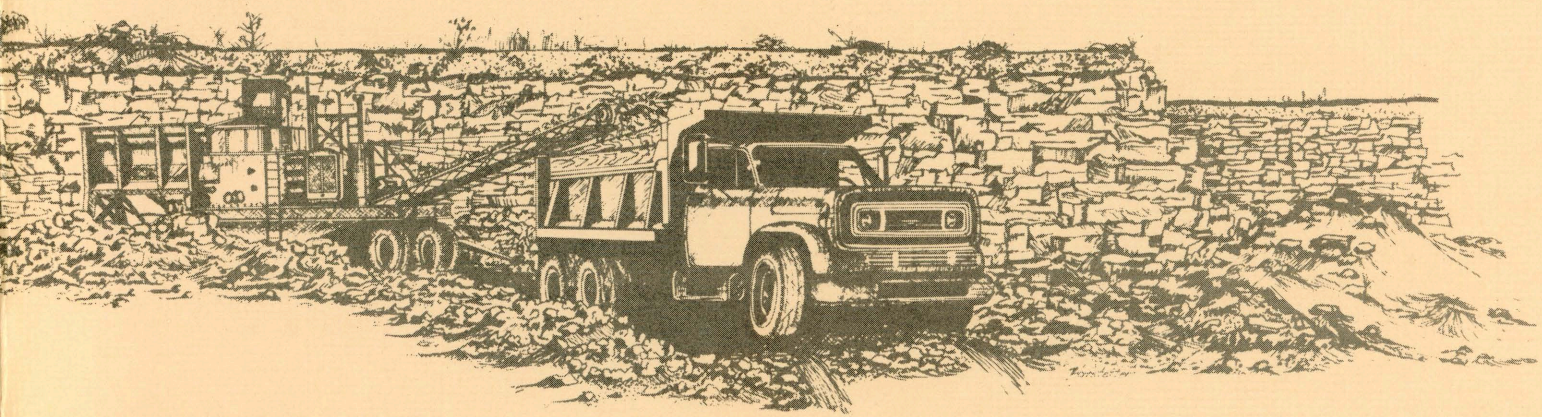
REPORT NO. 34

CONSTRUCTION MATERIALS INVENTORY



ALLEN COUNTY, KANSAS

Kansas Department of Transportation
Engineering Services Department
Planning and Development Department

CONSTRUCTION MATERIALS INVENTORY

OF

ALLEN COUNTY, KANSAS

by

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

1979

Construction Materials Inventory Report No. 34

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

CONTENTS

the Why?

WHAT?

and HOW?

of This REPORT

This report was compiled for use as a guide for locating construction materials in Allen 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.*

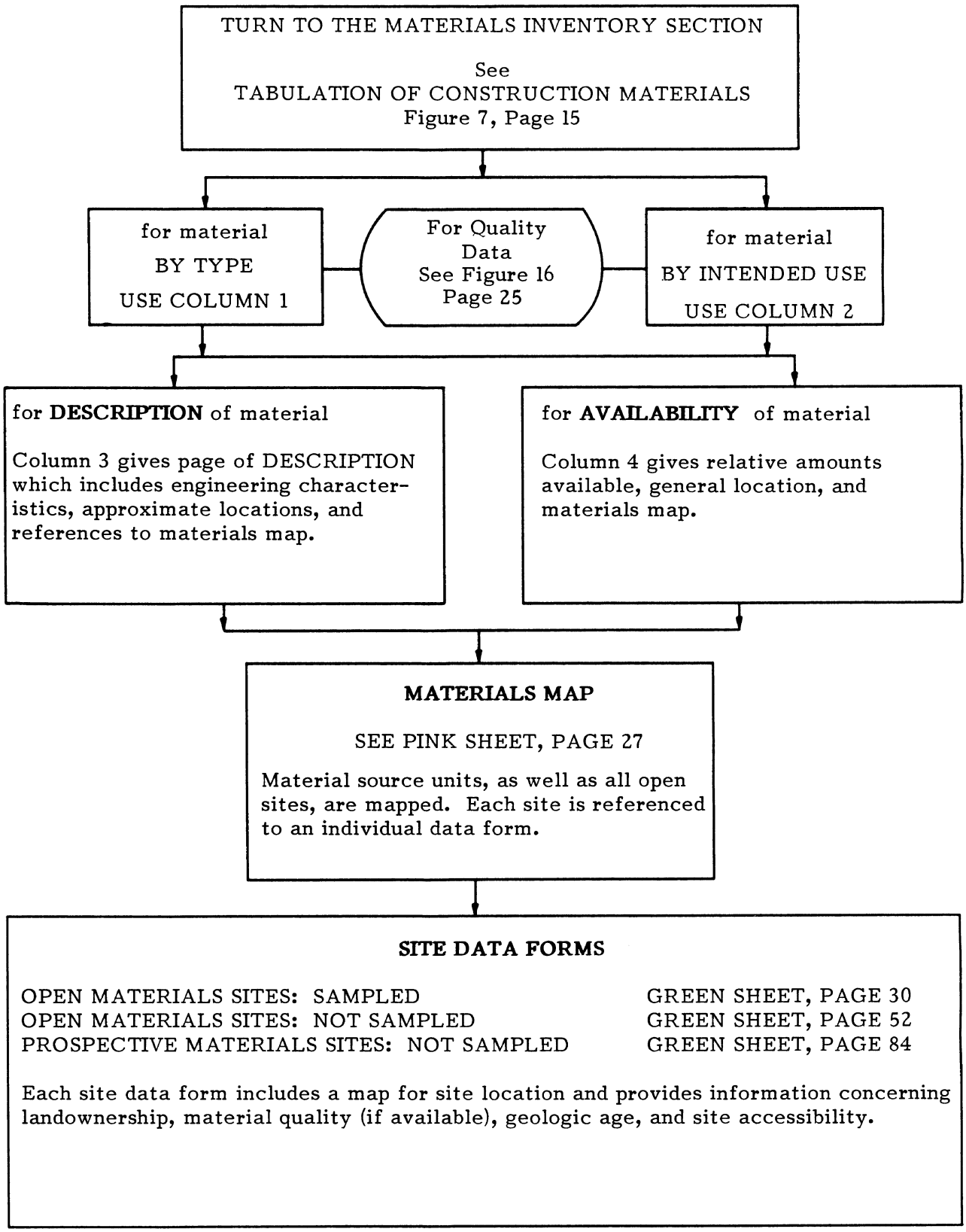
The diagram on page iv shows how the MATERIALS INVENTORY SECTION may be used to locate and evaluate mapped sites.

Material found in individually mapped sites represents only a small portion of the construction materials 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 Allen County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN ALLEN COUNTY



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 Allen and surrounding counties, provided the basic geologic information used in this investigation. Detailed geologic and soil data were obtained from centerline geologic profiles and soil surveys prepared for design of major highways in the county by the Kansas Department of Transportation.

Appreciation is extended to Mr. Jack Laymon, Allen County Road Supervisor, Mr. James L. Farrell, Fourth District Materials Engineer, and Mr. Walt Frederickson, Regional Geologist, Kansas Department of Transportation, for verbal information concerning construction materials contained in this report.

This report was prepared under the guidance of Robert R. Jones, P. E., Engineer of Engineering Services, G. N. Clark, P. E., Soils Engineer and L. D. Myers, Geologist IV Soils Section, Engineering Services Department.

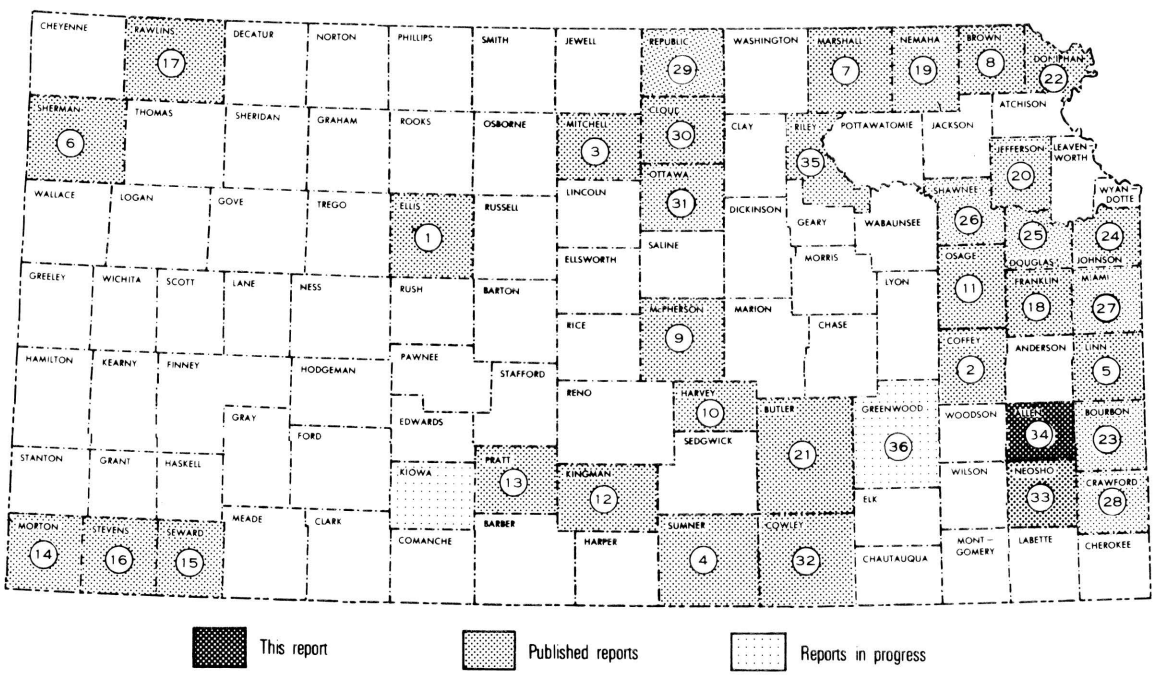


Figure 1. Index map of Kansas showing the location of Allen County along with the report numbers and location of counties for which reports have been or are being completed.

ABSTRACT

Allen County lies in the Osage Plains physiographic region of southeastern Kansas. Major topographic features include gently sloping upland plains and steep valley walls formed by erosion of thick limestones and shales, and the south trending plain of the Neosho River Valley.

The Neosho River and its tributaries drain all but the eastern edge of the county. This area is drained by tributaries of the Little Osage and Marmaton Rivers.

Sources of construction materials in Allen County are limestones of middle and upper Pennsylvanian age and limited amounts of chert gravel from Undifferentiated Quaternary terraces. Most construction aggregate is currently produced from the Iola, Plattsburg, and Stanton Formations. Limestone aggregate which is suitable for light type surfacing on local roads can be produced from almost all of the limestone units exposed in the county.

Large quantities of good quality water are available from the Neosho River. Moderate quantities of ground water are available in the alluvial and terrace deposits of the Neosho River. Limited to moderate quantities of water are available from the consolidated rock aquifers; however, water from these sources may have a high bicarbonate, sulfate, or iron content.

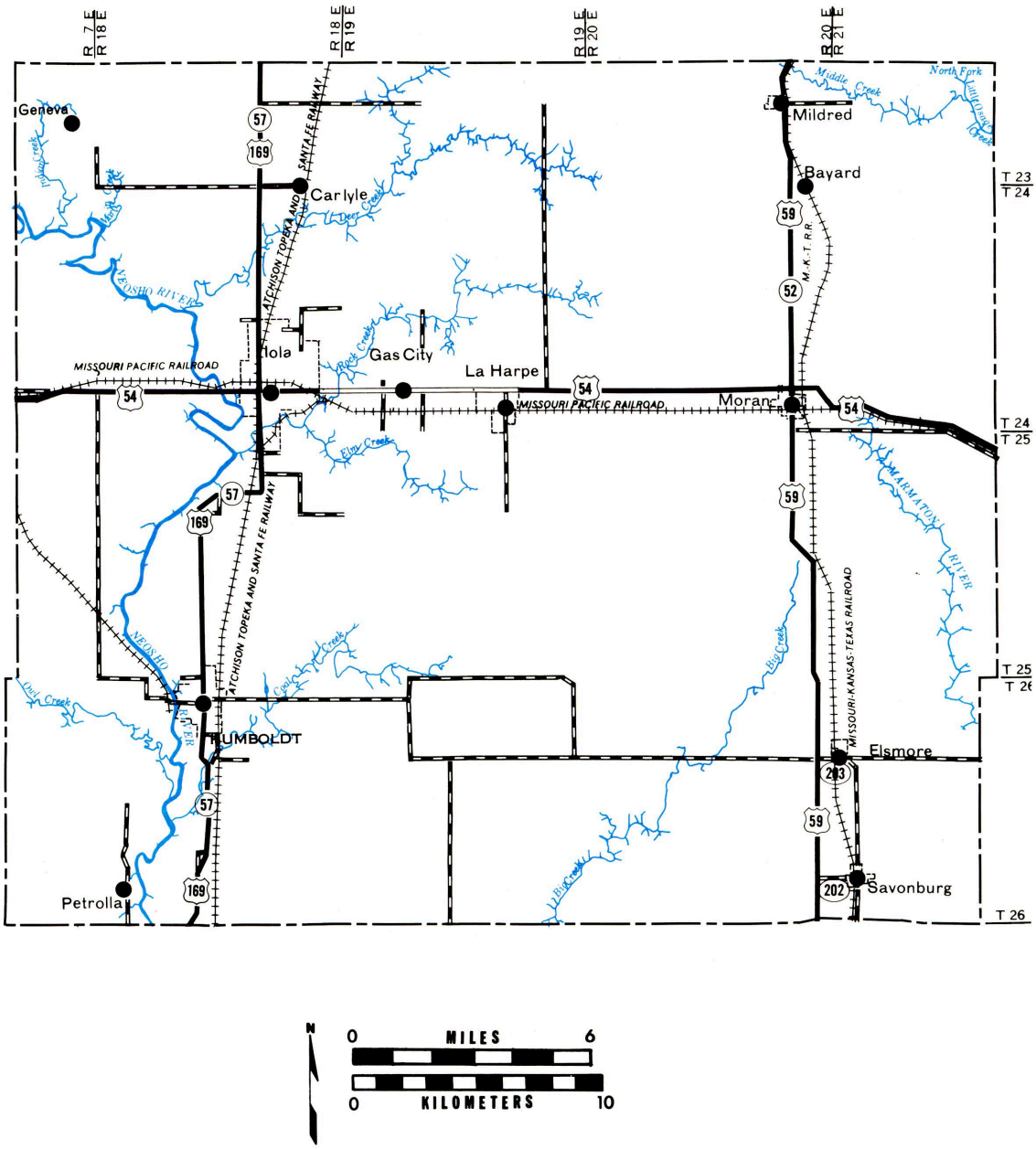


Figure 2. Drainage and major transportation facilities in Allen County.

FACTS ABOUT ALLEN COUNTY

Allen County is located in southeastern Kansas in the second row of counties west of the Missouri border and in the third tier of counties north of the Oklahoma border. It has an approximate area of 505 square miles (812.7 sq. km.) and a population of 16,019 in 1978 according to the Kansas State Board of Agriculture. The geographic location of Allen and other counties currently included in the construction materials inventory program are shown in figure 1 on page v.

Maximum relief in the county is approximately 250 feet (76.2 m) with the highest point, 1,165 feet (355.1 m) above mean sea level, located along the Allen, Anderson County line in sec. 20, T23S, R20E. The lowest point of elevation is approximately 915 feet (278.9 m) and is located where the Neosho River leaves the county near the southwestern corner.

A primary road system connects all major communities and a well developed secondary road system provides access to small communities. Figure 2, page 1 shows the major drainage and transportation facilities in Allen County.

METHODS OF INVESTIGATION

Investigation 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 was determined. Quality test results of samples taken Allen 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 was accomplished. Figure 3 illustrates aerial photographic coverage of Allen County. Geologic source beds and all open materials sites were mapped and classified on aerial photographs. All material sites were then correlated with the geology of the county.

Phase Three: This phase was conducted after the 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 classification of open sites was confirmed.

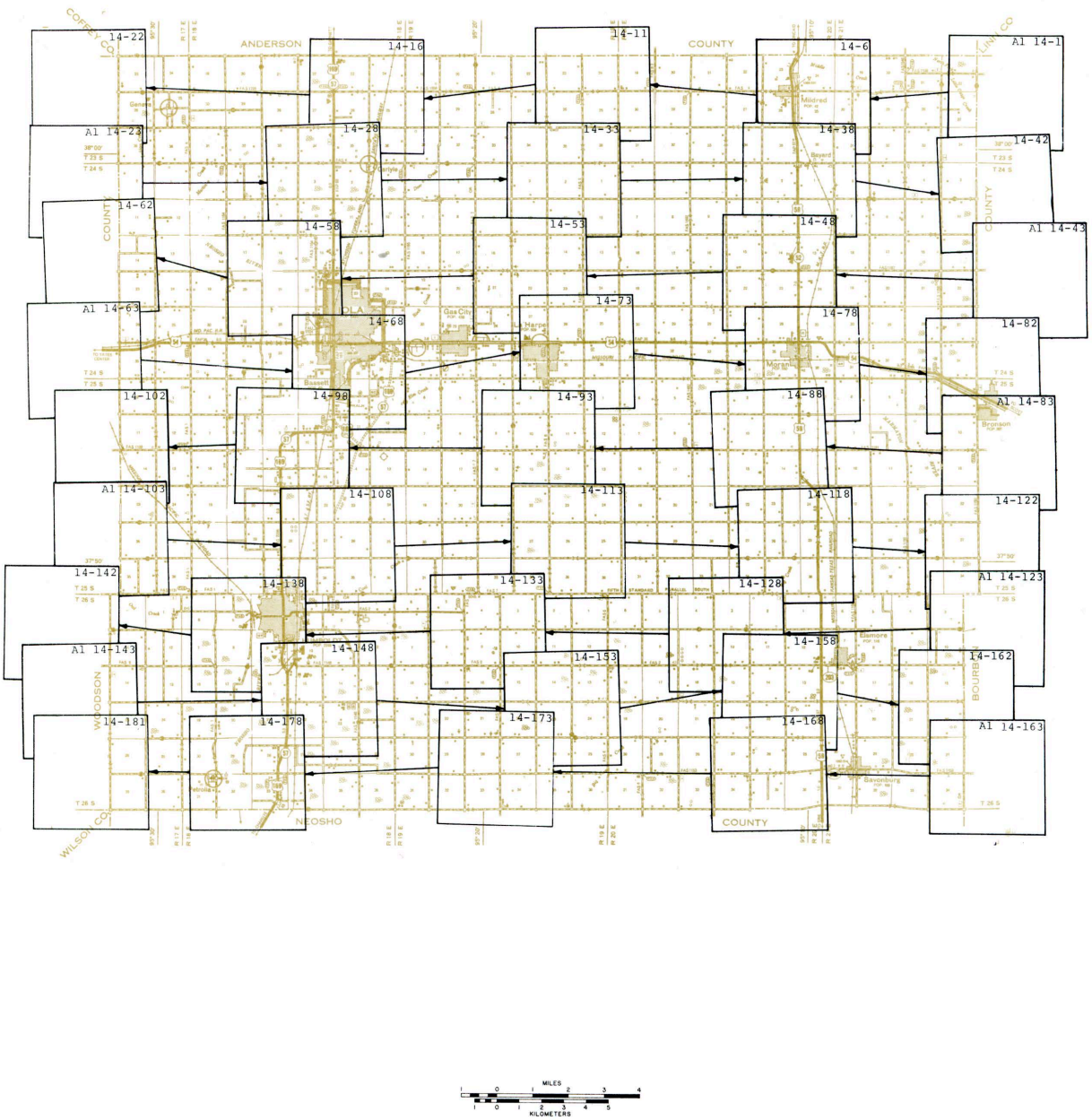
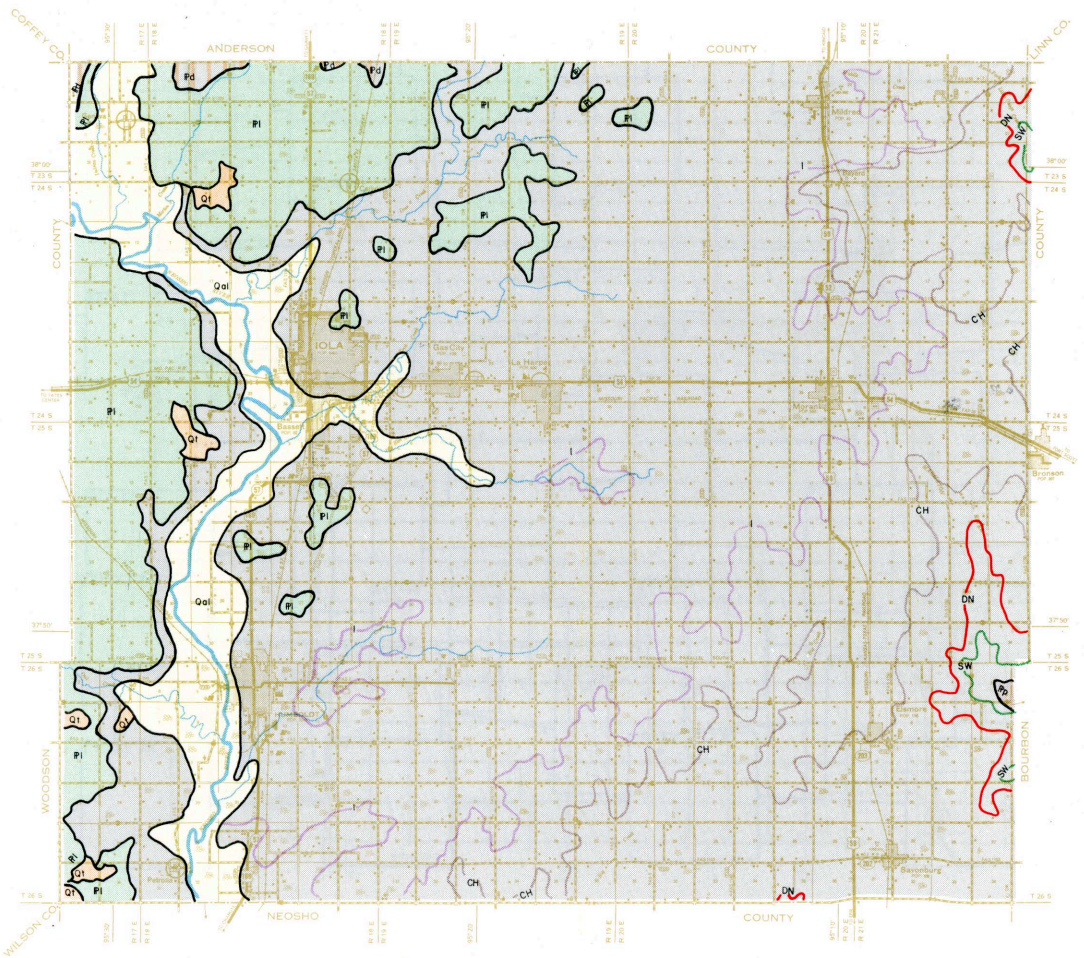


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Allen County. The numbers refer to photographs taken by the Photogrammetry Section, Engineering Services Department, Kansas Department of Transportation on 2-7-72 at a scale of 1" = 2000' (1 cm. = 240 m). Aerial photographs are on file in the KDOT Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

GEOLOGY SECTION



LEGEND

Quarternary Alluvium

Qal

Quarternary Terrace

Qt

Douglas Group

Pd

Lansing Group

Pl

Kansas City Group

I Iola Limestone
CH Chanute Shale
DN Dennis Limestone
SW Swope Limestone

Pleasanton Group

Pp

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, landform, 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 Allen 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 materials source unit in Allen County.

Subsurface rocks in the county range in age from Precambrian to Pennsylvanian. According to Cole and Ebanks (1974), three wells have penetrated to the Precambrian in Allen County. These wells encountered granitic and metamorphic rocks at a depth of 2,145 to 2,180 feet (653.8 - 664.5 m). Precambrian sediments are thought to underlie the northern third of the county (Merriam, 1963). Cambrian sandstone and dolomite lie directly upon the Precambrian surface. These Cambrian sediments have an approximate thickness of 150 feet (45.7 m). Ordovician dolomites rest conformably on the Cambrian sediments and have a thickness of about 590 feet (177.8 m). Sediments of late Ordovician and Silurian age are missing in the county. These missing sediments indicate a prolonged hiatus of pre-Devonian or early Devonian age according to Lee and Merriam (1954). The Chattanooga Shale of late Devonian or early Mississippian age lies unconformably on the Arbuckly Group of Cambrian and Ordovician age (Miller, 1969). Approximately 300 feet (91.4 m) of Mississippian limestones, dolomites and shales overlie the Chattanooga Shale. Subsurface Pennsylvanian sediments lie unconformably on the eroded surface of the Mississippian Limestones. The Cherokee Shale of Pennsylvanian age contains the "Squirrel" and "Bartlesville" sands from which much of the oil and gas was produced in Allen County.

Alternating beds of limestone, and shale along with scattered beds of sandstone and coal of early to middle Pennsylvanian age overlie Mississippian rocks in the county. Limestones and shales of Middle Pennsylvanian age comprise the exposed consolidated surface rocks of Allen County. Limestones of this age are the most important sources of construction materials in Allen County.

Late Paleozoic and Mesozoic sediments are absent in Allen County. During most of Mesozoic time (Triassic and Jurassic Periods) it is assumed that this area was part of a landmass where erosional processes removed large amounts of Peleozoic sediments and any sediments that may have been deposited during the Mesozoic Era. During Cretaceous time, the sea made its final advance into Kansas; however, if any sediments were deposited in Allen County during this time, they were subsequently removed by erosional processes which took place during Cenozoic time.

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	Graphic Legend	Formations and Members		Map Symbol	Thickness	General Description	Construction Materials
Quaternary	Pleistocene	Recent and Wisconsinan		Alluvium		Qal	0 - 25′ (0-7.6 m)	Silts and clays, fine to coarse sand and very coarse chert pebbles.	Construction aggregate.
		Illinoian		Illinoisan Terrace		Qti	0 - 32′ (0-9 7 m)	Fine silts and clays, some fine to medium sand in lower part, scattered lenses of chert gravel.	Light type surfacing.
		Nebraskan-Kansan?		Undifferentiated Quaternary Terraces		Qtu	0 - 8′ (0-2.4 m)	Angular to subrounded, tan to brown chert in clay matrix.	Construction aggregate.
Pennsylvanian System	Upper Pennsylvanian Series	Douglas Group		Stranger Fm.	Weston Sh. Mbr.		15 - 75′ (4.5-22.8 m)		
		Lansing Group		Stanton Limestone	South Bend Ls. Mbr.	Psc	6′ (1 - 8 m)	Bluish-gray to-gray, coarse grained thin bedded limestone.	Light type surfacing.
					Rock Lake Sh. Mbr.		7.6′ (2.5 m)		
					Stoner Ls. Mbr.		28′ (8.5 m)	Light-gray to-gray, fossiliferous limestone. Fine grained, thin bedded and contains thin shale partings.	Construction aggregate.
					Eudora Sh. Mbr.		5′ (1.5 m)		
					Captain Creek Ls. Mbr.		10 - 22′ (3.0-6.7 m)	Thin to medium bedded, gray, dense, moderately fossiliferous limestone that weathers light-gray to-white. Contains chert and calcite.	Construction aggregate.
				Vilas Shale			35′ ± (10.7 m)		
				Plattsburg Limestone	Spring Hill Ls. Mbr.	Pp	15 - 75′ (4.6-22.9 m)	Light-to medium-gray, thin to medium bedded limestone containing calcite filled veins. Fine to coarse grained.	Construction aggregate.
					Hickory Ck. Sh. Mbr.		.5′ ± (0.15 m)		
					Merriam Ls. Mbr.		2′ ± (0.6 m)	Gray-to bluish-gray, fine to medium grained, moderately fossiliferous limestone.	Light type surfacing.
				Lane and Bonner Springs Shale			30 - 100′ (9.1-30.5m)		
				Iola Limestone	Raytown Ls. Mbr.	Pi	31 - 47′ (9.4-14.3 m)	Light-gray to olive-gray, medium to coarse bedded, fine to coarse grained, limestone containing coarsley crystalline calcite and limonite.	Construction aggregate and riprap.
					Muncie Creek Sh.Mbr.		.5′ ± (0.15 m)		
					Paola Ls. Mbr.		2′ ± (0.6 m)	Massive, very fossiliferous, gray-to brownish-gray dense limestone.	Light type surfacing.
				Chanute Shale	Thayer Coal Bed		20 - 69′ (6.1-11.0 m)		
				Drum Limestone			2.6 - 3′ (0.8-0.9 m)		
		Kansas City Group		Cherryvale Shale	Quivira Sh. Mbr.		2.3′ ± (0.7 m)		
					Westerville Ls. Mbr.		1.2′ ± (0.4 m)		
					Wea Sh. Mbr.		4 - 24′ (1.2-7.3 m)		
					Block Ls. Mbr.		2′ ± (0.6 m)		
					Fontana Sh. Mbr.		5 - 45′ (1.5-13.7 m)		
				Dennis Limestone	Winterset Ls. Mbr.	Pd	31 - 35′ (9.4-10.7 m)	Medium bedded, light-to yellowish-gray, very fossiliferous, medium to coarse grained limestone. May contain chert, and cross bedded oolites and may be wavy bedded.	Construction aggregate.
					Stark Sh. Mbr.		4.6′ ± (1.4 m)		
					Canville Ls. Mbr.		1 - 2.6′ (0.3-.8 m)	Dense, fine grained, massive, bluish-gray to-gray limestone.	Light type surfacing.
				Galesburg Shale			1 - 17′ (0.3-5.2 m)		
				Swope Limestone	Bethany Falls Ls.Mbr.	Ps	40-65′ (12.2-19.8 m)	Dense, fine grained, light-to medium-gray, moderately fossiliferous limestone. Contains chert and is often oolitic.	Construction aggregate.
					Hushpuckney Sh.Mbr		5′ ± (1.5 m)		
					Middle Creek Ls.Mbr.		3 - 3.5′ (0.9-1.1 m)	Dense, massive, fine grained, dark-gray to-bluish gray, brittle limestone. Contains thin shale partings.	Light type surfacing.
				Ladore Shale			2 - 15′ (0.6-4.6 m)		
				Hertha Limestone	Sniabar Ls. Mbr.		9′ ± (2.7 m)		
					Mound City Sh. Mbr.		3′ ± (0.9 m)		
					Critzer Ls. Mbr.				

Figure 5. Generalized geologic column of the surface geology in Allen County, Kansas.

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.

The Cenozoic Era was marked by erosion of late and Post-Pennsylvanian deposits and the development of the present day drainage system. The resistant limestones and sandstones of the exposed Pennsylvanian sediments form the Osage Cuesta division of the Osage Plains in the county. Pre-Kansan chert gravels are found at several locations at altitudes of 40 to 120 feet (12.2-36.6 m) above the present flood plain of the Neosho River. These deposits indicate that extensive erosion of Pennsylvanian and Permian limestones containing abundant amounts of chert has taken place during the Pleistocene. Remnants of Kansan, Illinoisan and Wisconsinan age terraces are also found along the major drainage channels in the county.

GEOENGINEERING

This section provides a general appraisal of the geoengineering problems that may be encountered in Allen 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 may be necessary to ascertain the severity of specific problems and to make recommendations for design and construction procedures.*

Major geoengineering problems in Allen County are associated with alluvium of the major drainage channels, escarpment-forming limestones, and variations in soil mantle type and thickness. Additional geoengineering problems will be encountered in areas where oil or gas has been produced.

Alluvium and terrace deposits encountered in the valleys of the Neosho River and its tributaries are composed of silts and clays with lenses of sand and gravel. Cut-off meanders containing unconsolidated soils are located in the Quaternary alluvium of the Neosho River valley. Many of these areas can be readily identified on aerial photographs although agricultural practices have masked other areas to the extent that they must be located in the field. The material in these areas creates 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.

Major scarp forming units in the county are the Dennis, Iola, Plattsburg and Stanton Limestone Formations. Large quantities of rock excavation will be encountered in deep cut sections in these escarpments. The magnitude of rock excavation will depend on the limestone thickness, topographic relationships, and the character of overlying shales.

Soil mantle varies from a few inches of cover over limestones of the Lansing and Kansas City Groups to more than 25 feet (7.6 m) of alluvium in the valley of the Neosho River. Based on information gathered through photo interpretation and field observations, and field data obtained by our Soils and Geology Sections, a generalized concept of soil mantle thickness over upland areas was formulated. Soils occurring over limestones and on slopes with a 3 percent or steeper slope average less than 3 feet (0.9 m) in thickness, while soils developed over shales on relatively flat areas average 10 feet (3.0 m) in thickness. Soils developed over limestones generally have a higher plasticity index (40 plus) and exhibit less desirable engineering characteristics than those soils developed over shales which generally have a plasticity index of about 30.

Hydrology problems are associated with nearly every geologic member encountered in the county. Water movement is along the base of limestones, bedrock-soil mantle contacts, through sandstones and along well developed joint patterns such as those found in the Iola Formation. More persistent problems will occur during prolonged periods of heavy precipitation. Local variations in dip are common and may create traps for vadose water which will require underdrains on a highway alignment.

Natural gas has been produced near Iola since 1873 and the first oil production began in 1894 near Humboldt. Production has generally been from the "Bartlesville Sands" and the "Squirrel Sands" of the Cerokee Group at depths ranging from 550 to 1,000 feet (167.6 - 304.8 m). Additional production in the northwest part of the county is from Mississippian limestones. Many early wells were not cased and their locations were not recorded. If those wells are encountered during construction, they should be plugged to prevent inducement of water into fill sections in areas where secondary recovery repressuring operations exist. This will also prevent brine or saline waters being introduced into surface streams and water supplies.

Limestone and shale aquifers generally yield less than 5 gpm (.32 l/s); however, in some areas where the joint system of the beds is well developed, yields up to 20 gpm (1.3 l/s) have been reported (Miller, 1969). Sulfates, carbonates, and fluorides are common and generally make the quality of water suitable only for local domestic purposes. Sandstone aquifers usually yield 2 gpm (0.1 l/s) or less and therefore are not considered as a source of groundwater. Wells located in unconsolidated aquifers of the Wisconsinan and Recent Alluvium may yield up to 100 gpm (6.3 l/s); however, an average of 15 to 20 gpm (0.9 - 1.3 l/s) is common. The water from those deposits is usually very high in iron and calcium bicarbonate, and for some uses may require treatment.

Cities and towns in Allen County generally obtain their water supplies from surface water sources such as the Neosho River. Water for stock and domestic use is generally obtained from drilled wells.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Limestones of the Missourian Stage of the Pennsylvanian System make up the major portion of the available construction materials of Allen County. Chert gravel may be produced in limited amounts from the alluvial deposits and high Undifferentiated Quaternary terrace deposits of the Neosho River valley. Chat can be imported from the lead-zinc mining district of the Tri-State area to the southeast.

Construction materials types, their uses, and availability are tabulated in figure 7, page 15. Test results from a limited amount of sampling and testing are presented in figure 16, page 25.

CONTENTS

MATERIALS INVENTORY SECTION

TYPE Material and Geologic Source	USE	PAGE	AVAILABILITY
LIMESTONE *Swope Ls. Fm.* Middle Creek Ls. Mbr.	Light type surfacing.	16	Very limited source in southeastern part of county. Plate VI.
Bethany Falls Ls. Mbr.	Construction aggregate.	16	Very limited source in southeastern part of county. Plate VI.
Dennis Ls. Fm. Canville Ls. Mbr.	Light type surfacing.	17	Limited source along eastern and southern part of county. Plates II, IV and VI.
Winterset Ls. Mbr.	Construction aggregate.	17	Good source along eastern and southern part of county. Plates II, IV and VI.
Iola Ls. Fm. Paola Ls. Mbr.	Light type surfacing.	18	Limited source in central part of county. Plates II, III, IV, V and VI.
Raytown Ls. Mbr.	Construction aggregate and riprap.	18	Excellent source in central part of county. Plates II, III, IV, V and VI.
Plattsburg Ls. Fm. Merriam Ls. Mbr.	Light type surfacing.	20	Limited source in western and northern part of county. Plates I, II, III and V.
Spring Hill Ls. Mbr.	Construction aggregate	20	Good source in western and northern part of county. Plates I, II, III and V.
Stanton Ls. Fm. Captain Creek Ls. Mbr.	Construction aggregate.	21	Moderate source in northwestern part of county. Plates I and III.
Stoner Ls. Mbr.	Construction aggregate.	22	Limited source in northwestern part of county. Plates I and III.
South Bend Ls. Mbr.	Light type surfacing.	22	Very limited source in northwestern part of county. Plates I and III.
SAND AND GRAVEL Undifferentiated Quaternary Terrace (Chert gravel)	Construction aggregate.	22	Limited source in western third of county. Plates I, III and V.
Illinoisan Terrace	Light type surfacing	23	Very limited source in western third of county. Plates I, III and V.
Quaternary Alluvium	Construction Aggregate.	23	Limited source along Neosho and Marmaton River drainage. Plates I, III, V and VI.

Figure 7. Tabulation of construction material types and their availability in Allen County.

DESCRIPTION OF CONSTRUCTION MATERIALS

Limestone

Swope Limestone Formation

The Swope Limestone Formation is composed of two limestone members separated by a shale member. These members are, in ascending order, the Middle Creek Limestone, Hushpuckney Shale, and Bethany Falls Limestone. The thickness of the formation varies from 48 feet exposed to 74 feet in the subsurface (14.6 - 22.6 m). The base of the Swope Formation is mapped on plate VI.

Middle Creek Limestone Member

The Middle Creek is a massive, dense, fine grained, dark-gray to bluish-gray, brittle limestone that breaks to a hackly or conchoidal surface. In some areas it is composed of three limestone beds separated by thin shale partings. The Middle Creek has not been quarried in Allen or Bourbon Counties due to its limited thickness of about 3.5 feet (1.1 m) and the availability of the much thicker overlying Bethany Falls Limestone Member. Although no quality test data are available for this member, field observations indicate the material is suitable for light type surfacing.

Bethany Falls Limestone Member

The Bethany Falls is a dense, fine grained, light-to medium-gray, moderately fossiliferous limestone having a thickness of about 40 feet in its outcrop area to 65 feet in the subsurface in western Allen County (12.2 - 19.8 m). It has a mottled appearance which makes it easily identifiable in the field. The upper part of the member may contain chert and is often oolitic and crossbedded. Black fissle shales occur at approximately 20 feet (6.1 m) and at 30 feet (9.1 m) above the base of the member.

There are no quality test data available on this material in Allen County; however, quality test data on the Bethany Falls Limestone in adjoining Bourbon County to the east indicates the material there will meet all current KDOT specifications for construction aggregate. Field observations in Allen County indicate the material is very similar to the material from the tested locations in Bourbon County and therefore should also be acceptable. Tests should be run on each location before use.

Dennis Limestone Formation

The Dennis Limestone Formation is composed of three members which are, in ascending order, the Canville Limestone, Stark Shale and Winterset Limestone. The formation has an approximate thickness of 60 feet (18.3 m) and is exposed in eastern Allen County. It is mapped on plates II, IV and VI.

Canville Limestone Member

The Canville Limestone varies from 2 to 6 feet (0.6 - 1.8 m) in thickness. It is a dense, fine grained, massive, bluish-gray to-gray limestone. This member has not been quarried in Allen or surrounding counties due to the quality and quantity of the overlying Winterset Member. Field observations indicate the Canville is suitable for light type surfacing.

Winterset Limestone Member

The Winterset is a light-to yellowish-gray, very fossilferous, medium bedded limestone having an average thickness of 53 feet (16.2 m). The lower portion of the member is medium to coarse grained, contains coarsely crystalline calcite, and has thin shale partings. The upper part of the member is fine to medium grained, contains some chert and crossbedded oolite and may be wavy bedded.

Figure 8. Winterset Limestone Member exposed in an abandoned quarry located in the NE ¼, SE¼, sec. 9, T24S, R21E. (Stereogram).

Quality test data are not available for this member in Allen County; however, data available from a number of sites to the south in Neosho County indicate that material from selected outcrops will generally meet all current KDOT specifications for construction aggregate.

Iola Limestone Formation

The Iola Limestone is composed of three members which are, in ascending order, the Paola Limestone, Muncie Creek Shale, and Raytown Limestone. The average thickness of the Iola is approximately 40 feet (12.2 m) in Allen County. The base of the formation has been mapped on plates II thru VI.

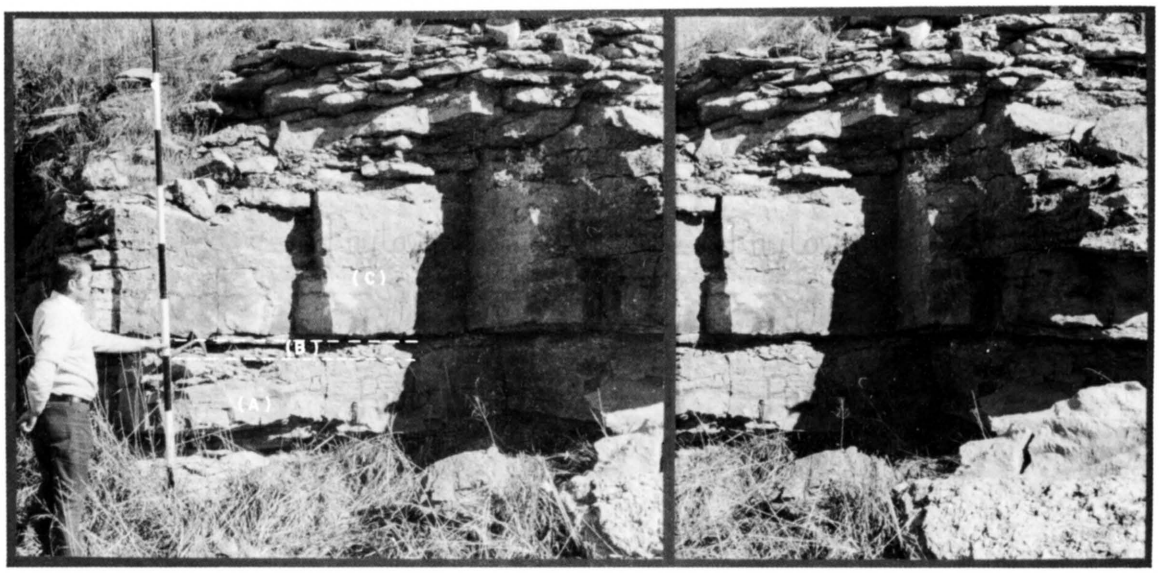


Figure 9. Basal part of Iola Limestone Formation. (A) Paola Limestone Mbr., (B) Muncie Creek Shale Mbr., and (C) Raytown Limestone Mbr., exposed in the NW ¼, sec. 1, T24S, R20E. (Stereogram).

Paola Limestone Member

The Paola Member is a unit-bedded, massive, very fossiliferous, gray-to brownish-gray, dense limestone. It varies from fine to coarse grained, and may have a wavy top which may contain "worm borings." It has a thickness of about 2.5 feet (0.8 m). Due to the limited thickness of the member, it has not been quarried in Allen or surrounding counties; however, field observations indicate the material should be acceptable for light type surfacing use.

Raytown Limestone Member

The Raytown is a light-gray to olive-gray, medium to coarse-bedded, fine to coarse grained, limestone containing coarsely crystalline calcite and limonite filled vugs. In some areas the Raytown may be massive bedded. It varies from fossiliferous in the lower part to very fossiliferous in the upper part. Thin shale intercalated beds are found in some localities at 3 feet (0.9 m) and 7 feet (2.1 m) above the main ledge of the member. The Raytown varies in thickness from 31 to 47 feet (9.4 -14.3 m). The low magnesium content and greater thickness of the Raytown in western Allen County make it a prime source rock for the manufacture of cement.

Quality test data for the Raytown Limestone Member in Allen County indicate the material is generally suitable for all types of construction aggregate; however, in some areas absorption and wear values may become marginal for bituminous aggregate. Tests should be run before use from each location to insure that the material will meet all current KDOT standard specifications for construction aggregate.

Figure 10. Main bed of Raytown Limestone Mbr. exposed in road cut in the NW¼, sec 28, T26S, R 18E (Stereogram).

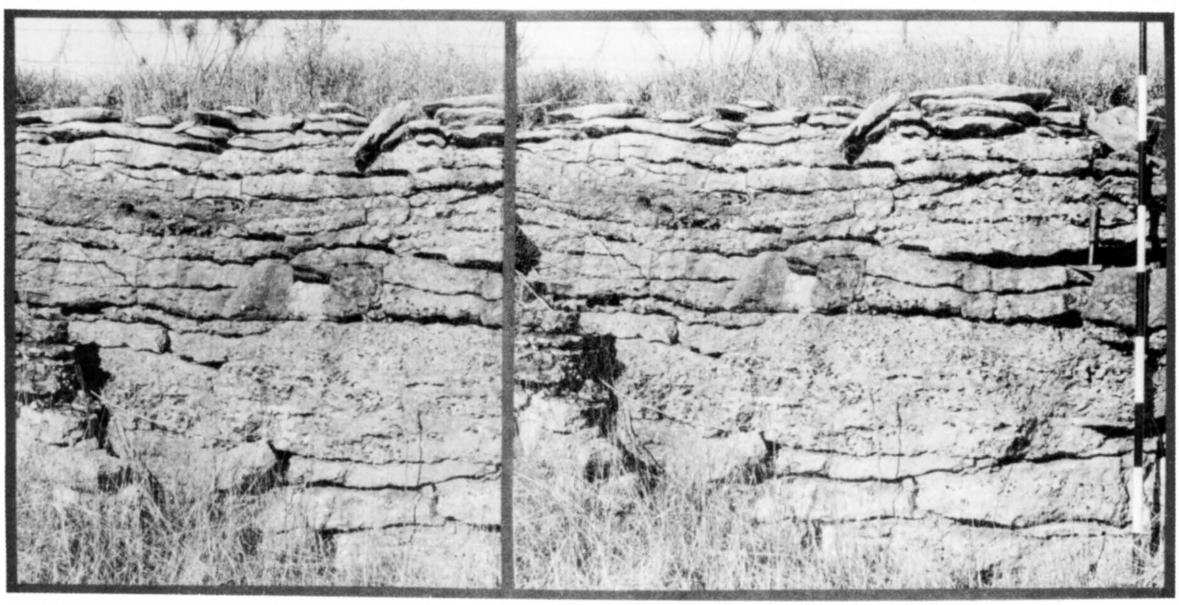


Figure 11. Raytown Limestone Mbr. exposed in the NE¼, sec. 23, T23S, R20E (Stereogram).

Plattsburg Limestone Formation

The Plattsburg Limestone is composed of three members which are, in ascending order, the Merriam Limestone, Hickory Creek Shale, and Spring Hill Limestone. The Plattsburg ranges in thickness from about 15 feet (4.6 m) in the southwestern part of the county to almost 80 feet (24.4 m) in the northern part of the county. The base of the Plattsburg Formation has been mapped on plates I, II, III and V.

Merriam Limestone Member

The Merriam is a gray to bluish-gray, fine to medium grained limestone that is moderately fossiliferous. Many small sponges are in the fossil assemblage. The outcrop of the unit is usually a single massive bed having a thickness of about 2 feet (0.6 m). The limited thickness of the member makes it uneconomical to quarry in Allen or surrounding counties. Although it has not been tested it appears suitable for use as light type surfacing aggregate.

Spring Hill Limestone Member

The Spring Hill is a light-to medium-gray, thin-to medium bedded limestone containing calcite filled veins. It is fine to coarse grained, contains some limonite, and has a brecciated appearance in the upper 5 feet (1.5 m). It is very brittle and may contain some carbonaceous material in the upper part of the member in some areas. It is fossiliferous and contains small shale partings throughout the member and it has an approximate thickness of 20 feet (6.1 m).

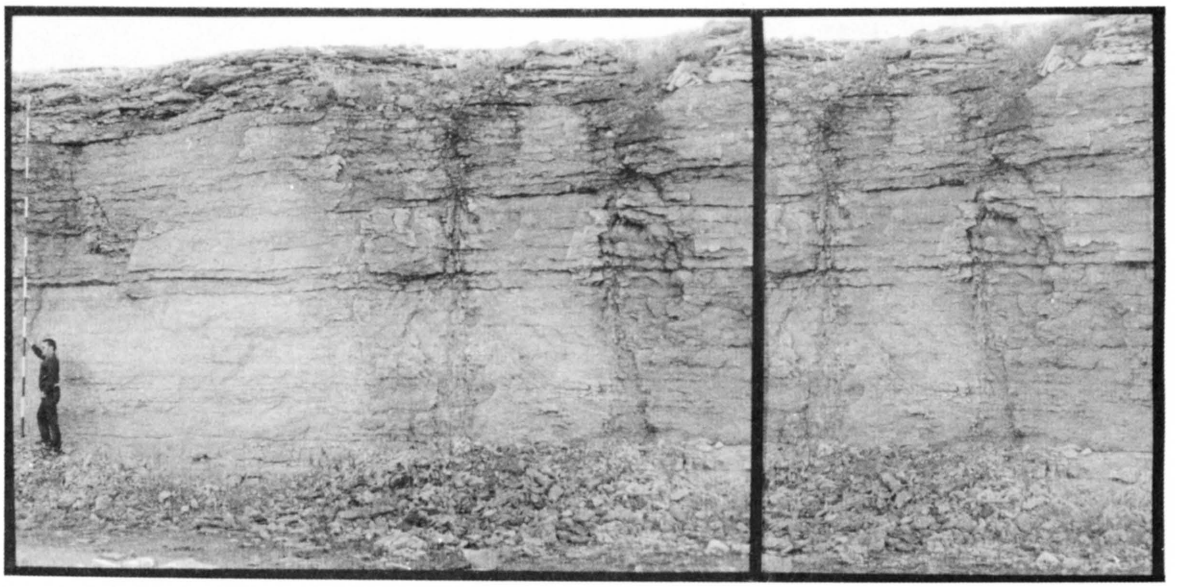


Figure 12. Spring Hill Limestone Member exposed in a quarry in the NE¼, SE¼, sec. 5, T24S, R19E (Sterrogram).

Quality test data available for the Spring Hill Limestone in Allen County indicate the material will meet all current KDOT standard specifications for construction aggregate, however, tests should be run on each location before use.

Stanton Limestone Formation

The Stanton Limestone Formation is composed of three limestone and two shale members which are, in ascending order, the Captain Creek Limestone, Eudora Shale, Stoner Limestone, Rock Lake Shale, and South Bend Limestone. The Stanton Formation has an average thickness of 47 feet (14.3 m) in Allen County. The Stanton Formation has been mapped on plates I and III.

Captain Creek Limestone Member

The Captain Creek is a thin to medium bedded, gray, dense, moderately fossiliferous limestone. It weathers light-gray to-white and may appear as a single massive bed in the outcrop. Chert and calcite stringers may be present in the upper part of the bed. It has an average thickness of 11 feet (3.4 m) in Allen County.

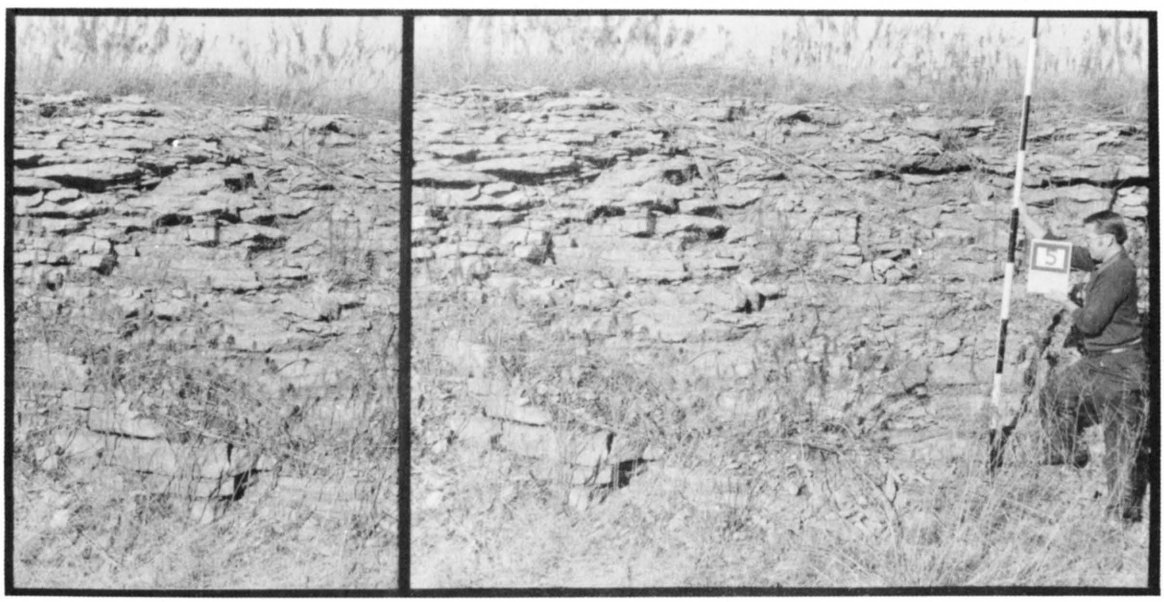


Figure 13. Captain Creek Limestone Member exposed in a road cut in the SE¼, sec. 25, T24S, R17E (Stereogram).

The Captain Creek has been tested at only one location (LS + 2) in Allen County; however, test results from this location indicate the material is of very high quality and will readily meet all current KDOT standard specifications for construction aggregate.

Stoner Limestone Member

The Stoner Member is a light-gray to-gray, fossilferous limestone having a thickness of approximately 25 feet (7.6 m). The lower part of the unit is fine-grained, thin-bedded and contains thin shale partings. The upper part is tan-to brown, coarse-grained, wavy and thick-bedded. Due to limited exposures no accurate measurements of the member were possible..

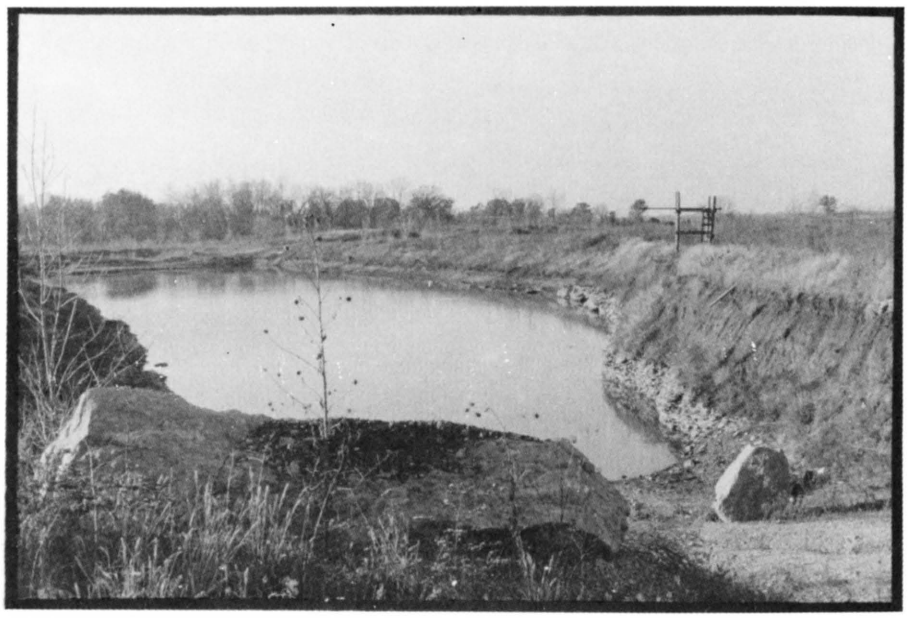


Figure 14. Stoner Limestone Member exposed in a water filled quarry in the NE¼, sec 26, T26S, R17E.

Limited quality test data from site LS + 1 (plate 1) indicate the material will meet all current KDOT standard specifications for construction aggregate. Quality tests should be completed on material from any location before use is comtemplated.

South Bend Limestone Member

The South Bend is a bluish-gray to-gray, coarse grained, thin bedded limestone having a thickness of about 6 feet (1.8 m). It is very poorly exposed in Allen County. The limited areal extent and thickness of this member limit its use to local light type surfacing material.

Sand and Gravel

Undifferentiated Quaternary Terrace

High terrace deposits located from 40 to 120 feet (12.2 - 36.6 m) above the Neosho River are found along the upland surfaces on the west side of the river and in the northwestern corner of the county. These deposits are composed of tan to brown chert pebbles in a heavy clay matrix. These deposits vary from a few inches in

thickness to as much as 8 feet (2.4 m). These deposits are discontinuous, small in areal extent, and most are not economical to produce for any use other than light type surfacing.

Figure 15. Chert gravel exposed in a cut in the NW¼, SW¼, sec. 27, T23S, R18E.

There are no quality test data available for this material in Allen County; however, when mixed with proper amounts of sweetner, this material should meet all current KDOT standard specifications for construction aggregate. Difficulty will be encountered in sawing joints in concrete pavement constructed with chert gravel aggregate. These deposits have been mapped on plates I, III, and V.

Illinoisan Terrace

Illinoisan terrace deposits which have been mapped on plates I, III and V are discontinuous throughout the county. In areas where the terraces are present, they have a thickness ranging up to 32 feet (9.6 m). The Illinoisan terraces are composed of fine silts and clays with some lenses of sand and gravel and chert gravel or chert pebbles.

The Illinoisan terrace deposits are not considered as a source of construction aggregate in the county but were mapped as an aid to the understanding of the local geology and geologic history.

Quaternary Alluvium

Deposits of Wisconsinan and Recent ages were mapped together as Quaternary Alluvium in this report. These deposits are located along the Neosho River and its tributaries, and the Marmaton River and have been mapped on plates I, III, V and VI.

The alluvium is composed of silts and clays, fine to coarse sand and very coarse chert pebbles. The chert is generally confined to the base of the deposit in a zone with a maximum thickness of 12 feet (3.7 m). The total thickness of the alluvium is approximately 25 feet (7.6 m).

There was no active production of aggregate from the alluvial deposits during the time of this investigation. Chert gravel from the alluvium when mixed with proper amounts of limestone sweetner, should meet all current KDOT standard specifications for construction aggregate. Difficulty will be encountered in sawing joints in concrete pavement constructed with the chert gravel aggregate.

An extensive exploratory drilling program would be required to delineate the size and areal extent of the chert gravel deposits within the Quaternary Alluvium due to the lack of surface manifestation and lensing nature.

Site Data Form No.	Material Type	Date of Test	Sp. Gr. Sat.	Sp. Gr. Dry	% Wear	% Soundness	% Absorption	Source of Data SHC Lab No.
Source of Material: Iola Limestone (Raytown Mbr.) Pi								
LS+6	Limestone	8-24-62	2.56	2.49	36.0%(B)	0.98	3.11%	24094
		1-25-65	2.56	2.49	32.5%(B)	0.99	2.98%	38415
LS+7	Limestone	6-5-62	2.55	2.47	34.5%(B)	0.98	3.09%	22761
		8-28-62	2.54	2.45	34.4%(B)	0.99	3.45%	24253
		10-25-62	2.54	2.46	34.7%(B)	0.99	3.19%	25391
		1-6-64	2.55	2.47	34.2%(B)	0.98	3.07%	32267
LS+8	Limestone	3-25-77	2.57	2.50	36.0%(B)	0.99	2.80%	77-441
LS+9	Limestone	10-9-73	2.55	2.46	36.0%(B)	0.99	3.50%	73-2942
LS+10	Limestone	3-28-77	2.56	2.48	37.0%(B)	0.99	3.10%	77-495
LS+11	Limestone	3-27-68	2.58	2.52	32.4%(B)	0.99	2.40%	68-816
		3-27-68	2.58	2.50	35.2%(B)	0.98	2.46%	68-817
		2-3-69	2.56	2.49	35.8%(B)	0.97	3.11%	69-160
		2-10-69	2.57	2.50	35.0%(B)	0.98	2.63%	69-159
LS+12	Limestone	5-12-58	2.52	2.42	36.0%(B)	0.94	4.06%	1413
		4-5-62	2.55	2.47	37.5%(B)	0.98	3.15%	21501
LS+13	Limestone	3-12-73	2.56	2.48	37.0%(B)	0.97	3.30%	73-328
LS+14	Limestone	10-26-71	2.57	2.49	45.0%(B)	0.98	3.08%	71-3192
LS+15	Limestone	11-6-63	2.56	2.49	36.3%(B)	0.96	2.93%	31395
		2-3-65	2.59	2.53	32.9%(B)	0.99	2.29%	38417
LS+16	Limestone	9-22-54	2.57	2.50	34.2%(B)	0.97	2.60%	84886
LS+17	Limestone	3-13-68	2.57	2.49	38.4%(B)	0.98	3.10%	68-578
LS+18	Limestone	9-16-74	2.60	2.53	34.0%(B)	0.99	2.70%	74-2161
LS+19	Limestone	10-19-61	2.51	2.43	40.4%(B)	0.98	3.39%	19614
		11-6-61	2.53	2.45	39.3%(B)	0.98	3.41%	19922
		3-19-62			33.6%(B)			21565
		1-6-64	2.52	2.44	37.7%(B)	0.98	3.23%	32266
Source of Material: Plattsburg Limestone (Spring Hill Mbr.) Pp								
LS+3	Limestone	8-20-69	2.60	2.54	35.3%(B)	0.98	2.70%	69-2335
		10-22-69	2.60	2.55	32.4%(B)	0.97	2.18%	69-3169
LS+4	Limestone	3-13-68	2.64	2.60	30.1%(B)	0.96	1.66%	68-577
LS+5	Limestone	5-25-56	2.62	2.56	28.4%(B)	0.94	2.11%	92878
		1-23-62	2.60	2.54	30.2%(B)	0.92	2.34%	21154
Source of Material: Stanton Limestone Ps								
LS+1	Limestone Stoner Ls. Mbr.	4-23-74	2.59	2.51	31.0%(B)	0.96	3.00%	74-667
LS+2	Limestone Captain Creek Ls. Mbr.	4-30-62	2.65	2.61	27.0%(B)	0.97	1.39%	22060
		6-1-62	2.65	2.63	26.7%(B)	0.97	1.02%	22680
		2-26-63	2.54	2.46	31.9%(B)	0.99	3.17%	27087
		3-16-65	2.60	2.54	27.5%(B)	0.99	2.42%	65-124

Figure 16. Results of Tests.