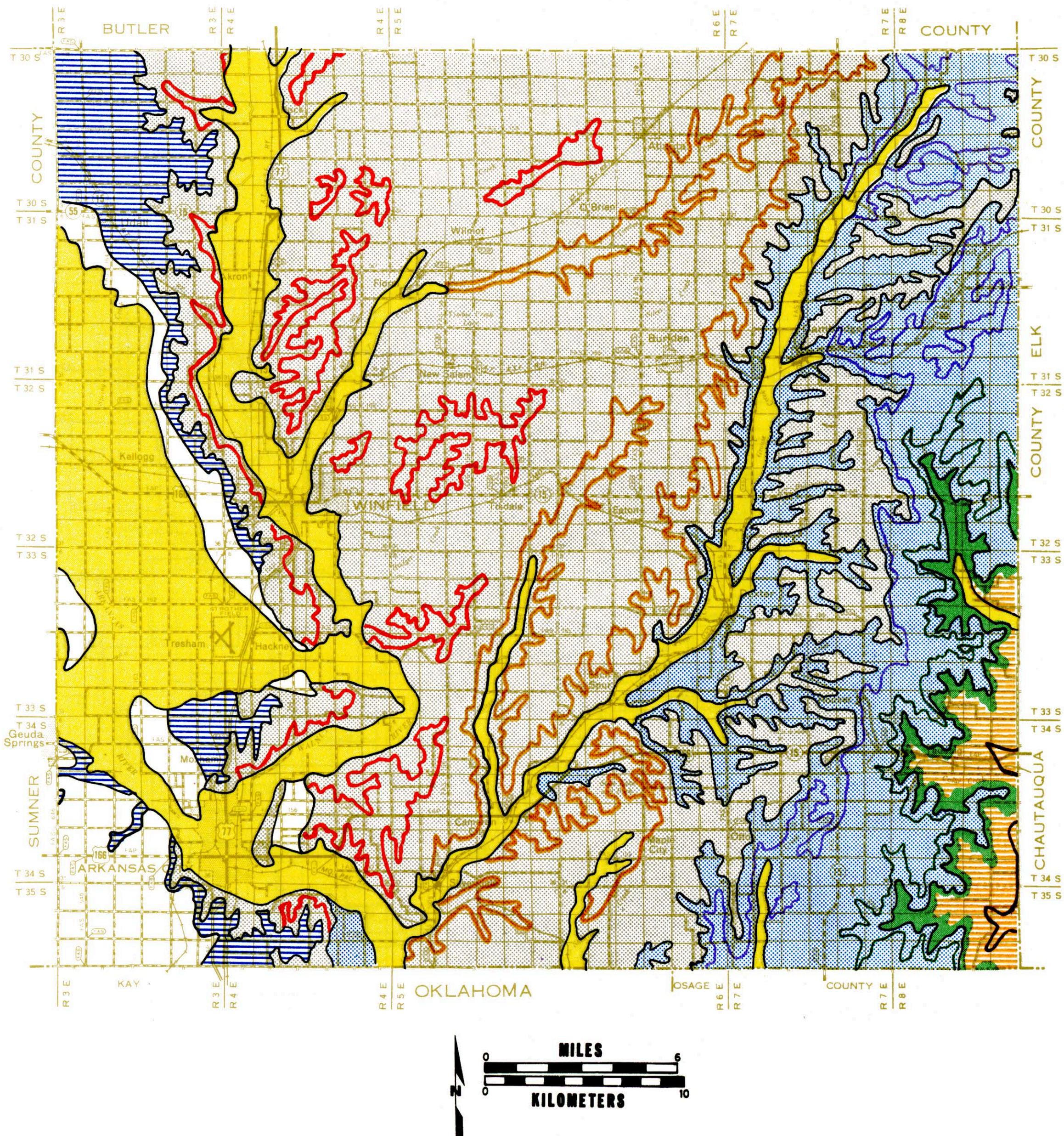


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Cowley County. The numbers refer to photographs taken by the Photogrammetry Section, Kansas Department of Transportation, on 12-17-76, 2-17-77, and 3-8-77 at a scale of 1"=2000'. (1 cm. = 240 m) Aerial photographs are on file in the KDOT's Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION



LEGEND

- Alluvium
- Loess
- Sumner Group
- Chase Group
- Winfield Limestone Base
- Barneston Limestone Base
- Council Grove Group
- Crouse Limestone Base
- Red Eagle Limestone Base
- Admire Group
- Wabaunsee Group
- Zeandale Limestone Base

GENERAL GEOLOGY

GEOLOGY is the basis for this materials inventory. Knowledge of the geology makes it possible to: (1) ascertain the general properties of the material source, (2) identify and classify each source according to current geologic nomenclature, and (3) establish a uniform system of material-source-bed classification. By knowing the geologic age, origin, land form, and quality information of the source units, one can derive general information for untested materials sites and prospective locations.

It is important to note that the quality of material from a given source may vary from one location to another, especially in unconsolidated deposits.

Material for this discussion is based on information obtained from field observations and reports on Cowley and surrounding counties compiled by the Kansas Geological Survey, and the Kansas Department of Transportation. The geologic timetable, figure 4, shows in graphic form the major time periods and the approximate duration of each. Figure 5, Page 7, illustrates the surface geology and stratigraphic position of each material source unit in Cowley County.

Subsurface rocks in the county range in age from Precambrian to upper Pennsylvanian. Based on samples obtained from wells located in the western and central parts of the county, the Precambrian rocks have been identified as granites. According to Merrian (1963), these wells penetrated to depths in excess of 4,000 feet (1219.2 m). Evidence from wells drilled for oil exploration throughout the county indicates that the surface of the Precambrian has a westward dip from a subsurface elevation of 2,400 feet (731.5 m) below sea level to 3,800 feet (1158.2 m) below sea level. The surface of the Precambrian may rise to 2,000 feet (609.6 m) below sea level in the northwestern part of the county due to the presence of the Nemaha Anticline (Bayne, 1962).

Marine sedimentary rocks of Cambrian and Ordovician age lie directly on the Precambrian surface. During this time of the Chautauqua Arch began to emerge and sediments of Silurian and Devonian age on the arch were eroded away as the uplift continued (Merriam, 1963). The development of the Chautauqua Arch ceased and the Chattanooga Shale of Late Devonian or early Mississippian age as well as Mississippian sediments were deposited over the arch. Late Mississippian and early Pennsylvanian time consisted of an erosional period which thinned the strata over structurally high areas and deposited sediments in the developing Cherokee Basin. Another major erosional disconformity is found between Middle Pennsylvanian and Upper Pennsylvanian Series sediments in Cowley County.

Marine deposits of the Upper Pennsylvanian Series are the oldest sediments exposed in the county. These sediments are alternating thin limestones and shales with scattered sandstone beds found with the sequence. This cyclothemic depositional sequence continued through the Lower Permian with limestones becoming thicker in the Council Grove and Chase Groups (Figure 5). These limestones are the most important materials source units of the county.

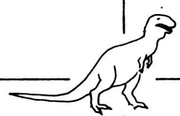
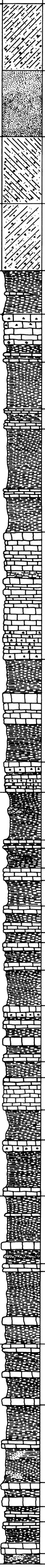
ERAS	PERIODS	ESTIMATED LENGTH IN YEARS	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE) 	1,800,000	Glacial drift; river silt, sand, and gravel; dune sand; wind-blown silt (loess); volcanic ash.	Sand and gravel; volcanic ash; agricultural soils; water.
	TERTIARY 	63,500,000	Silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.	Sand and gravel; volcanic ash; diatomaceous marl; water.
MESOZOIC	CRETACEOUS	71,000,000	Chalky shale, dark shale, vari-colored clay, sandstone, conglomerate; outcropping igneous rock.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; ceramic materials; water.
	JURASSIC	59,000,000	Sandstone and shale, chiefly subsurface.	
	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN 	55,000,000	Limestone, shale, evaporites (salt, gypsum, anhydrite), red sandstone and siltstone, chert, and some dolomite.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and building stone; natural gas, salt, gypsum, water.
	PENNSYLVANIAN 	40,000,000	Alternating marine and non-marine shale; limestone, sandstone, coal, and chert.	Concrete and bituminous aggregate, light type surfacing, shoulder and subgrade material, riprap, and limestone and shale for cement; ceramic materials; oil, coal, gas, and water.
	MISSISSIPPIAN 	25,000,000	Mostly limestone, predominantly cherty.	Chat and other construction materials; oil, zinc, lead, and gas.
	DEVONIAN	50,000,000	Subsurface only. Limestone and black shale.	Oil.
	SILURIAN	45,000,000	Subsurface only. Limestone.	Oil.
	ORDOVICIAN	60,000,000	Subsurface only. Limestone, dolomite, sandstone, and shale.	Oil, gas, and water.
	CAMBRIAN 	70,000,000	Subsurface only. Dolomite and sandstone.	Oil.
PRE-CAMBRIAN	(Including PROTEROZOIC and ARCHEOZOIC ERAS)	4,600,000,000 +	Subsurface only. Granite, other igneous rocks, and metamorphic rocks.	Oil and gas.

Figure 4. Geologic Timetable.



System	Series	Stage or Group	Formations and Members		Map Symbol	Thickness	General Description	Construction Materials
Quaternary	Pleistocene	Recent	Alluvium		Qal	0-50'± (0-15.2m)	Silt, clay, fine sand, sand and gravel. Sand and gravel composed of quartz, chert, limestone gravel and minor amounts of igneous material.	Bituminous aggregate, light type surfacing, concrete aggregate if sweetener added to pass wetting and drying test.
			Dune Sand		Qds	0-50'± (0-15.2m)	Tan to gray, cross-bedded, fine-grained quartzite sand.	Limited use as mortar sand.
		Wisconsinan	Wisconsinan Terrace		Qtw	0-55'± (0-16.8m)	Silt, clay, organic material, scattered lenses of chert gravel and limestone gravel.	Bituminous aggregate and light type surfacing, concrete aggregate if sweetener is added to pass wetting and drying test.
		Kansan	Kansan Terrace		Qtk	0-10'± (0-3m)	Brown to gray, well rounded chert gravel and clay.	Bituminous and concrete aggregate and light type surfacing.
Permian	Lower Permian	Sumner	Wellington Formation			80'± (24.4m)		
		Chase	Nolans Limestone	Herington Ls. Mbr.	Pnh	5-30'± (1.5-9.1m)	Limestone, light buff to tan, dolomitic, punky appearance, contains many geodes.	Light type surfacing.
				Paddock Shale Mbr.		7-8.8'± (2.1-2.7m)		
				Krider Limestone Mbr.		3.7-8.9'± (1.1-2.7m)		
			Odell Shale			35-45'± (10.7-13.7m)		
			Winfield Limestone	Cresswell Ls. Mbr.	Pwc	15-20'± (4.6-6.1m)	Hard, dense limestone, small solution cavities, high absorption.	Light type surfacing, concrete aggregate if selectively quarried.
			Doyle Shale	Gage Shale Mbr.		40-60'± (12.2-18.3m)		
				Towanda Limestone Mbr.		2.7-5.8'± (.8-1.8m)		
				Holmesville Shale Mbr.		4-35'± (1.2-10.7m)		
			Barneston Fm.	Fort Riley Ls. Mbr.	Pb	45-80'± (13.7-24.4m)	Thick bedded, massive limestone, many sink holes in northern portion of county. High absorption values.	Building stone, light type surfacing, ag lime.
				Florence Ls. Mbr.		12-35'± (3.7-10.7m)		
			Matfield Shale	Blue Springs Shale Mbr.		19-34'± (5.8-10.4m)		
				Kinney Limestone Mbr.		13-30'± (4.0-9.1m)		
				Wymore Shale Mbr.		8-38'± (2.4-11.6m)		
			Wreford Limestone	Schroyer Ls. Mbr.		6-10'± (1.8-3.0m)	Uneven bedded, massive limestone containing abundant chert. Forms good outcrop.	Suitable for light type surfacing. Excessive chert makes quarrying uneconomical for other than local use.
				Havensville Shale Mbr.	Pw	5'± (1.5m)		
				Threemile Ls. Mbr.		16-20'± (4.9-6.1m)		
		Council Grove	Speiser Shale			29-48'± (8.8-14.6m)		
			Funston Limestone			7.3'± (2.2m)		
			Blue Rapids Shale			6-20'± (1.8-6.1m)		
			Crouse Limestone		Pc	8-12'± (2.4-3.7m)	Flaggy, massive limestone containing some chert.	Suitable for all but bituminous aggregate.
			Easly Creek Shale			10-25'± (3.0-7.6m)		
			Bader Limestone	Middleburg Ls. Mbr.		5-8'± (1.5-2.4m)		
				Hooser Shale Mbr.		9'± (2.7m)		
				Eiss Limestone Mbr.		10'± (3.0m)		
			Stearns Shale			6-10'± (1.8-3.0m)		
			Beattie Limestone	Morrill Limestone Mbr.		3.5-9'± (1.1-2.7m)		
				Florena Shale Mbr.		2.5-11'± (.8-3.4m)		
				Cottonwood Ls. Mbr.		5-6'± (1.5-1.8m)		
			Eskridge Shale			21-35'± (6.4-10.7m)		
			Grenola Limestone	Neva Limestone Mbr.		17-25'± (5.2-7.6m)		
				Salem Point Shale Mbr.		6'± (1.8m)		
				Burr Limestone Mbr.		4'± (1.2m)		
				Legion Shale Mbr.		3-8'± (.9-2.4m)		
				Sallyards Ls. Mbr.		3-5'± (.9-1.5m)		
			Roca Shale			15'± (4.6m)		
			Red Eagle Limestone	Howe Limestone Mbr.		2.5-3'± (.8-.9m)	Massive, hard, fossiliferous, dense, gray limestone. Contains some thin shale seams.	Bituminous and concrete aggregate, and light type surfacing.
				Bennett Shale Mbr.	Pr	18'± (5.5m)		
				Glenrock Ls. Mbr.		1'± (.3m)		
			Johnson Shale			20-30'± (6.1-9.1m)		
			Foraker Limestone	Long Creek Ls. Mbr.		8-12'± (2.4-3.7m)		
				Hughes Creek Sh. Mbr.		25-35'± (7.6-10.7m)		
				Americus Ls. Mbr.		4-9'± (1.2-2.7m)		
		Admire	Janesville Shale	Hamlin Shale Mbr.		40-47'± (12.2-14.3m)		
				Five Point Ls. Mbr.		2-4'± (.6-1.2m)		
				West Branch Sh. Mbr.		12-14'± (3.7-4.3m)		
			Falls City Limestone			3-5'± (.9-1.5m)		
			Onaga Shale	Hawxby Shale Mbr.		35-45'± (10.7-13.7m)		
				Aspinwall Ls. Mbr.		1-3'± (.3-.9m)		
				Towle Shale Mbr.		13-20'± (4.0-6.1m)		
Pennsylvanian	Upper Pennsylvanian	Wabaunsee	Wood Siding Formation	Brownville Ls. Mbr.		1-2'± (.3-.6m)		
				Pony Creek Shale Mbr.		15-20'± (4.6-6.1m)		
				Grayhorse Ls. Mbr.		2-4'± (.6-1.2m)		
				Plumb Shale Mbr.		20'± (6.1m)		
				Nebraska City Ls. Mbr.		1-2'± (.3-.6m)		
			Root Shale	French Creek Sh. Mbr.		30-35'± (9.1-10.7m)		
				Jim Creek Ls. Mbr.		1-2'± (.3-.6m)		
				Friedrich Shale Mbr.		18-35'± (5.5-10.7m)		
			Stotler Limestone	Grandhaven Ls. Mbr.		4-6'± (1.2-1.8m)		
				Dry Shale Mbr.		5-7'± (1.5-2.1m)		
				Dover Limestone Mbr.		8-10'± (2.4-3.0m)		
			Pillsbury - Willard Shale			10-15'± (3.0-4.6m)		
			Emporia Limestone	Elmont Limestone Mbr.		2-5'± (.6-1.5m)		
				Harveyville Shale Mbr.		10-14'± (3.0-4.3m)		
				Reading Limestone Mbr.		6-10'± (1.8-3.0m)		
			Auburn Shale			5-10'± (1.5-3.0m)		

Figure 5. Generalized geologic column of the surface geology in Cowley County.

Although sediments of the Mesozoic Era are present in western Kansas, no deposits of this age are found in Cowley County. This area is assumed to have been a landmass during most of this era and any sediments which might have been deposited were subsequently removed by erosion. Erosional processes were active through most of Tertiary time. Any sediments which have been deposited during this time were removed by erosion during the Quaternary Period.

The Quaternary Period (Figure 6) was a period of repeated glacial and interglacial cycles throughout much of North America. During Kansan time the glaciers advanced as far south as northeast Kansas to the vicinity of the Kansas River. Although Cowley County did not receive glacial outwash material, climatic changes did affect the Pleistocene deposits over the county. According to Bayne (1962), the Arkansas River and other streams in the area established their present courses during pre-Illinoisan time. Agradational cycles during this period deposited terraces containing sand and gravel. Climatic changes during the Pleistocene which caused streams agradational to degradational cycles, continue to the present.

Divisions of the Quaternary Period

Period	Epoch	Age	Estimated length of age duration in years	Estimated time in years elapsed to present
Quaternary	Pleistocene	Recent		10,000
		Wisconsinan Glacial	80,000	90,000
		Sangamonian Interglacial	160,000	250,000
		Illinoisan Glacial	110,000	360,000
		Yarmouthian Interglacial	160,000	520,000
		Kansan Glacial	280,000	800,000
		Aftonian Interglacial	450,000	1,250,000
		Nebraskan Glacial	550,000	1,800,000 +

Figure 6. Geologic timetable of the Quaternary Period.

Sand dunes found along the north side of the Arkansas River were formed by an arid cycle during Recent time. This material was derived from alluvial deposits along the Arkansas River and transported to its present location by prevailing winds.

GEO-ENGINEERING

This section provides a general appraisal of the geo-engineering problems that may be encountered in Cowley County during highway construction. Potential groundwater problems and the quality of water available for concrete are briefly reviewed along with engineering soil types present in the area. *Detailed field investigations will be necessary to ascertain the severity of specific problems and to make recommendations in design and construction procedures.*

Major geo-engineering problems in Cowley County are associated with alluvium and terrace deposits of major drainage channels, escarpment forming limestones, and variations in soil mantle type and thickness. Additional geo-engineering problems can be expected in areas where sink holes are encountered, and in dune sand areas located in the vicinity of the Arkansas River.

Major escarpment forming units are the Foraker, Wreford, Barneston, and Winfield Limestone Formations. The Nolans Limestone Formation also forms an escarpment in some areas west of the Walnut River where it has not been covered by Quaternary deposits. Large quantities of rock excavation will be encountered in deep cut sections through these escarpments. The magnitude or difficulty of rock excavation will depend on the limestone thickness, topographic relationships and the character of overlying shales.

Stability problems in subgrades and back slopes will be encountered where the Speiser, Blue Springs, Holmesville, Gage and Odell Shales are encountered. Problems may also occur in other shales within the section; however, detailed field studies will be needed to delineate the full areal extent and magnitude of problems.

Soil mantle varies in thickness from a few inches (cm) in the eastern part of the county to in excess of 30 feet (9.1 m) where eolian silts overlie coarse gravels of the Sappa and Grand Island Formations in the western third of the county (Bayne 1962). Generalized soil thickness are based on information derived from photo interpretation, field observation and field data obtained by the Geology and Soils Section of the Kansas Department of Transportation. Soils occuring on top of Permian age limestones will generally average less than 3 feet (0.9 m) in thickness and are characterized by high clay content while soils developed over shales will generally have a thickness ranging up to 10 feet (3.0 m). The soils developed over the limestone units have poor engineering characteristics due to their high clay content. Varying thicknesses of soil and talus will be encountered along steeper slopes. Soils derived from shales generally have a plasticity index of approximately 30 while soils developed over limestones have a plasticity index in the vicinity of 40.

Alluvial and terrace deposits are found in three areas of the county; the Arkansas River valley, the Walnut River valley, and the valleys of other tributaries. The alluvium and terraces of the Arkansas and Walnut Rivers contain many old meander scars which have unconsolidated and sometimes organic material which is conducive to differential consolidation under fill sections. Detailed studies should be conducted in these areas to determine construction procedures which will minimize the effects of this consolidation. The need for borrow for fill construction in alluvium will require exploration to acquire sufficient material above the water table unless pumping operations are contemplated. The granular material and eolian loess found in the Arkansas River valley and the area between the Arkansas and Walnut Rivers are susceptible to erosion. Suitable design practices should be followed in these areas to inhibit excessive errosional rates. Terrace deposits of the Walnut River are high in clay content with scattered lenses of chert and limestone gravel. Alluvium and terrace deposits found in the smaller streams have a limited thickness and areal extent due to high stream gradients. Erosion by high flow rates in these areas is excessive.

Hydrology problems are anticipated at the bases of most limestones as well as the soil mantle bedrock contact. For example, the Americus Limestone was observed to carry a moderate amount of water on K-38 near the Chautauqua County line. The quantity of all these water sources is subject to large variations directly proportional to the rainfall. Perched water tables may be encountered in gravel lenses along the Walnut River.

Oil and gas have been produced in Cowley County since shortly after the turn of the century. Although production has generally declined from a peak in 1925 (Bayne, 1962) the increased demand for petroleum products has caused an increase in exploration drilling with many new wells being completed at the time of this study. Most production is from shallow zones in the Admire and Douglas Groups. Many early wells were not cased and their locations were not accurately recorded. If wells are encountered during construction they should be plugged. This will prevent water being induced into fill sections in areas where secondary recovery repressuring operations exist.

Karst topography has developed in the county where the Barneston Limestone forms the main element of topography. The most extensive sink hole development is in the north central part of the county (T30S, R5W) where sinkholes follow joint patterns in the limestone. Other sink areas are located in central Cowley County in the southern part of T32S, R5E and the northeastern part of T33S, R5E.

Areas of dune sand (plates IV, VII, and X) may present a construction and maintenance problem due to severe erosion when vegetation is removed. Binder material such as soil or asphalt will also be needed to prepare a stable subgrade for construction equipment.

Water supplies in the county vary in both quality and quantity. Wells in the eastern third of the county generally yield less than 10 gpm (0.63 l/s) while wells in the central third yield from 10 to 100 gpm (0.63 - 6.3 l/s). In areas where the Cresswell and Herington Limestones are located in the western third, yields of less than 10 gpm (0.63 l/s) can be expected. Alluvial and terrace deposits of the

Arkansas and Walnut Rivers will yield from 100 to 1,000 gpm (6.3 - 63 l/s). Gravels of Quaternary age that are found between the Arkansas and Walnut Rivers as far north as Udall also yield from 100 to 1,000 gpm (6.3 - 63 l/s).

Water produced from limestone, sandstone, and shale sequences of early Permian and late Pennsylvanian age is generally high in bicarbonate. In some areas in the southern part of the county the water has excessive chlorides and sulfates. Water from Quaternary deposits is generally very good; however, brine contamination from past oil production in the area has polluted some aquifers.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Siliceous sand and gravel deposits of Quaternary age provide a major portion of the available construction aggregate of Cowley County. Limited amounts of chert gravel are located in some of the terraces along major drainage channels and on some of the upland areas along abandoned channels. However, these gravels have a large percentage of clay as a matrix.

Limestones of Permian age are found throughout the county. Many of the limestones are suitable for construction aggregate and building stone.

Construction materials types, their uses, and availability are tabulated in figure 8. Test results from limited sampling and testing are presented in figure 17 (page 27).

CONTENTS

MATERIALS INVENTORY SECTION

TYPE material and Geologic Source	USE	PAGE	AVAILABILITY
LIMESTONE Red Eagle Limestone Formation	Concrete and bituminous aggregate, light type surfacing and rip-rap.	16	Moderate to good source in eastern quarter of county. Plates VI, IX and XII.
Crouse Limestone Formation	Concrete aggregate and light type surfacing.	17	Limited to moderate source in eastern third of county. Not mapped in this report.
Wreford Limestone Formation	Light type surfacing.	18	Good source in eastern half of county. Plates III, VI, VIII, IX, XI, and XII.
Barneston Limestone Formation	Concrete aggregate, light type surfacing, and building stone.	19	Good source in areas east of Walnut River. All except plate X.
Winfield Limestone Formation	Light type surfacing.	21	Good source in western half of county. Plates I, II, IV, V, VII, VIII, X and XI.
Nolans Limestone Formation	Light type surfacing.	22	Limited source in western third of county. Not mapped in this report.
SAND AND GRAVEL Chert Gravel	Concrete and bituminous aggregate, light type surfacing.	23	Very limited sources located as high terrace deposits flanking Walnut River. Not mapped in this report.
Dune Sand	Sweetner or mortar sand.	24	Limited source in western quarter of county. Plates IV, VII, and X.
Wisconsinan Terrace	Concrete and bituminous aggregate, light type surfacing.	24	Limited to moderate source along all major drainage channels. All plates.
Quaternary Alluvium	Concrete and bituminous aggregate, light type surfacing.	24	Good source along Arkansas River. Plates IV, VII, X and XI.

Figure 7. Tabulation of the construction materials types and their availability in Cowley County.

Limestone

Red Eagle Limestone Formation

The Red Eagle Limestone Formation is composed of two limestone members and one shale member. These members are, in ascending order, the Glenrock Limestone, Bennett Shale, and Howe Limestone. The Red Eagle Limestone has an approximate thickness of 28 feet (8.5 m) in Cowley County. The Bennett Shale Member which is almost entirely limestone in the county, and the overlying Howe Limestone Member were being actively quarried for construction aggregate during the time of this study.

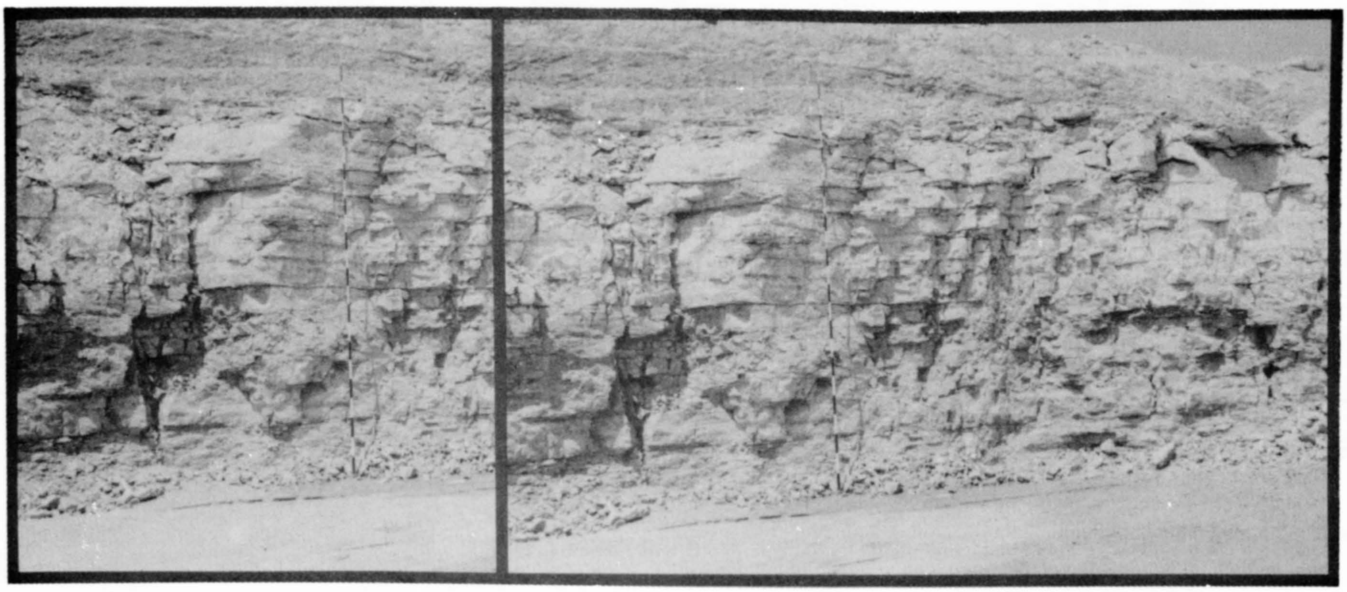


Figure 8. Red Eagle Limestone Formation exposed in a quarry located in the SW¼, sec. 7, T34S, R8E. (stereogram)

The Glenrock is a light gray, fossiliferous limestone having an average thickness of 1 foot (0.3 m). This member is the floor of the quarry shown in figure 8.

The Bennett Shale Member has an average thickness of 18 feet (5.5 m), is almost entirely limestone, and is commonly referred to as the "Bennett Reef" in this area. The lithology of the member changes from a shale to a limestone due to variations in the depositional environment. The Bennett is light to tan gray, to brown, massive, hard, crystalline, sparsely to moderately fossiliferous limestone.

Thin shale seams that range in thickness from 0.1 - 0.3 inches (0.25-0.76 cm) are found in the unit. The lowermost bed of the unit contains fossils of the Orbiculoidea fauna. These fossils serve to identify the "Bennett Reef" inasmuch as they are not found in the Glenrock or Howe Members.

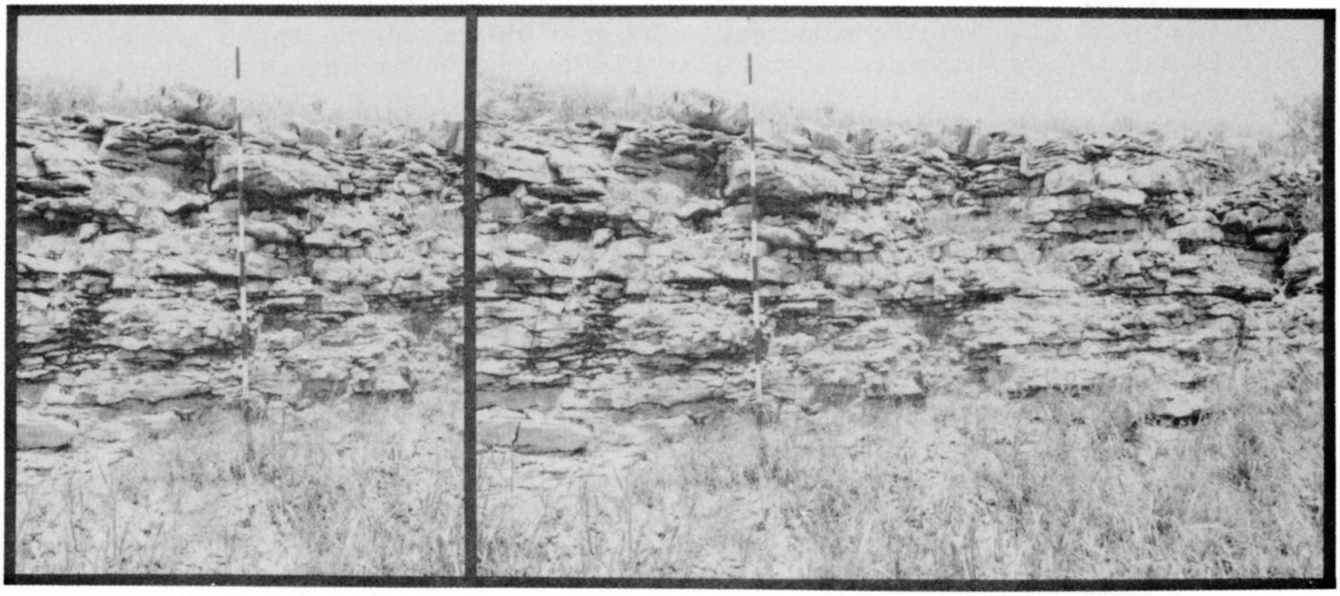


Figure 9. "Bennett Reef" exposed in a road cut along K-38 in the NW¼, sec. 24, T32S, R8E. (stereogram)

The Howe Limestone, the uppermost member of the Red Eagle Limestone, is a hard, gray-brown to buff, massive, fossiliferous limestone, which has a thickness of 2.5 to 9 feet (0.8 - 2.7 m). The weathered surface of the unit is very granular as a result of the uneven weathering of the calcareous fossils and the calcite matrix.

Quality test data on samples taken from the Red Eagle in Cowley County indicate the material is generally suitable for construction aggregate; however, quality tests should be completed at each production site. Test results show L.A. wear values from 26% to 30% and absorption values from 1.8% to 2.9%.

The outcrop pattern of the Red Eagle Formation which is not distinctive in the field, is shown on plates VI, IX and XII.

Crouse Limestone Formation

The Crouse is a yellowish-gray to bluish-gray limestone that weathers to a light-gray color. It is a flaggy to massive limestone that contains some chert and has a thickness of 8 to 12 feet (2.4 - 3.7 m). The Crouse can be divided into three distinct units; a lower thin-bedded, shaly unit, 2 to 3 feet (0.6 - 0.9 m) thick; a middle unit, 4 to 5 feet (1.2 - 1.5 m) thick, dense, bluish gray and containing some chert; and an upper flaggy unit 3 to 4 feet (0.9 - 1.2 m) thick. Both the lower and upper units weather much more readily than the middle zone, allowing the middle unit to break off in large slabs and form a distinctive outcrop.

Available test results on samples from a Crouse quarry in the northeast part of the county indicate the soundness ranges from .97 to .98, absorption 1.80 to 6.49 and L.A. wear values ranges from 25.4 to 34.8. The limited thickness, excessive overburden, and close proximity to the outcrop of the Red Eagle Formation has limited production from the Crouse to local use only. The Crouse was not mapped for this report but lies between the Red Eagle and Wreford Formations which are shown on plates III, VI, IX and XII.

Wreford Limestone Formation

The Wreford Limestone is composed, in ascending order, of the Threemile Limestone, Havensville Shale, and the Schroyer Limestone. The formation has a thickness of approximately 33 feet (10.1 m).

Figure 10. Threemile Limestone Member exposed in a road cut in the E½, sec. 32, T33S, R6E. (stereogram)

The Threemile Member is a buff to white or gray, hard, unevenly bedded, massive limestone containing chert nodules interbedded with thin beds of limestone in the lower two thirds of the member. The lower part is sparsely fossiliferous and weathers to a yellow tan. The upper third of the member is primarily a buff to tan limestone that weathers to a deeply pitted surface and is fossiliferous. The pitted surface is thought to be the result of cylindrical openings of clam borings which have been enlarged by weathering (Bayne, 1962). The thickness of the Threemile Member is approximately 16-20 feet (4.9 - 6.1 m).

The Havensville Shale Member overlies the Threemile Member and is composed of a one foot (0.3 m) thick shale, a 3 to 6 feet thick (0.9 - 1.8 m) limestone containing numerous chert nodules and another one foot (0.3 m) thick shale. There were few exposures of the Havensville Shale in Cowley County.

The Schroyer Limestone Member, the uppermost unit of the Wreford Limestone, has an average thickness of 6 to 10 feet (1.8 - 3.0 m). The color ranges from a white to gray buff and weathers tan. Numerous chert nodules characterize the member and it is generally close jointed, massive, and contains numerous fossils. The Schroyer is not resistant to weathering and thus does not form a distinctive outcrop.

Material for local use as light type surfacing can be produced from the Wreford Formation; however, the excessive chert makes it very difficult and costly to produce. The base of the Wreford has been mapped on plates III, VI, VII, IX, XI and XII.

Barneston Limestone Formation

In Cowley County the Barneston Limestone is composed of the basal Florence Limestone Member and the overlying Fort Riley Limestone Member. The Oketo Shale Member which normally separates the Florence and Fort Riley Members in other areas of the state was not observed in the county. The formation is highly variable and ranges from 65 to 125 feet(19.8 to 38.1 m) in thickness.

The Florence is a light buff limestone that weathers to a gray or white color. It is massive and exhibits some wavy bedding in the lower third of the unit. It contains abundant chert bands and nodules in the middle third with lesser amounts in the lower and upper thirds. The bed is soft and fossiliferous, and the upper part weathers much more easily than the lower part.

The Florence has not produced in the county due to the excessive amounts of chert and the availability of the overlying Fort Riley.

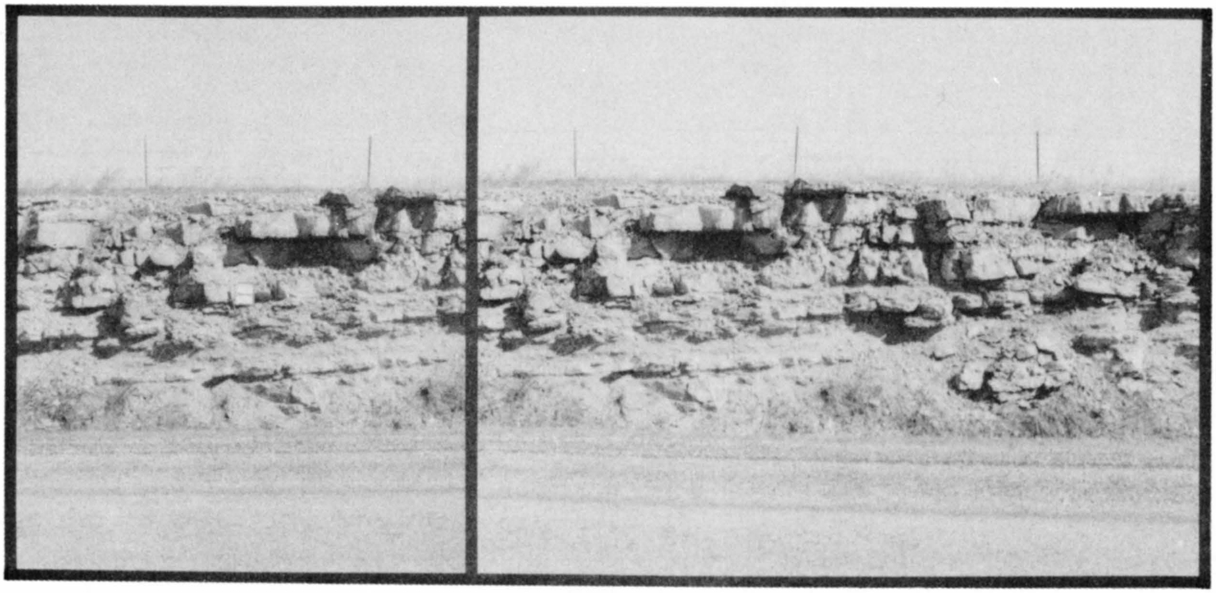


Figure 11. Florence Limestone Member exposed in a road cut in the NW¼, sec. 14, T33S, R6E. (stereogram)

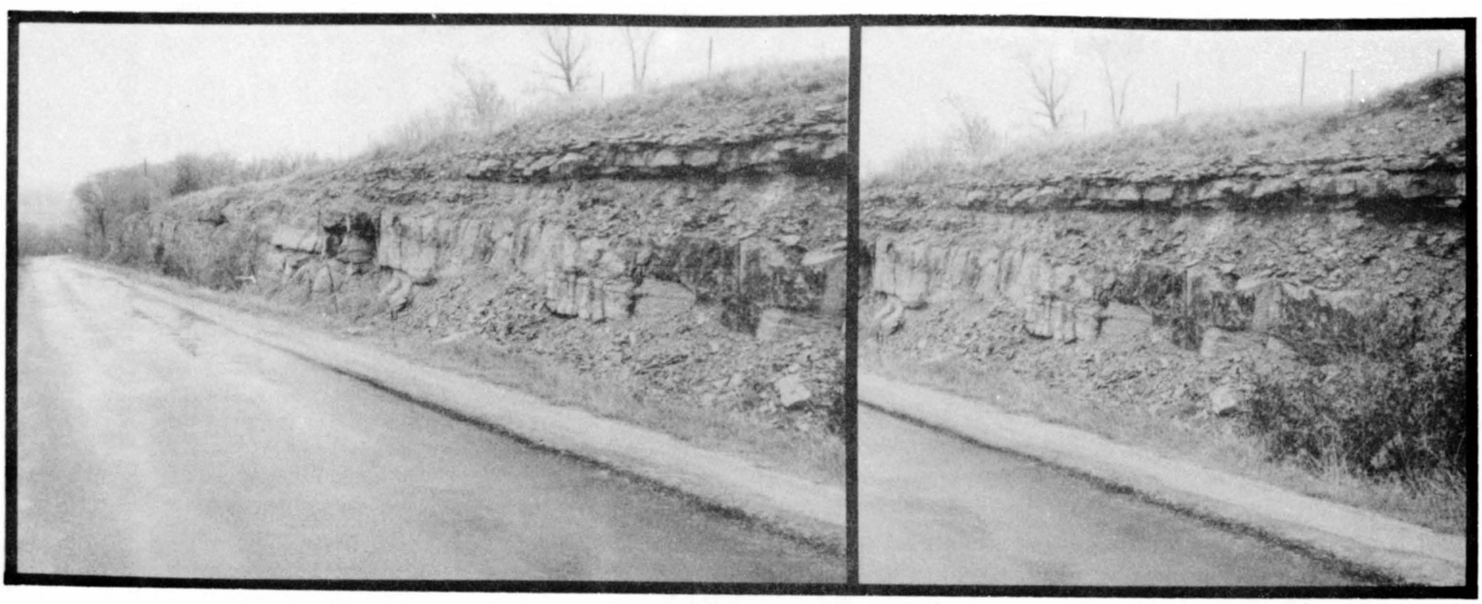


Figure 12. Fort Riley Limestone Member exposed in a road cut in the NW¼ of sec. 17, T35S, R5E. (stereogram)

The Fort Riley is a buff, thick-bedded, massive limestone that contains a few thin shale zones in the upper part. The unit has a highly variable thickness that ranges from 45 feet (13.7 m) to as much as 80 feet (24.4 m). The Fort Riley weathers rusty brown to gray and is sparsely to moderately fossiliferous. The upper part of the member is slabby to thin bedded. The lower part contains the massive "Silverdale" zone that has been quarried extensively for building stone. Sink holes have formed along joint patterns in the northern part of T30S, R5E and the south half of T33S, R6E where a fairly thick bedded zone with apparent cross bedding was observed (Bayne, 1962).

Although the "Silverdale" zone of the Fort Riley is used extensively as building stone, quality test data indicate the material has excessively high wear and absorption values for use as construction aggregate. Absorption values ranged from 4.17% to 9.5% and the L.A. wear ranged from 34% to 50%. Soundness values varied from 81% to 97% with most values falling in the 91% to 92% range. These test results indicate that the material is generally acceptable only for light type surfacing. Because of the relatively high calcium carbonate content (approximately 95%), the Fort Riley is a potential source of agricultural lime.

The exposure pattern of the Barneston Formation is mapped on all except plate X.

Winfield Limestone Formation

The Winfield Limestone Formation is normally composed of the basal Stovall Limestone Member, the Grant Shale Member, and the overlying Cresswell Limestone Member. In Cowley County only the Cresswell Member is recognized and the base of it has been mapped on plates I, II, IV, V, VII, VIII, X, and XI.

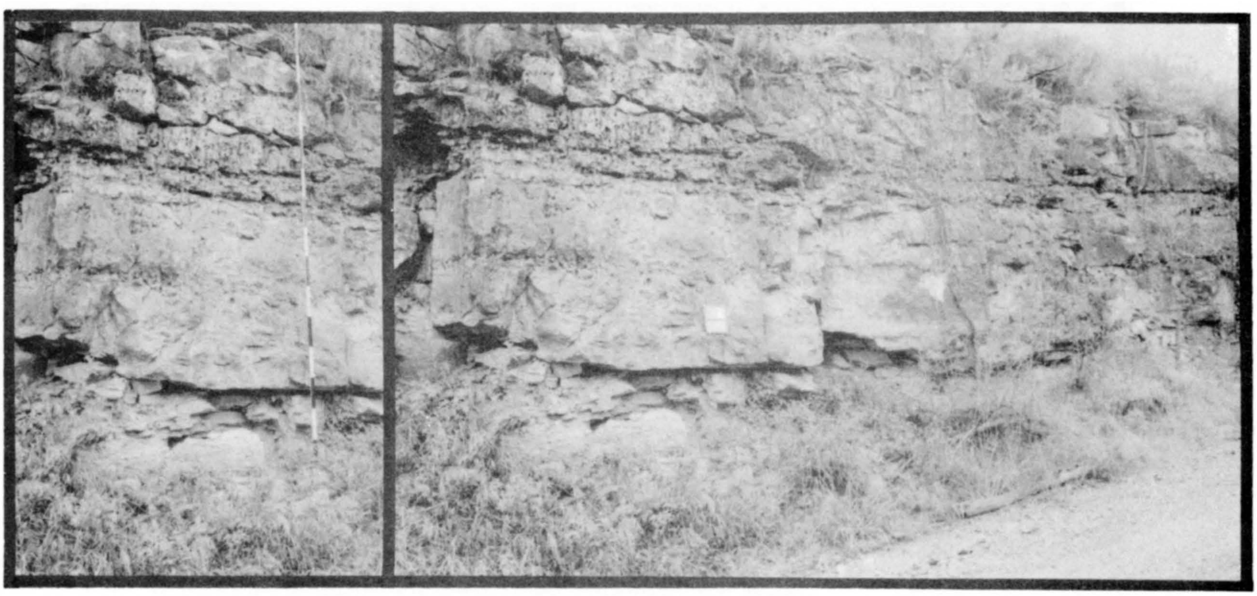


Figure 13. Cresswell Limestone Member exposed in a road cut in the NE¼, sec. 13, T31S, R3E. (stereogram)

The Cresswell is a white to gray, hard, dense limestone that weathers to a gray or yellowish-tan color. It may be divided into a lower massive unit with a thickness of 10 to 15 feet (3 - 4.6 m) and an upper thin bedded, shaly unit with a thickness that varies from 15 to 20 feet (4.6 to 6.1 m). The lower unit is the prominant scarp-forming limestone due to its more resistive nature. The Cresswell is fossiliferous throughout with the upper part being very fossiliferous.

Quality test data available on the Cresswell Member in Cowley County indicate the material is suitable only for light type surfacing. The L.A. wear values range from 26 to 34, soundness ranges from 78 to 91 and absorption 4.1% to 6.2%. Selective quarrying and crushing may yield aggregate for all but bituminous specifications, but the material may be marginal for other uses as well.

Nolans Limestone Formation

The Nolans Limestone Formation has a total thickness of approximately 40 feet (12.2 m) and is composed, in ascending order, of the Krider Limestone, Paddock Shale, and Herington Limestone Members.

The Krider is a blue-gray to gray, hard limestone having a thickness of 4 to 9 feet (1.2 - 2.7 m), is divided into an upper and lower unit by 3 feet (0.9 m) of gray shale. The upper unit is a hard, dense, brittle, non fossiliferous limestone while the lower unit is very fossiliferous and is soft to hard. The Krider has not been commercially quarried in the county.

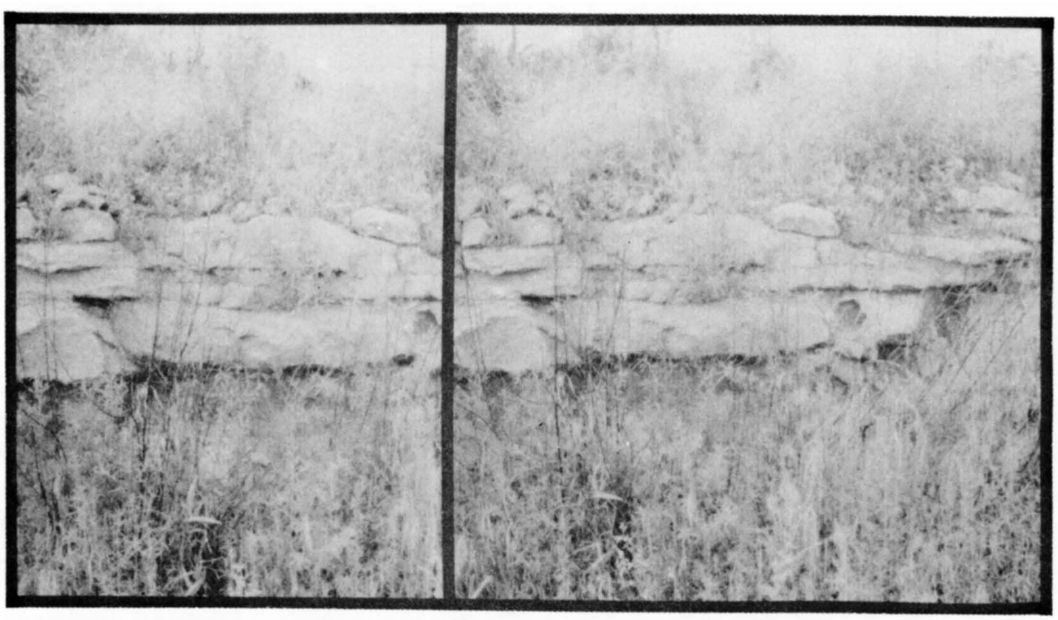


Figure 14. Herington Limestone in north road ditch SE¼ sec. 2, T32S, R3E. (stereogram)

The Herington is a light buff, massive, limestone that is dolomitic in the upper part. The thickness varies from 10 to 15 feet (3.0 - 4.6 m) with chert nodules in the upper part and geodes in the lower part. Field observations indicated the Herington to be soft and porous.

No quality test date were available for the Nolans Formation although the Herington Member has been quarried in the SE¼ sec. 35, T34S, R3E. The Herington can be used for light type surfacing; however, tests should be run at each location before use due to variations in lithology.

The Nolans Limestone Formation was not mapped for this report; however, it is found above the Winfield Formation which has been mapped on plate I, IV, V, VII, VIII, X and XI.

Sand and Gravel

Chert Gravel

Chert gravel deposits ranging in thickness from less than one foot (0.3 m) to more than 10 feet (3 m) are found occupying elements of higher topography along the Walnut River. Most of these deposits are thin and discontinuous. The chert is a gray-brown to brown color and the average size ranges from .5 to 1.25 inches (1.27 - 3.18 cm) in diameter. Most of the thicker deposits are depleted and those remaining have such a heavy clay matrix as to render them uneconomical to produce for other than light type surfacing.

Figure 15. Chert gravel exposed in a road cut in the NE¼ sec. 20, T34S, R5E. (stereogram)

Quality test data from similar deposits in Butler County to the north indicate the material will meet all Kansas Department of Transportation specifications for construction aggregate; however, if used in concrete difficulty will be experienced in sawing joints. When used in bituminous and concrete aggregate the material is slow in developing strength. According to Carl Crumpton, Assistant Engineer of Planning and Development - Research, Development and Implementation (verbal communication) this low early strength is the result of poor bonding between the chert and matrix; however, the bonding and strength increase with ageing.

The chert gravel deposits were not mapped for this report; however, individual sites have been shown on plates I, IV, VII and X.

Dune Sand

Dune sand of recent age occurs along the northeast side of the Arkansas River. These eolian deposits are cross bedded, tan to buff color and composed primarily of fine quartz grains. The topographic relief varies from 0 to 50 feet (15.2 m). Dune sand has a very limited use due to its well sorted, fine gradation; however, these deposits are mapped on plates IV, VII and X.

Wisconsinan Terrace

Most of the stream valleys in Cowley County have terrace deposits of Wisconsinan age. The terrace deposits in the Arkansas River valley are composed of arkosic sand and gravel near the base and silts and clays in the upper part, and have a thickness that varies from 40 to 55 feet (12.2 - 16.8 m). The terraces in smaller valleys are composed of limestone and chert gravels near the base and silts and clays in the upper part along with some small sand lenses. Limestone and chert gravels have been produced from terrace deposits along and in the Walnut River near Arkansas City.

Quality tests show that with proper processing the material will meet all Kansas Department of Transportation specifications for construction aggregate. Chert gravel, if used in concrete, will cause difficulty in sawing joints. Due to difficulty in developing proper bonding a low early strength can be expected in bituminous and concrete mixes; however, the strength will increase with age.

The Wisconsinan Terraces have been mapped on all plates.

Quaternary Alluvium

The alluvium of the Arkansas River valley is an excellent source of large quantities of granular material ranging from fine sand to gravel size. The sand and gravel is composed of quartz, feldspar, calcite, chert, and limestone fragments. Large volumes of sand and gravel have been produced by pumping operations near Arkansas City and Gueda Springs on the Sumner, Cowley County line. The alluvial surface is rough to rolling with many old meander scars. It floods easily and has a maximum thickness of 50 feet (15.2 m). Quality tests indicate that the material will meet all Kansas Department of Transportation specifications for construction aggregate; however, sand and gravel from the Arkansas River valley is classified as a reactive aggregate by the Kansas Department of Transportation. Siliceous aggregate from this source when used with cement is susceptible to expansion, cracking, and distress in concrete. The cement reacts with the silica which then hydrates to produce a silica gel that causes the concrete to expand and deteriorate. To alleviate these problems prescribed amounts of sweetner such as limestone, sandstone, or specified sand and gravel must be added to meet K.D.O.T. standard specifications.

The alluvium has been mapped on plates IV, VII, X, and XI.

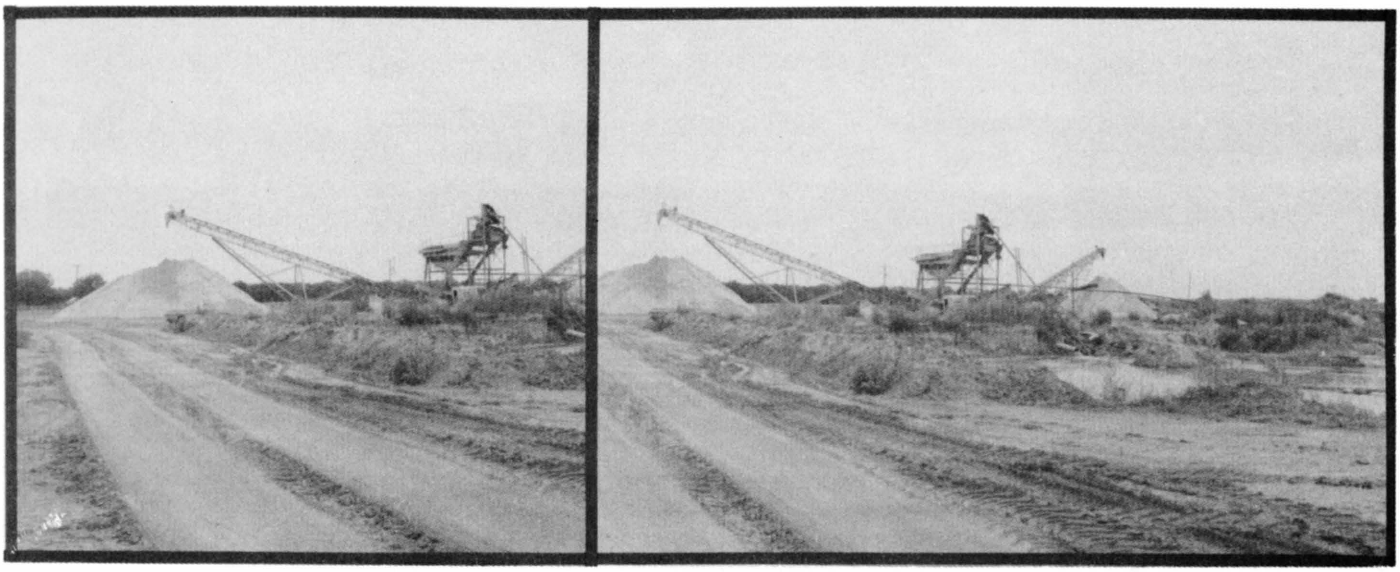


Figure 16. Sand plant located in the N½ sec. 26, T34S, R3E. (stereogram)

Site Data Form No.	Material Type	Date of Test	Percent Retained									Wash	G.F.	Sp. Gr. Sat.	Sp. Gr. Dry	% Wear	% Soundness	% Absorption	Source of Data SHC Lab No.
			1½	3/4	3/8	4	8	16	30	50	100								
Source of Material: Alluvium - Qal																			
SG + 40	Mineral Filler Sand & Gravel	12-31-57								2	4	95							AB-619
										0	16	77							
										1	7	78							
SG + 3	Sand & Gravel	1-60		1	3	12	38	75	93	98	100	0.15	4.20	2.61		31.2	0.97	0.50	10,001
SG + 13	Sand & Gravel	5-62			1	5	16	36	58	82	98		2.96	2.62				0.7	
SG + 15	Sand & Gravel	1-1-60		0	3	20	51	74	89	97	99	0.45	4.33	2.62		30.1	0.98	0.6	9992
SG + 7	Sand & Gravel	11-72		0	4	13	34	71	88	96	99		4.05	2.63		31		0.3	71-3059
SG + 14	Sand & Gravel	10-30-73		0	4	13	28	50	69	89	98		3.51	2.57 2.60		33	0.99	1.13 0.30	72-1178
CG + 18	Chert Gravel	4-17-75		12	45	58	64	68	77	93	95	4.31	5.12	2.63	2.56	22 21	0.99	3.4 1.5	74-1578
	Chert Gravel			0	18	40	51	59	72	93	97	2.97	4.30	2.60	2.53	22 21	0.97	4.2 2.7	74-2074
	Chert Gravel			0	50	88	96		98					2.55	2.48	19	0.97	3.2 2.7	74-2304
Source of Material: Wisconsinan Terrace - Qtw																			
CG + 10	Chert Gravel	2-54		17	48	61	68	77	87	98	99	.7	5.55	2.51		23.2	0.99		81630
CG + 17	Sand & Gravel	4-62		0	2	23	58	81	96	99			4.59	2.55		20.7	0.99	1.79	21365
CG + 16	Sand & Gravel	4-62		0	23	47	60	69	83	96	99		4.77	2.45	2.36	20.6	0.98	3.92	21810
LS + 11	Limestone	4-17-75		42	95	96	96		97					2.41	2.29	34	0.90	5.1	75-268
Source of Material: Kansan Terrace - Qtk																			
CG + 19		2-54	9	28	54	72	85	91	93	93	93	7							81631
CG + 20			6	20	45	64	69	72	74	75	76	25							
CG + 22			7	23	49	68	74	79	81	82	82	17							
Source of Material: Winfield Limestone (Cresswell) - Pwc																			
LS + 1	Limestone	2-54												2.44		26.5	0.91	4.74	78374
														2.46		27.3	0.91	4.87	78375
LS + 8	Limestone	11-72		0	52	97	100	100	100	100	100			2.43	2.28	33	0.78	6.22	71-1188
Source of Material: Barneston Formation (Fort Riley) Pbf																			
LS + 4	Limestone	12-31-53												2.44		40.6	0.92	5.0	81592
														2.30		47.0	0.87	8.33	81593
														2.33		46.8	0.94	8.33	81594
														2.34		46.0	0.81	7.78	81595
														2.30		43.6	0.87	8.00	81596
LS + 39	Limestone	2-54												2.31		39.0	0.95	4.94	81608
														2.28		38.8	0.97	5.33	81609
														2.18		38.9	0.94	8.56	81610
LS + 23	Limestone	2-54												2.38		39.7	0.93	6.56	81587
														2.31		49.5	0.94	8.17	81588
														2.25		49.6	0.92	9.28	81589
														2.23		48.3	0.92	10.61	81590
														2.23		49.5	0.95	10.7	81591
LS + 21	Limestone	2-54												2.39		39.4	0.91	6.67	81597
														2.38		41.0	0.91	6.67	81598
														2.27		47.7	0.95	9.50	81599
														2.20		50.9	0.96	11.67	81600
														2.27		39.7	0.94	8.87	81601
LS + 5	Limestone	2-54												2.30		35.1	0.96	8.99	81611
														2.37		38.0	0.91	6.22	81612
														2.31		45.2	0.91	7.72	81613
LS + 9	Limestone	2-54												2.19		50.0	0.84	11.36	81614
														2.34		37.8	0.92	5.83	81615
														2.49		34.3	0.82	4.17	81616
Source of Material: Wreford Limestone (Threemile) Pwt																			
LS + 12	Limestone	2-54												2.51		21.4	0.95	2.78	81623
														2.43		20.6	0.95	4.11	81624
LS+ 42	Limestone	2-54												2.37		35.1	0.92	5.67	81617
														2.30		32.6	0.93	7.06	81618
														2.53		23.1	0.97	2.33	81619
														2.35		26.9	0.94	5.56	81620
Source of Material: Crouse Limestone																			
LS + 6	Limestone	12-12-57												2.30		33.2	0.97	4.73	100372
														2.54		25.4	0.97	1.80	100373
														2.32		26.2	0.97	4.65	100374
														2.13		34.8	0.98	6.49	100375
LS + 41	Limestone	2-54												2.48		30.7	0.96	2.94	81602
														2.57		33.3	0.97	2.00	81603
														2.57		33.0	0.94	2.23	81604
Source of Material: Red Eagle Limestone Formation																			
LS + 24	Limestone	2-54												2.46		38.1	0.93	4.44	81605
														2.59		31.4	0.95	2.44	81606
														2.61		33.0	0.95	1.39	81607

Figure 17. Results of Tests.