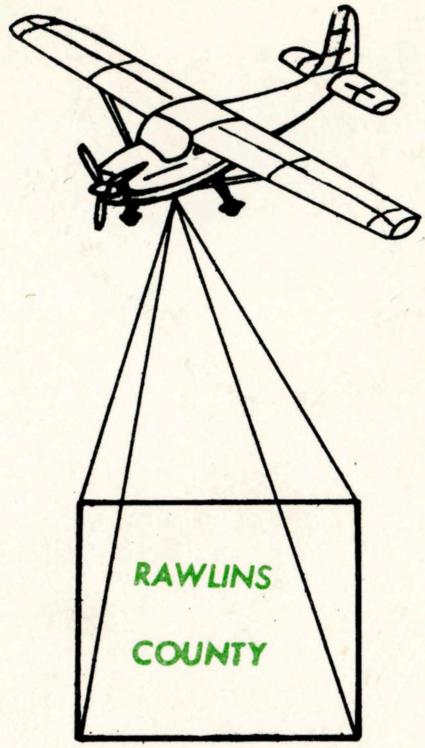

MATERIALS INVENTORY

PREPARED BY THE
STATE HIGHWAY COMMISSION OF KANSAS
LOCATION AND DESIGN CONCEPTS DEPARTMENT
IN COOPERATION WITH THE
U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

State Highway Commission of Kansas
Planning and Development Department -
Location and Design Concepts Department

MATERIALS INVENTORY OF RAWLINS COUNTY, KANSAS

by

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assisted by
Robert L. Kibby
Photo Interpretation Section

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

1968

Materials Inventory Report No. 17

the **Why ?**

What ?

& **How ?**

Of This Report

This report was compiled for use as a guide when prospecting for construction material in Rawlins County.

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

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

> *Prospective sites are areas where geologic conditions are best for finding construction material.*

The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to evaluate and locate <u>mapped sites</u>.

The individually mapped sites certainly do not constitute the total construction material resources of the county. And, the data outlined in the diagram may be used for purposes other than the evaluation and location of these sites.

Beginning on page 9 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 material sources in the geologic units throughout Rawlins County.

TO LOCATE AND EVALUATE
A MAPPED SITE OF CONSTRUCTION MATERIAL IN RAWLINS COUNTY

Turn To The Materials Inventory Section

See
TABULATION OF CONSTRUCTION MATERIALS
Page 29

for material
BY TYPE
USE COLUMN 1

For Quality Data
See Figure 17
Page 44

for material
BY INTENDED USE
USE COLUMN 3

for **DESCRIPTION** of MATERIAL

Column 4 gives page of DESCRIPTION which includes engineering characteristics, approximate locations, and references to materials maps.

for **AVAILABILITY** of MATERIAL

Column 5 gives relative amounts available, general location, and references to materials maps.

MATERIALS MAPS

SEE PINK SHEET PAGE 45

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

SITE DATA FORMS

OPEN SITES - NOT SAMPLED	GREEN SHEET PAGE 47
OPEN SITES - SAMPLED	GREEN SHEET PAGE 89
PROSPECTIVE SITES - NOT SAMPLED	GREEN SHEET PAGE 119
PROSPECTIVE SITES - SAMPLED	GREEN SHEET PAGE 125

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 Bureau of Public Roads and the State Highway Commission of Kansas, financed by highway planning and research funds. The objective of the project is to provide a state-wide inventory of construction materials, on a county basis, to help meet the demands of present and future construction needs.

Several previous surveys in Rawlins County provided basic geologic and materials data for this report. "Geology and ground-water resources of Rawlins County, Kansas" by Kenneth L. Walters of the State Geological Survey of Kansas, provided geologic information. Data issued by the United States Geological Survey and the Materials Department of the State Highway Commission provided quality test results and other general facts pertaining to construction materials resources of the county. Detailed geologic and soil data were obtained from soil surveys and centerline geological profiles prepared for design of major highways in the county by the State Highway Commission.

Appreciation is extended to Gerald Vernon, Rawlins County Engineer, for verbal information concerning construction materials in the area. The authors acknowledge the contributions made by the late A. C. Lundgren, former Third Division Materials Engineer.

This report was prepared under the guidance of Jonn D. McNeal, State Highway Engineer, and the project engineer, Ray R. Biege, Jr., Engineer of Location and Design Concepts, and Glen M. Koontz, Coordinating Engineer, Location and Design Concepts Department.

ABSTRACT

Rawlins County lies in the High Plains physiographic division in the northwestern part of Kansas. It is drained, for the most part, by Beaver Creek, Sappa Creek, and their tributaries. The topography along major drainage channels is very rugged and contrasts sharply with the nearly flat to gently rolling terrain that characterizes the interstream land surface.

The Pierre Shale of Cretaceous age underlies the entire county and is exposed in the extreme northwestern part of the county and in some areas along the major streams. The Ogallala Formation of Pliocene age overlies the Pierre and is a significant part of the construction materials resources of the county. Sand and gravel, volcanic ash, chert, and sedimentary quartzite can be produced from the Ogallala in this area.

A limited amount of volcanic ash (Pearlette) can be produced at scattered locations from the Sappa Formation which occupies the upper part of the valley walls of the major streams. This type of material has been produced from at least two such pits.

Crete terraces are located below the Sappa Formation and above the floodplains of the major drainage channels. Siliceous sand and gravel are produced from the Crete with most production being in the southeastern part of the county.

Sand and gravel can also be produced from the Alluvium of the major streams in Rawlins County. However, this source for the most part, has not been exploited. A coarser material can be produced from this unit than from any other source.

It is unlikely that the Pierre Shale will be encountered in highway construction except possibly in the extreme northwest corner of the county. If encountered, consideration should be given to its high swell characteristics.

Most highway improvements in Rawlins County will encounter the Ogallala Formation. Because of its heterogeneous nature, a variety of construction problems can be anticipated; the most common being the classification of the Ogallala for excavation purposes.

Loess deposits, which cap older geologic units, will be encountered on most projects in the county. Loess, for the most part, is satisfactory as construction material in this area because of the relatively low annual rainfall.

The mineral content of the water supply is significant. Highly mineralized water (especially with high chloride and sulfate) may have a damaging affect on Portland Cement concrete. In general, a good quality of water for concrete can be produced from the Ogallala and Alluvium in Rawlins County. However, in some areas where the water has been in prolonged contact with the Pierre Shale, it has high concentrations of dissolved solids which would preclude its use in concrete.

GENERAL INFORMATION SECTION

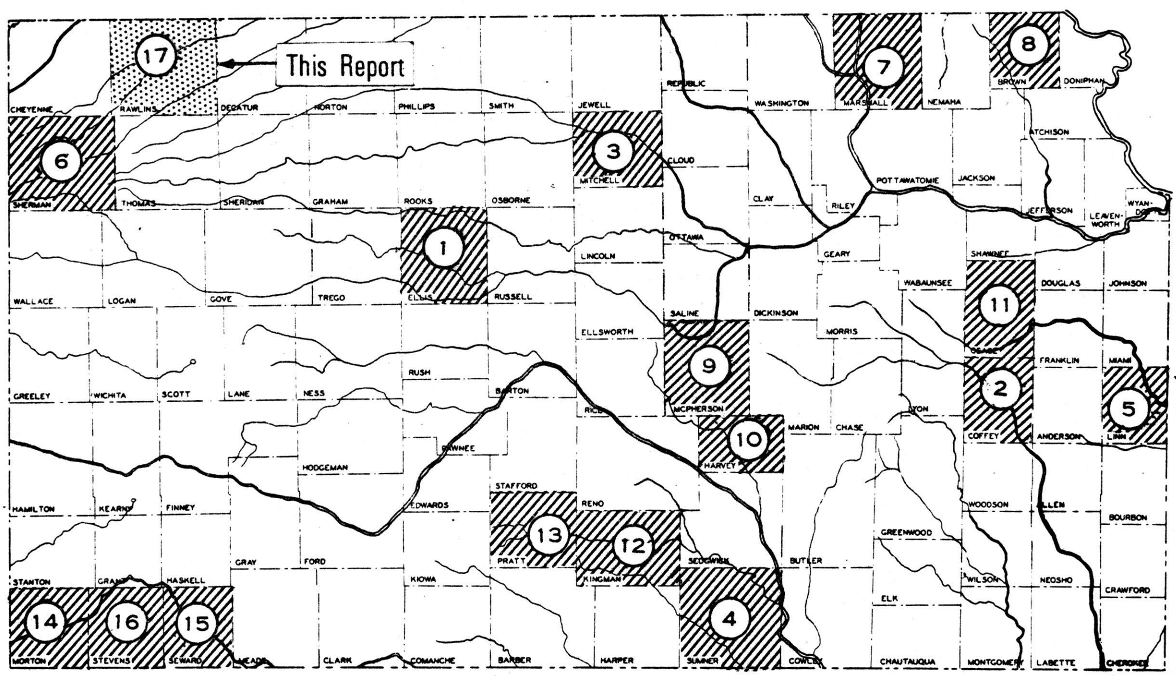


Figure 1. Index map of Kansas showing the location of Rawlins County along with the number and location of counties for which reports have been or are being completed.

RAWLINS COUNTY

Rawlins County has an area of 1,080 square miles. The 1968 population, according to the Kansas Board of Agriculture, is 5,020. It lies in the High Plains physiographic division of Kansas and is bounded by parallels 39° 34' and 40° 00' north latitude and meridians 100° 44' and 101° 25' west longitude.

Figure 1 shows the location of Rawlins County as well as other counties currently included in the materials inventory program.

Rawlins County drainage is generally northeasterly. The southeastern part of the county is drained by the South Fork Sappa, Sappa, and North Fork Sappa Creeks. Beaver Creek, the largest stream in the county, drains the central area which comprises about one-half of the county. The northwestern and north-central part of the county is drained by Timber, Burntwood, North Fork Driftwood and South Fork Driftwood Creeks.

The interstream terrain varies from nearly flat to gently rolling with many undrained depressions and a few shallow valleys. Areas bordering the major streams of the county are deeply dissected and have very rugged topography contrasting sharply with the nearly upland areas.

Rawlins County has a Chicago, Burlington and Quincy Railroad line which serves the cities of Herndon, Ludell, Atwood, and McDonald. U. S. Highway 36 runs east-west through the approximate center of the county serving Atwood, the principal city and county seat, and McDonald. State Highway 25 extends north-south through the county intersecting U. S. 36 at Atwood. State Highway 117 runs from U. S. 36 to the north county line, serving the city of Herndon. There is also a well developed system of secondary roads throughout the county except in highly dissected areas adjacent to the major streams.

METHODS OF INVESTIGATION

Investigation for this report consisted of three phases: 1. Research and review of available information, 2. Photo interpretation, and 3. Field reconnaissance.

During phase one, pertinent information pertaining to the geology, soils, and construction materials was reviewed, and the general geology of the county, relative to material sources, was determined. The results of quality tests of samples taken in Rawlins County were correlated with the various geologic units and deposits.

Phase two consisted of study and interpretation of aerial photographs taken by the State Highway Commission at a scale of one inch equals 2,000 feet. Figure 2 shows the photographic coverage of Rawlins County.

The geologic source beds were mapped and classified on photographs as were all open material sites previously sampled and reported. Then all material sites were correlated with the geology of the county. Prospective areas were tentatively selected on the basis of the geology and aerial photographic pattern elements.

Phase three, a field reconnaissance of the county, was conducted after initial study of the aerial photographs. This enabled the interpreter to examine the material with which he was working, to verify doubtful mapping situations, and to better acquaint himself with the geology of the county. Geologic classification of open sites was confirmed and prospective areas were inspected. Since geologic units are usually uniform throughout the county,

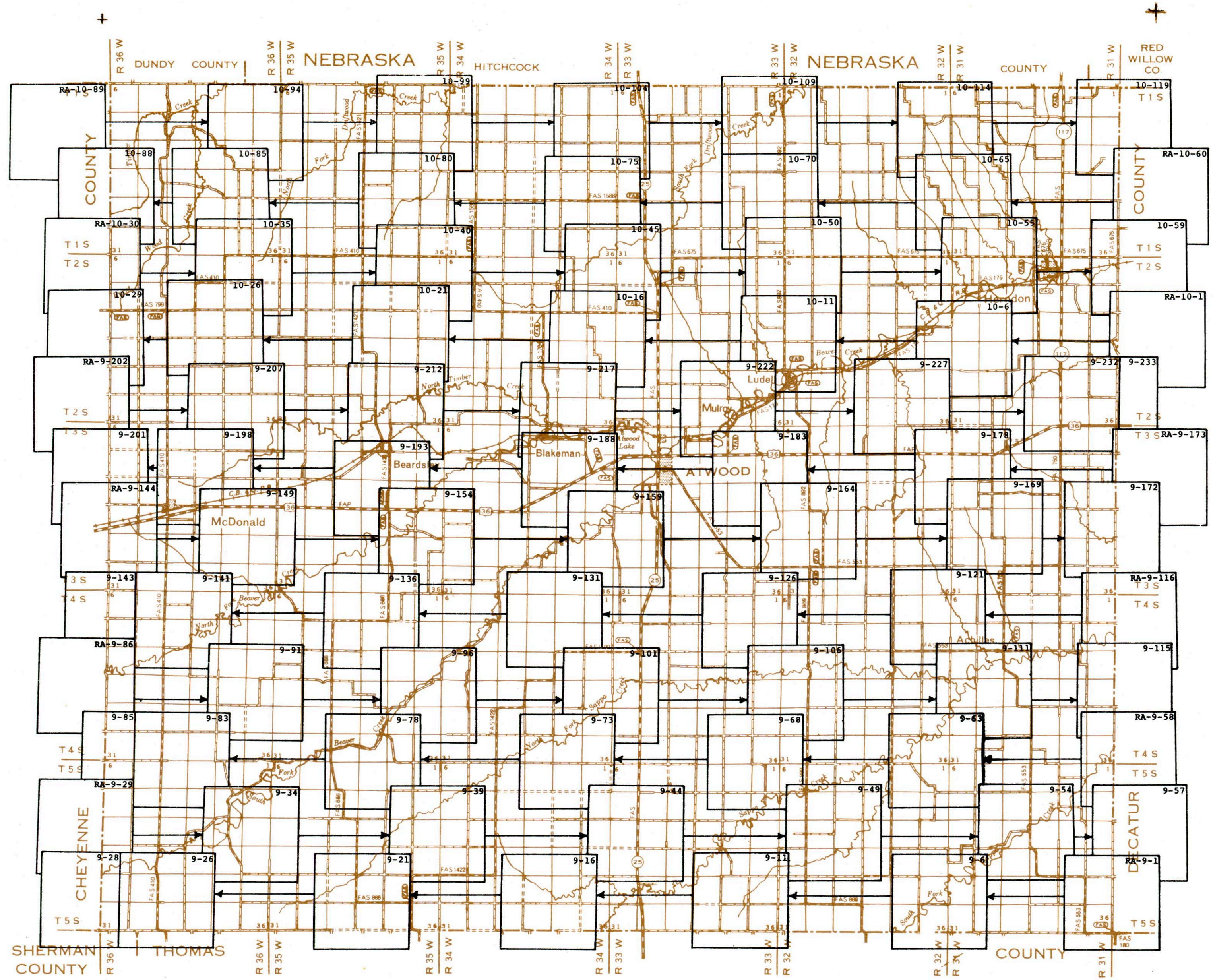
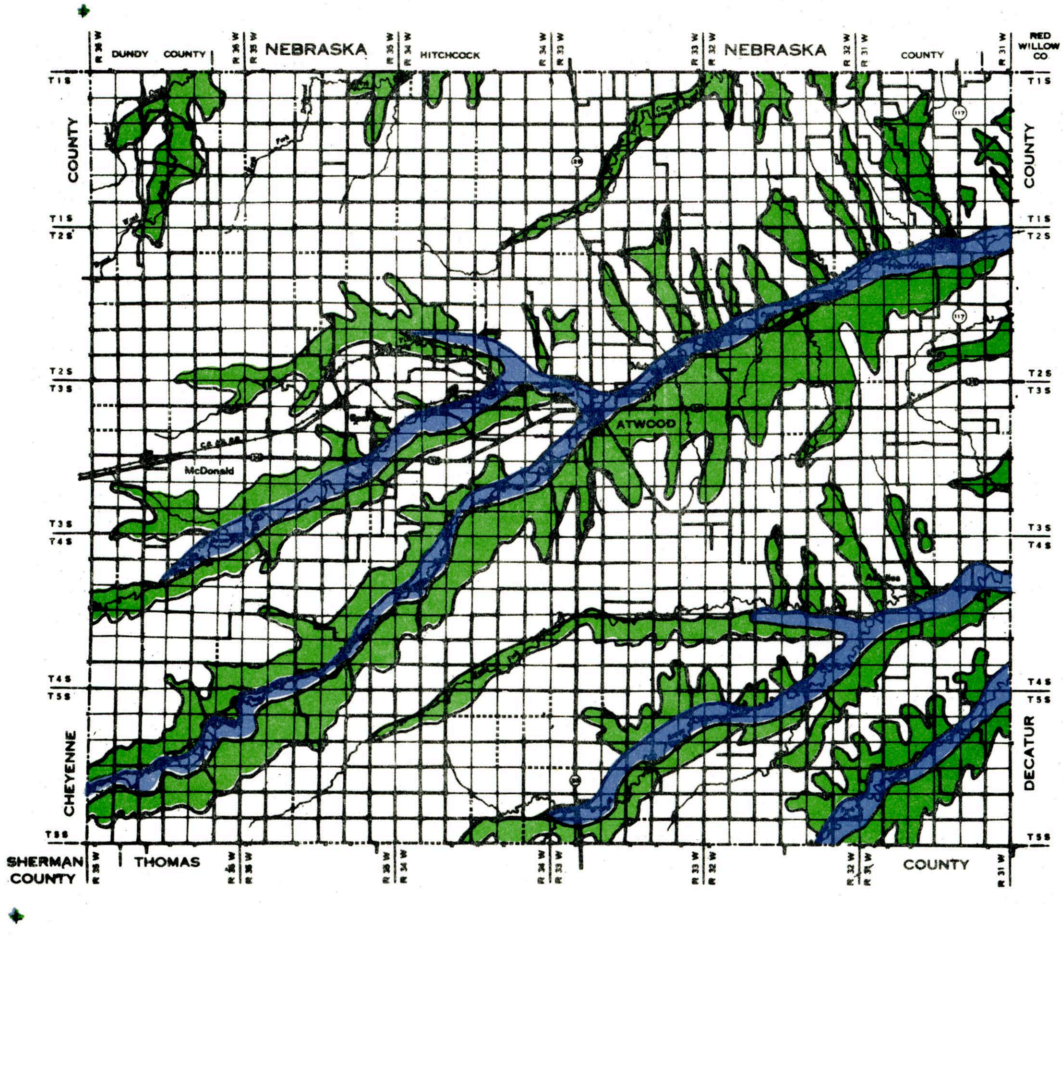


Figure 2. Aerial photographic coverage map. The numbers refer to photographs taken by the Photogrammetry Section of the State Highway Commission of Kansas. The southern two-thirds of the county was photographed December 12, 1966 and the northern one-third on February 28, 1967. Aerial photographs are on file in the Photogrammetry Laboratory State Office Building, Topeka, Kansas.

material in prospective areas generally could be evaluated on the basis of material produced from open pits located in the same unit.

GEOLOGY SECTION



GENERAL GEOLOGY

GEOLOGY is used as the basis for conducting this materials inventory project because all material source units are the product of geologic agents. A knowledge of the geology of the area makes it possible to ascertain the general properties of the material source, to identify and classify each according to current geologic nomenclature, and, thereby, establish a uniform system of material source bed classification. However, it is important to note that the quality of material from a given source may vary from one location to another, especially when one is dealing with unconsolidated deposits. Usually the geologic classification attached to unconsolidated deposits denotes age rather than material type; therefore, two deposits laid down during the same time period in different parts of the state may have the same geologic name or classification, but may vary in composition because of the difference in parent material, mode of deposition, or carrying capacity of the depositing agent.

By knowing the mode of deposition, type of source bed, geologic age, type of landform associated with a particular source unit, and the results of quality tests completed on samples obtained from similar deposits, one can derive general information concerning the material in prospective sites. Consequently, sites selected for development generally can be evaluated by data obtained elsewhere from the same source unit.

Rawlins County geology, as discussed in this report, is based primarily on information from a report published by the State Geological Survey of Kansas, "Geology and Ground-Water Resources of Rawlins County, Kansas," by Kenneth L. Walters.

The geologic timetable, figure 3, shows in graphic form the major time periods and the approximate duration of each.

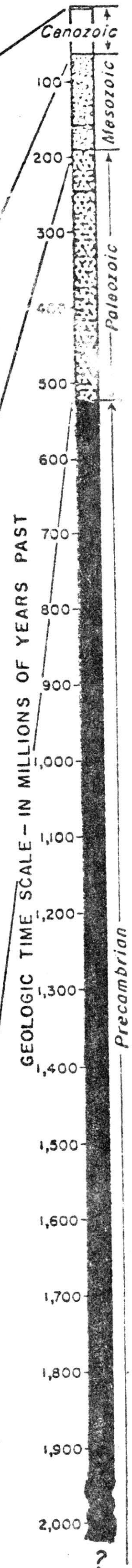
Since construction material sources are usually exposed or near the surface, the deposits laid down during Cenozoic time are the major sources of construction material in the county and the geologic history of that period is emphasized in this report. Figure 4 is a generalized geologic column of the surface geology of Rawlins County which illustrates the relative stratigraphic position of the geologic source units.

Rocks which occur in the subsurface but do not outcrop in Rawlins County, range from Precambrian to Cretaceous in age. According to Walters (1956, page 16), Precambrian rocks are found at depths ranging from 4,500 to 5,250 feet in this county. These rocks are overlain by about 2,600 feet of Paleozoic sedimentary rocks. During Paleozoic time, deposits were laid down when the surface was below sea level and generally, erosion occurred during periods of emergence. Most of the Paleozoic rocks are of marine origin; however, toward the end of the era, nonmarine sediments (e.g. red beds) and evaporites were deposited.

By the close of the Paleozoic Era, the seas withdrew from the area and by early Mesozoic time erosional processes were prominent. No Triassic beds have been identified in Rawlins County and if any deposits of this age were laid down, they were subsequently removed by erosion. As much as 175 feet of Jurassic

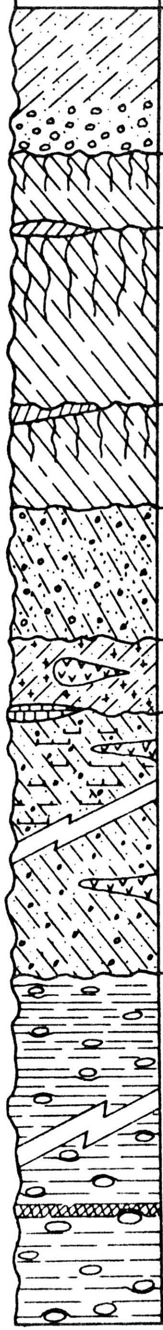
ERAS	PERIODS	ESTIMATED LENGTH IN YEARS	TYPE OF ROCK IN KANSAS	PRINCIPAL MINERAL RESOURCES
CENOZOIC	QUATERNARY (PLEISTOCENE)	1,000,000	*Glacial drift; river silt, sand, and gravel; dune sand; wind-blown silt (loess); volcanic ash.*	Water, agricultural soils, sand and gravel, volcanic ash.
	TERTIARY	59,000,000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

(Not scaled for geologic time or thickness of deposits)



State Geological Survey of Kansas

Figure 3. Geologic timetable *(Reproduced with the permission of the State Geological Survey of Kansas).*



Thickness	System	Series	Stage	Formation and Deposits	Map Symbol	Generalized Description	Material Significance
0 to 50'	Quaternary	Pleistocene	Wisconsinan and Recent	Alluvium and Terrace Deposits	Qal	Clay, silt, sand, and gravel along stream valleys. Locally, coarse gravel in lower part.	Aggregate
0 to 10'	Quaternary	Pleistocene	Wisconsinan	Bignell Formation	Ql	Well-sorted silt, light yellow-gray to tan. Caps the uplands in some areas.	Embankment, shoulder and subgrade construction. Subject to severe water and wind erosion.
0 to 75'	Quaternary	Pleistocene	Wisconsinan	Peoria Formation	Ql	Well-sorted silt, clayey, light yellow-gray. Underlies uplands and slopes. Brady buried soil at top.	Embankment, shoulder and subgrade construction. Subject to severe water and wind erosion.
0 to 30'	Quaternary	Pleistocene	Illinoisan	Loveland Formation	Ql	Silt, clayey, reddish-tan to tan. Underlies uplands. Sangamon buried soil at top.	Embankment, shoulder and subgrade construction. Subject to severe water and wind erosion.
0 to 45'	Quaternary	Pleistocene	Illinoisan	Crete Formation	Qc	Silt, sand and gravel, generally well sorted. Found 40 to 60 feet above floodplains of major drainage channels.	Aggregate
0 to 10'	Quaternary	Pleistocene	Kansan	Sappa Formation		Silt, clayey with caliche. Recognized in Rawlins County only where Pearlette volcanic ash is present. Occurs 60 to 80 feet above floodplain of major drainage channels.	Mineral Filler (Volcanic ash)
0 to 280'	Tertiary	Pliocene		Ogallala Formation	To	Clay, silt, light tan to white with sand and gravel. Partly cemented by $CaCO_3$ (mortar bed) impure limestone, volcanic ash, quartzite and chert.	Aggregate Rural Road Surfacing Mineral Filler
400-1200'	Cretaceous	Upper Cretaceous		Pierre Shale Formation	Kp	Shale, black to deep brown and gray. Contains bentonitic beds and concretionary limonite zones.	No construction material. Highly plastic material. Slides and slip-outs common. Should be avoided for shoulder and subgrade construction. Water that has been in prolong contact with this unit is highly mineralized.

Figure 4. Generalized geologic column of the surface geology in Rawlins County.

rocks (tentatively correlated with the Morrison Formation) are found in the subsurface in Rawlins County. The area was subjected to erosional processes following the deposition of the Jurassic rocks and remained above sea level during late Jurassic and early Cretaceous time. The area was again submerged during the late Cretaceous. The Dakota Formation probably was deposited in a deeper sea during late Cretaceous time. About 2,000 feet of Cretaceous rocks are found in Rawlins County. The Pierre Shale of late Cretaceous age, is the oldest rock exposed in this area.

The end of the Cretaceous Period (Mesozoic Era) and the beginning of the Tertiary Period (Cenozoic Era) was marked by the final withdrawal of the sea from this region. The area was subjected to erosion during most of Tertiary time and varying amounts of Cretaceous rocks were stripped away. Near the end of Tertiary time (Pliocene Epoch), eastward flowing streams, originating in the Rocky Mountain area, shifted back and forth as they crossed the area and deposited a thick blanket of silt, sand, and gravel (the Ogallala Formation) on the eroded Cretaceous surface. At the close of Tertiary time, it is believed that the Ogallala surface was nearly flat. According to some geologists, fresh-water lakes in which the "Algal Limestone" was formed existed at this time. This limestone caps the Ogallala in some localities in Rawlins County and in other parts of western Kansas.

The Pleistocene Epoch of the Quaternary Period represents approximately the last one million years in the Cenozoic Era and a time of repeated glacial and interglacial cycles in North America. Glacial activity in Kansas was restricted to the extreme northeastern corner of the state. However, the sequence of glaciation occurring during this time played a controlling role in the development of Pleistocene nomenclature. The glacial ages (Nebraskan, Kansan, Illinoisan, and Wisconsinan) represent the advance of the glaciers, while the three interglacial ages (Aftonian, Yarmouthian, and Sangamonian) represent periods of major glacial recession. Figure 5 is a geologic timetable which shows the dividions of the Quaternary Period and the approximate duration of each.

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	45,000	55,000
		Sangamonian Interglacial	135,000	190,000
		Illinoisan Glacial	100,000	290,000
		Yarmouthian Interglacial	310,000	600,000
		Kansan Glacial	100,000	700,000
		Aftonian Interglacial	200,000	900,000
		Nebraskan Glacial	100,000	1,000,000

Figure 5. Geologic timetable of the Quaternary Period

During early Quaternary time, the present day drainage system of Rawlins County had begun to form, cutting into the unconsolidated Ogallala sediments. Deposits of Nebraskan age have not been identified, but by Kansan time, the streams were well established and alluvial deposits (Sappa Formation) of Kansan age were laid down. Today, these deposits occur as high terraces along the main drainage channels of the county. During the time that the Sappa Formation was being deposited, ash was thrown into the air by volcanic action in the southern Rocky Mountain belt and was carried by prevailing southwesterly winds over Kansas and adjacent areas. This material settled to the ground or was carried down by rains, resulting in a thin layer of fine textured ash being spread extensively over the land surface. Subsequently, local stream action transported some of this material into undrained depressions. This mode of accumulation accounts for the irregular size and thickness of the Pearlette ash deposits.

By Illinoisan time the streams had cut to a lower elevation, and deposits of silt, sand, and gravel were laid down. Today these deposits compose the Crete Formation which occurs about 30 to 40 feet below the Sappa.

During late Illinoisan and early Wisconsinan time, loess represented by the Loveland, Peoria, and Bignell Formations, was laid down. Throughout late Wisconsinan and Recent time, the loess topography has been modified by erosion and slumping. In some localities, wind and gravity have removed silt from the high areas and redeposited it along the valley walls. As a result of redeposition, the loess is abnormally thick in areas normally characterized by thin overburden. During and since late Wisconsinan time, the streams have alluviated their valleys.

GEO-ENGINEERING SECTION

INTRODUCTION

This section is a general appraisal of the material available in Rawlins County for embankment, shoulder and subgrade construction. Potential ground-water problems and the quality of water available for concrete are briefly reviewed. Detailed field investigations would be necessary to ascertain the severity of specific problems and to make recommendations concerning design and construction procedures.

MATERIAL USAGE

Pierre Shale Formation

The Pierre is a gray, blue-gray and black clayey shale containing zones of abundant concretions, thin beds of bentonite, and crystals of gypsum. According to Walters (page 48, 1956) the thickness of the Pierre, underlying Rawlins County, ranges from 400 feet to about 1,200 feet. The Pierre underlies all of Rawlins County and is exposed in the extreme northwestern part of the county along Timber and Burntwood Creeks. It is also found in many small areas along Beaver, Little Beaver, and North Fork Sappa Creeks in the central part of the county.

The Pierre has a high affinity for water and is very plastic. Soil derived from this unit has plastic index values which may range from 40 to 55. The material is classified as a clay by the State Highway Commission of Kansas and as a silt-clay (A-7 type soil) by the American Association of State Highway Officials (AASHO) system of soil classification.

Extensive slides do occur in the Pierre and slope stability problems may be anticipated. Generally, backslopes should be 3:1 or flatter to prevent slipouts and slides; however, the severity of such problems will be affected by local ground-water and weathering conditions.

This shale is objectionable for use in subgrade and shoulder construction. If used for embankment, it should be well distributed and blended with soil.

Both piling and spread footings can be used for bridge foundations in Pierre Shale. Weathering of the shale is the determining factor. Piling is usually necessary since conditions favorable for spread footings are restricted to the northwest corner of the county and along some major streams in the central portion. Because weathering varies considerably throughout the county, each bridge site will require investigation.

Ogallala Formation

This formation is composed of silt, sand, and gravel with some localized calcium and silica cemented zones. It underlies all of Rawlins County except in the northwestern corner and in small areas along Beaver, Little Beaver, and North Fork Sappa Creeks. Most roadways constructed in the county will involve the Ogallala, and because of its heterogenous nature, several different types of problems may be encountered. A large part of the Ogallala is composed of unconsolidated silt, sand, and gravel. This material is granular (less than 35% passing the no. 200 sieve) according to A.A.S.H.O. classification. Most of it would be classified as a sand or sand loam in the State Highway Commission soil classification system.

The granular portion of the Ogallala is satisfactory for subgrade construction, however, when used on shoulders and slopes it should be blended with denser soils to enhance its ability to resist erosion and support vegetation. It may also require the blending of binder soils to provide a surface dense enough to support heavy construction equipment.

In Rawlins County, the Ogallala Formation is characterized by zones of silt, sand and/or gravel cemented with calcium carbonate along with lenses of clay. These zones known as mortar beds are highly irregular in distribution and cementation. They are normally classified as rock excavation even though pockets occur which are not firmly cemented. Such conditions make it difficult to accurately classify excavation by core drilling. Figure 6 shows an outcrop of mortar bed in the southwest part of the county.

Figure 6. An outcrop of mortar bed in southwestern Rawlins County.

Tests completed on some samples of silt and clay seams found in the Ogallala reveal that the material is highly plastic and has a P.I. that varies from 17 to 45. This material is classified as a silt, clay loam, and clay by the State Highway Commission and as an A-6 or A-7 by A.A.S.H.O. standards. These highly plastic soils would be objectionable for subgrade and shoulder construction. All material from the Ogallala is satisfactory for embankment purposes, provided the highly plastic material is not used in large, isolated quantities.

Cut slopes in the Ogallala generally are stable on a minimum 1:1 or flatter slope with exception of the resistant cemented beds.

Initially, these zones will stand on a near vertical slope. Eventually, however, slumping may occur in these horizons resulting in maintenance problems.

Bridge foundations on the Ogallala Formation are generally supported by pile. The depth of penetration for required bearing will depend upon the composition of the formation at each individual site. Friction pile will usually obtain substantial bearing when driven 10 to 15 feet into basically granular type material. Whereas in clayey type material, deeper penetration will be required for the same bearing.

The Ogallala Formation is not commonly used for spread type bridge footing. However, certain upland bridges may be satisfactorily supported by spread footings if no compressible clayey type material is encountered within the foundation boundaries. Under these circumstances spread footings may be used if the designed load does not exceed two tons per square foot.

Loveland, Peoria, and Bignell Formations

The Loveland, Peoria, and Bignell Formations are composed of well-sorted, eolian silt occupying higher terrain in the county. The Bignell Formation is present only in isolated areas and is relatively insignificant from the geo-engineering point of view. The thickness of the other two silt formations ranges up to 132 feet in the western part of the county; however, most of the county is covered by thicknesses that range from 30 to 34 feet. Most of this material is classified as a silt-loam by the State Highway Commission and as an A-4 type soil by A.A.S.H.O. standards. It is desirable for subgrade and shoulder construction and is usable for embankment, but it should be stabilized by vegetation as quickly as possible to retard erosion. Some silt has been reworked by water and gravity, accumulating organic material in the process. Thus, a higher plastic type material can be found in the valleys of the drainage system. This colluvial material may fall in the clay classification with plastic index values as high as 27 and would have an A.A.S.H.O. classification of an A-7 soil. Generally, most of these soils perform satisfactorily due to the low annual rainfall (about 18½ inches); however, in low areas where moisture may accumulate, they may be objectionable for subgrade construction and would require a thicker pavement design than for soils encountered in the high areas.

Many highway cuts in Rawlins County will be in the Loveland and Peoria Formations. Backslopes constructed in this material require some stabilization. The Loveland and Peoria silts will stand temporarily in vertical backslopes, but permanent slopes should not be constructed steeper than 3:1 and should be seeded to prevent erosion.

POSSIBLE HYDROLOGY PROBLEMS IN ROAD CONSTRUCTION

Because of the semi-arid climate, fewer and less severe hydrology problems will be encountered in Rawlins County than in the eastern part of the state.

A potential ground-water problem exists along the contact of the Pierre Shale and the overlying Ogallala Formation; however, it is very doubtful that the grade of a proposed project would be low enough to encounter this contact except possibly in the extreme northwestern part of the county.

QUALITY OF WATER

According to Walters (1947, page 23) ground-water is produced primarily from the Ogallala Formation and alluvial deposits of the major streams in Rawlins County. The mineral content of water from both sources is comparatively low, but, it is generally higher in the Alluvium.

Although the Pierre Shale yields no water, it acts as an impervious floor below the younger, water-bearing formations. When downward percolation of water is stopped by the shale it moves laterally along the contact. Water from this source has a high concentration of dissolved solids because of prolonged contact with the Pierre Shale. This situation is encountered in the northwestern part of the county where streams have eroded deeply into the unit. One test of water produced from this area showed a sulfate concentration too high for concrete. The proximity of the shale beneath other alluvial deposits in the county may explain the relatively high mineral content of the water produced from the Alluvium. The lack of any appreciable oil and gas production in the county eliminates the possibility of polluting the streams with salt water brine.

Generally, water produced in Rawlins County from the Ogallala and Alluvium will meet the requirements for use in concrete as specified by current State Highway Commission of Kansas specifications, except in areas where the water has been in prolonged contact with the Pierre Shale.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Most of the construction material found in Rawlins County is derived directly or indirectly from the Ogallala Formation. Sand and gravel from the Ogallala have been eroded, transported, and redeposited at different times to form the Sappa Formation, Crete Formation, and Alluvium. It is a source of sand and gravel throughout western Kansas; however, the Rawlins County Ogallala produces a relatively poorer grade of material because of the higher percent of silt, caliche, and mortar bed. Better quality material can be produced from the Crete because more sorting action has been accomplished. A limited amount of material has been pumped from the Alluvium of Beaver Creek, but this source has not been fully exploited.

According to Gerald Vernon, Rawlins County Engineer, material is pumped from the Republican River in Hitchcock County, Nebraska, and imported for use in the northern part of Rawlins County.

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TABULATION OF THE CONSTRUCTION MATERIALS TYPES
AND THEIR AVAILABILITY IN RAWLINS COUNTY

Material Types	Geologic Source	Material Use	Descrip- tion	Availability
Sand and Gravel	Ogallala Formation	Light type surfacing and bituminous construction aggregate	Page 31	Found throughout the county along major drainage channels where overlying silts have been eroded away. Mapped on all plates.
	Crete Formation	Light type surfacing and bituminous construction aggregate.	Page 33	Found in the valleys of Beaver, Sappa, and South Fork Sappa Creeks. Mapped on plates II, III, IV, V, and VI.
	Alluvium	Light type surfacing, bituminous, and concrete construction aggregate.	Page 35	Found in the valleys of Beaver and Sappa Creeks and their tributaries. Material has been produced from Beaver Creek valley. Mapped on plates II, III, IV, V, and VI.
Sedimentary Quartzite	Ogallala Formation	Light type surfacing material.	Page 36	Found along Beaver Creek valley in the northeast part of the county. Mapped on plates II and IV.
Chert	Ogallala Formation	Light type surfacing material.	Page 38	Found along North Fork Beaver Creek in the southwest part of the county. Mapped on plates III and V.
Volcanic Ash	Ogallala Formation	Mineral Filler	Page 40	Found in the west-central part of the county. Mapped on plate III.
	Sappa Formation	Mineral Filler	Page 41	Found in the west-central part of the county. Mapped on plate III.

DESCRIPTION OF CONSTRUCTION MATERIALS

Sand and Gravel

Ogallala Formation

In Rawlins County, the Ogallala Formation consists of gravel, sand, silt, volcanic ash, quartzite, and chert. The most common lithology is a poorly sorted sand which contains silt, clay, and zones of caliche. According to Walters (1956, page 49) the maximum known thickness in the county is 246 feet. The Ogallala underlies the county except in the northwest corner and in parts of the major stream valleys. The geographic distribution of the Ogallala is shown on plates I through VI.

Sand and gravel deposits found in the Ogallala Formation in Rawlins County are characterized by a relatively high percentage of clay, silt, and (or) caliche. Ledges of mortar bed (calcium cemented sand and gravel) are common, and their presence hinders the production of material from the unit. Most production occurs along Beaver and Sappa Creeks and their tributaries. A generally better quality of material is produced in the southwest part of the county along Beaver Creek. Figure 7 shows a sand and gravel pit in the southwest part of the county. Thirty-seven sand and gravel pits in the Ogallala were detected, 12 of which had been sampled and tested. In some areas, such as Beaver Creek valley in northeastern Rawlins County, Loess has been redeposited by wind and gravity during relatively recent times. These deposits form a heavy overburden along the valley walls where, normally, the Ogallala would be exposed. Figure 8 illustrates this situation.

Quality tests completed on sand and gravel from the Ogallala show a dry specific gravity range of 2.51 to 2.63, weight per cubic

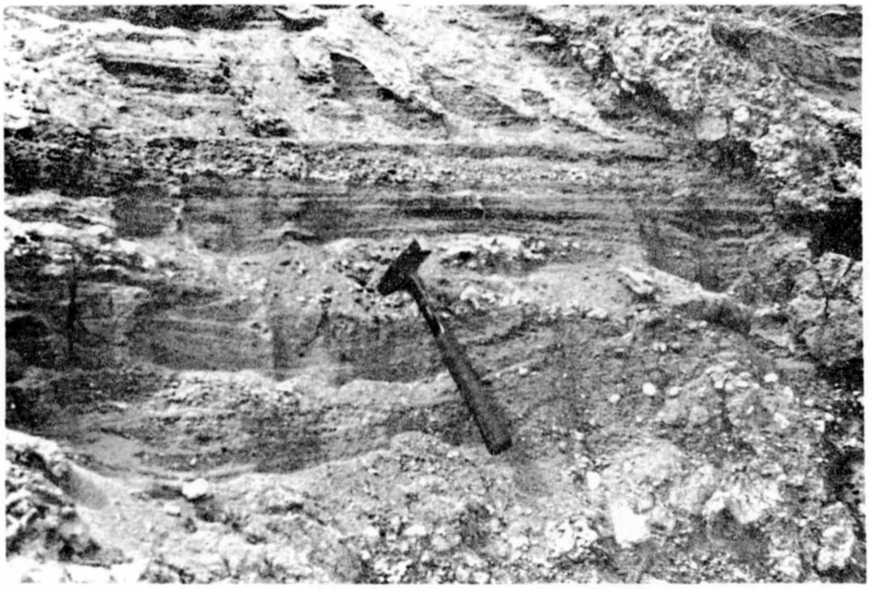

Figure 7. ***Sand and gravel of the Ogallala*** *Formation in the southwest part of Rawlins County.*

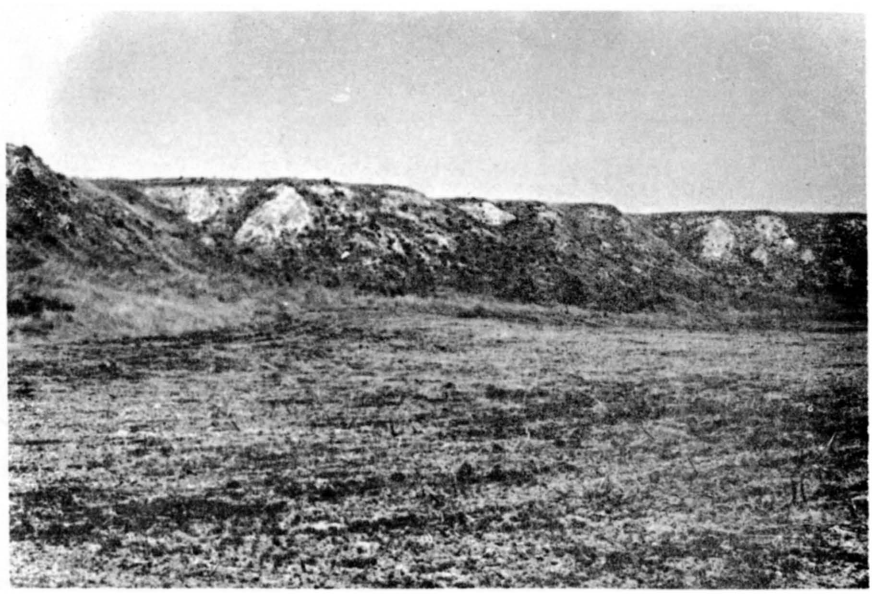

Figure 8. Thick Loess deposits along the valley wall of Beaver Creek in northeastern Rawlins County.

foot from 106 to 114.4 pounds, Los Angeles wear from 28.1 to 34.3 percent and a soundness loss ratio from .88 to 1.00. More detailed test data is presented in figure 17.

Sand and gravel from the Ogallala is usable for most phases of highway construction. Material gradation will generally meet specifications for bituminous and concrete construction; however, it is highly variable in local areas and additional aggregate may be required for sweetening.

In many Ogallala pits there is sufficient minus 200 material for use as mineral filler. However, in some pits the P.I. may be too high due to the overabundance of silt and clay size particles.

Crete Formation

In Rawlins County, Crete terraces are found from 40 to 60 feet above the floodplains of the major drainage channels. In many areas younger eolian deposits cover the valley walls resulting in a continuous slope which makes it nearly impossible to ascertain the lateral extent of some of the terraces. Also, when younger silt deposits overlay the Crete, the contact is gradational, making it difficult to delineate the upper limits of the deposit. Figure 9 shows Crete terraces in the southeastern part of the county.

At the time this report was compiled there were 29 known sand and gravel pits located in the Crete, 14 of which had been sampled. Most of the Crete production is along South Fork Sappa and Sappa Creeks; however, several smaller size pits have been opened along Beaver Creek valley. The geographic distribution of the Crete is shown on plates II, III, IV, V, and VI.

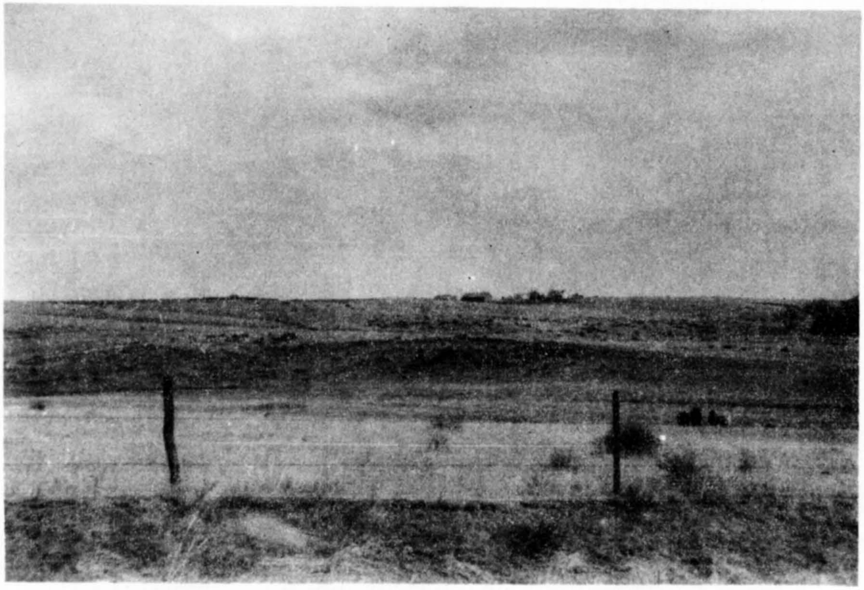

Figure 9. A view of Crete terraces along the South Fork of Sappa Creek in southeastern Rawlins County.

The Crete is composed of silt, sand, and gravel. Since it was derived, for the most part, from the Ogallala, the quality of the material produced from the two sources is similar. Quality test results on samples of the Crete indicate that the specific gravity (saturated) ranges from 2.54 to 2.62, the Los Angeles wear from 26.6 to 34.1(D) percent, and the soundness loss ratio from .90 to .99. The absorption ranged from 1.01 to 2.40 percent. Sieve analyses show that the gradation of the Crete and Ogallala material is similar. However, in the field, the material derived from the Crete appeared to be a cleaner and better sorted aggregate than that produced from the Ogallala. Figure 10 shows an abandoned sand and gravel pit in the Crete located in the southeastern part of the county.

Sand and gravel from the Crete can be used for most phases of highway engineering. It will meet quality specifications for bituminous construction; however, the material probably will have to be processed and sweetened in order to meet gradation requirements.

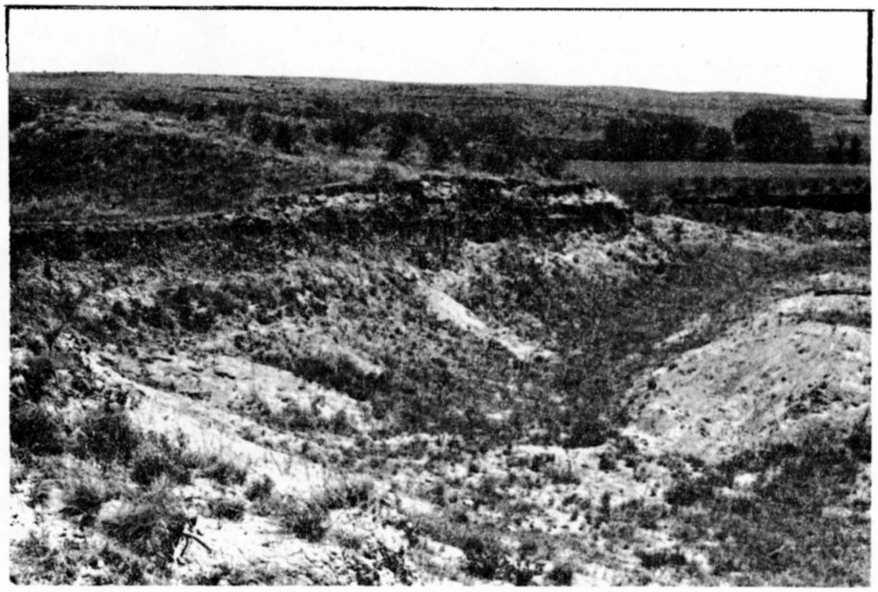

Figure 10. An abandoned Crete sand and gravel pit located in the southeastern part of Rawlins County.

Alluvium

Alluvium deposits and undifferentiated terrace deposits of Wisconsinan and Recent age occur in the valleys of the major drainage channels and are included in the Alluvium source unit. The material in the upper part of the Alluvium and low terraces is composed, primarily, of silt and clay having been derived, chiefly, from the Loveland and Peoria Formations. The lower part of this source unit is composed of sand and gravel derived from the Ogallala. The known maximum thickness is 50 feet.

The Alluvium source unit is mapped on all plates; however, adequate quantities of sand and gravel for commercial production purposes probably can be found only in Beaver and Sappa Creeks. At site $\frac{\text{SG+44}}{\text{Qal}}$, material is pumped and used for concrete construction in nearby Decatur County. Figure 11 shows a part of

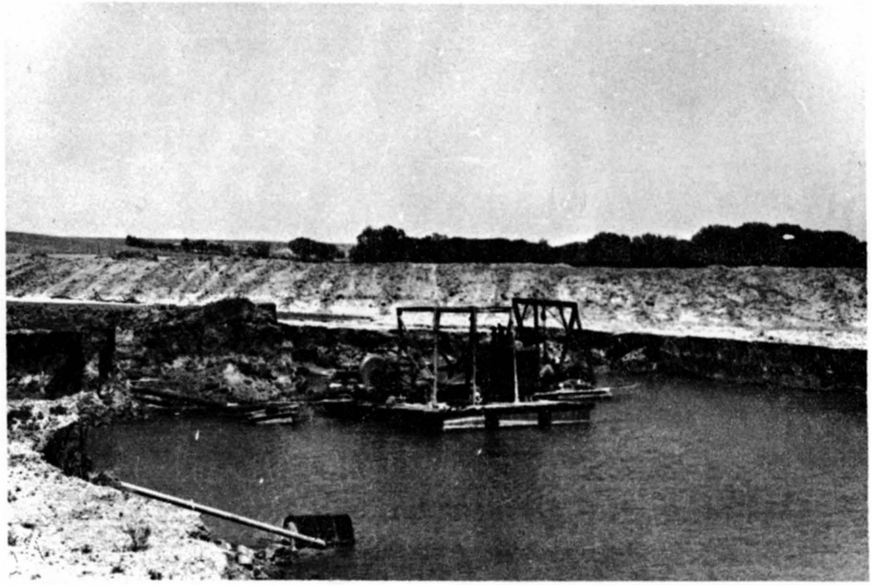

Figure 11. Pumping operation in the Alluvium in Beaver Creek valley.

the pumping operation at this site. All production from this unit will have to be by pumping, inasmuch as, the water table is fairly high in the valley floor.

Quality test results show the material has a specific gravity (saturated) of 2.54, a loss during the Los Angeles wear test of 31.8 percent (grade D), and a soundness loss ratio of .90. The material will meet specifications for bituminous and concrete construction as well as other phases of highway construction. Sieve analyses of material produced from site $\frac{SG+44}{Qal}$ show a relatively larger percentage of coarse material (retained on No. 4 sieve).

Sedimentary Quartzite

The term quartzite in this report refers to sandstone and conglomerate cemented by silica which, in many areas, is an opaline cement. This type of material differs from metamorphic quartzite which is produced by recrystallization of quartz sandstone under heat and pressure. The material which is found in the Ogallala Formation, is lenticular and interbedded with loose sand and gravel. Its thickness ranges from a few inches to 24 feet (Frye and Swineford, 1946, page 71). For the most part, the rock is green in color and ranges from fine-textured at the top to conglomeratic near the base. Quartzite is exposed at several localities in northeastern Rawlins County along the south side of Beaver Creek. In most cases, it immediately overlies the Pierre Shale. According to Frye and Swineford (1946, page 70) 300,000 tons of quartzite are estimated to be available in the county. Quartzite outcrops are shown on plates II and IV.

Limited testing on the quartzite indicates that the Los Angeles wear is about 45 to 50 percent and the soundness loss ratio is 0.93.

In Rawlins County, quartzite has been used as a building stone on a limited basis. When crushed, it can be used for rural road surfacing material, however, tests indicate the material is marginal for use in bituminous and concrete construction. Similar material found in central Kansas has been used for riprap.

Chemical analyses completed by Frye and Swineford (1946, page 62) show that solubility of quartzite samples in hydrochloric acid is less than six percent and the silica content ranges from about 87 to 98 percent. Inasmuch as opal is present in the quartzite, its use as a concrete aggregate in conjunction with high alkali cement may prove unsatisfactory. Figure 12 shows an exposure of quartzite in northwestern Rawlins County.

Figure 12. An outcrop of sedimentary quartzite along Beaver Creek in northwestern Rawlins County.

Chert

The term "chert" is used in this report to refer to uneven or irregular calcium rich zones in the Ogallala that have been silicified. The major constituents of the chert are opal, chalcedony and a very fine-grained crystalline calcium carbonate, with minor amounts of quartz and feldspar grains and secondary calcite. Its color ranges from white to light gray with some dark mottlings. The results of physical tests and chemical analyses of a chert sample from Rawlins County as presented by Frye and Swineford (1946, page 63) are presented below:

Physical Tests

Specific Gravity	Absorption	Loss Freeze and Thaw
2.21	3.27%	(5 cycles) 0.49%

Chemical Analyses

SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO
55.08%	1.07%	0.11%	22.5%	0.80%

The results of physical tests and chemical analyses of a chert sample from Rawlins County.

In most cases, the chert deposits have a high percent of calcium carbonate; however, some zones are composed of pure silica. In Rawlins County there are several exposures along the North Fork of Beaver Creek from the west boundary of the county northeast for approximately three miles. Plates III and V show the geographic distribution of the chert. According to Frye and Swineford (1946, page 71) the chert has a maximum thickness of 12 feet. Frye and Swineford (1946, page 70), estimated that 500,000 tons of chert are available in the county.

A limited amount of testing by the State Highway Commission of Kansas shows that the Los Angeles wear is 34.8 percent, the soundness loss ratio is 0.83 and the absorption is 3.76 percent. Inasmuch as the degree and type of cementation varies, the quality of the material may similarily change. Because of its low soundness, the chert which was tested would not be suitable for either concrete or bituminous construction; however, it would be suitable for light type surfacing material. The high percent of opal present may be detrimental to concrete using a high alkali cement. At the time this report was being compiled, light type surfacing material was being produced from site $\frac{\text{C-29}}{\text{To}}$ (see plate V). Figure 13 shows an outcrop of the chert at this site.

Figure 13. An outcrop of chert in the southwestern part of Rawlins County.

Volcanic Ash

Ogallala Formation

Volcanic ash in the Ogallala is exposed in Rawlins County at several locations. According to Frye and Swineford (1946, page 25) Pliocene (Ogallala) ash generally has a higher specific gravity and a higher percent of iron than ash of Pleistocene (Sappa) age. Usually the Ogallala ash is more weathered due to age and, in many cases, because of the thinner deposits. One deposit (W½SW¼ sec. 4, T4S, R34W) has been identified as the Reager ash bed. This deposit is approximately two feet thick and overlain by 40 to 50 feet of overburden. It is slightly altered by weathering and contains small calcite inclusions. Other ash deposits occur in the NW¼NW¼ sec.33, T3S, R34W; the NE¼NW¼ sec.11, T3S, R33W; the NE¼NE¼ sec.30, T4S, R32W; and the SE¼SE¼ sec.20, T5S, R36W. All of these are two feet or less in thickness and have heavy overburden except the one in the NW¼NW¼ sec.33, T3S, R34W. This deposit is approximately six feet thick and is believed to extend to the northeast approximately one quarter mile. The material has been altered by weathering, in some areas, and contains from 2 to 18 percent calcium carbonate. The Ogallala ash has not been sampled or tested, but it would probably meet specifications for mineral filler. However, in areas where the ash is thin and overlying silt and clay particles have contaminated it, the material will be characterized by a high plastic index. Figure 14 shows an exposure of Pliocene ash in Rawlins County.

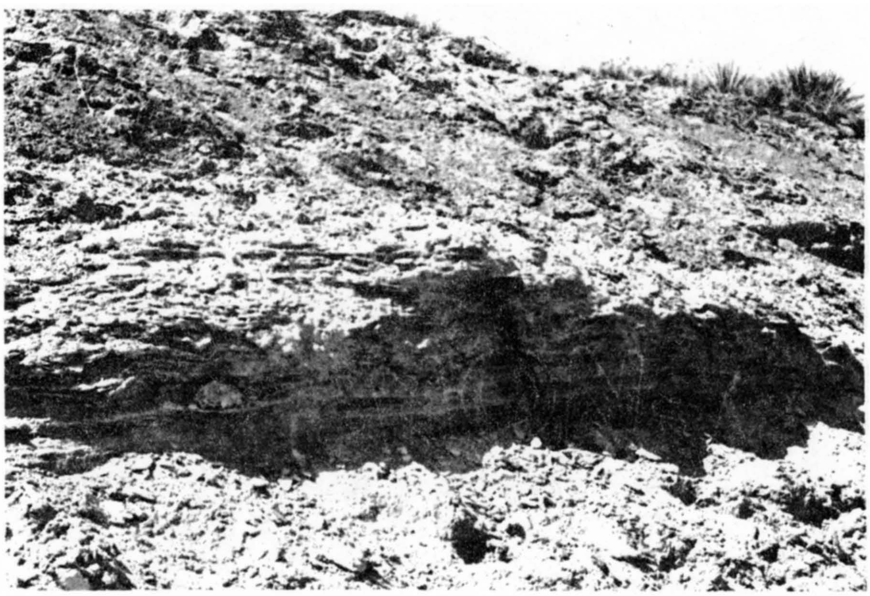

Figure 14. An exposure of volcanic ash in the Ogallala Formation.

Sappa Formation

The Sappa Formation occurs as high terraces along the major drainage channels about 60 to 80 feet above the valley floors. These terraces are composed of clay, silt, and sand but have been identified only in areas where the Pearlette volcanic ash is present. Almost all deposits have been covered by younger silt and are rarely exposed. For this reason the Sappa is not shown on the materials map; however, the volcanic ash deposits are shown on plate III.

Two ash deposits of Sappa age have been produced in Rawlins County. Sites $\frac{\text{VA-52}}{\text{Qs}}$ and $\frac{\text{VA-53}}{\text{Qs}}$ have been sampled and tested but drilling indicates that the deposits are not extensive. Heavy overburden is encountered at both sites and where the thickness of the ash is only a few feet, the ash is contaminated by overlying silt and clay which may cause an excessive plastic index for mineral filler purposes. Figure 15 shows the heavy overburden encountered at site $\frac{\text{VA-53}}{\text{Qs}}$. If the ash is produced in the pure state, it will have a very low plastic index and will be acceptable for mineral filler purposes.

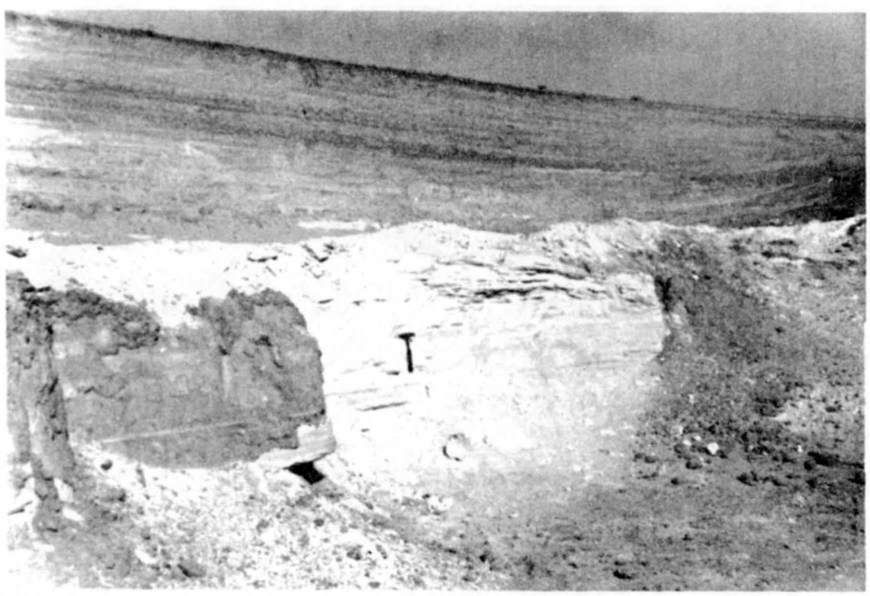

Figure 15. An exposure of Pearlette volcanic ash in the southwestern part of Rawlins County.

Algal Limestone

A limited amount of algal limestone caps the Ogallala Formation in some localities of Rawlins County and elsewhere in western Kansas. Although no quality tests have been completed on any samples from Rawlins County, it is probable, that the material is too soft for any use other than rural road surfacing material.

The algal limestone is very limited in areal extent and is found in the southwestern and west-central parts of the county. No deposit thicker than 18 inches was found during a reconnaissance investigation. Figure 16 shows the algal limestone in the west-central part of Rawlins County.

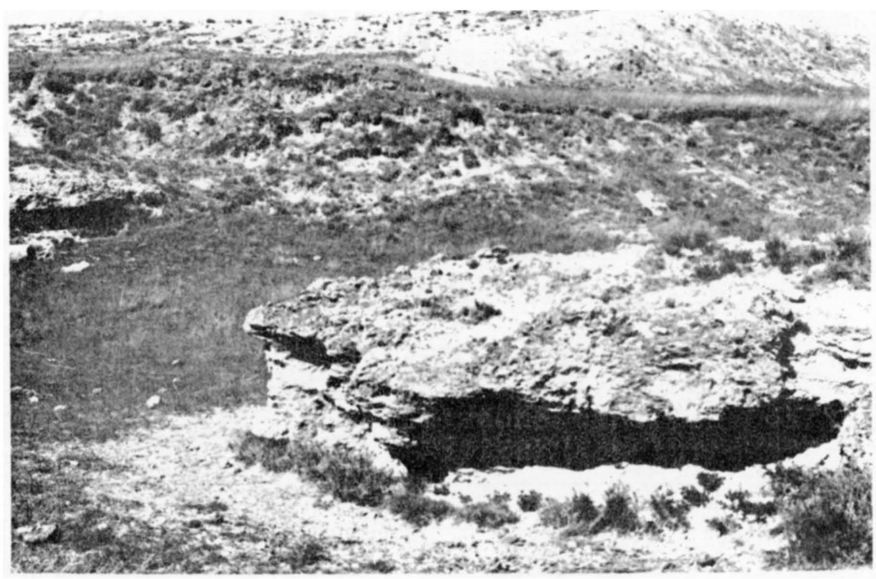

Figure 16. A ledge of Algal Limestone in the west-central part of Rawlins County.

Site No.	Material Type	Percent Retained 3/4	3/8	4	8	16	30	50	100	Wash Pass 200	G.F.	P.I.	L.L.	Sp. Gr. Sat.	Sp. Gr. Dry	Wt./Cu.Ft.	Wear	Soundness	Absorption	Source of Data
Source of Material: Ogallala Formation-To																				
Q-42	Quartzite													2.36			48.8	0.93		Av. SHC Form 619 No. 77-8
SG-45	Sand & Gravel	1	5	21		70			100	1					2.62	112.0				Ma-3 of USGS Circular 132 Lab.No. 36837
SG-46	Sand & Gravel	1	3	14		54			92	6	3.54				2.54	111.1	28.2	0.90		Ma-5 of USGS Circular 132 Lab.No. 64746
SG+51	Sand & Gravel			3	11	27	45	70	86	10			19.4	2.51			32.8	0.97	2.56	Av. SHC Form 619 No. 77-24
SG+54	Sand & Gravel		3	7	18	34	63	82	90	7	2.97			2.62		112.0	29.1	1.00		Av. SHC Form 619 No. 77-11
SG-57	Sand & Gravel	1	3	9	19	33	58	81	89	8	2.93			2.60		106.0	29.6	0.88		Av. SHC Form 619 No. 77-4
SG-58	Sand & Gravel			2		39			94	2	2.79				2.60	114.4	30.0	0.94		Fa-2 of USGS Circular 132 Lab.No. 64745
C-61	Chert														2.05		34.8	0.83	3.76	Ch-1 of USGS Circular 132
SG-62	Sand & Gravel		7	12		44			85	14	3.15				2.62	112.0	29.8	0.97		Ma-18 of USGS Circular 132
SG-64	Sand & Gravel		1	4		31			97	1	2.88				2.61	110.5				Fa-6 of USGS Circular 132 Lab.No. 64638
SG-66	Sand & Gravel	1	4	9	19	36	57	74	87	8				2.63			30.8	0.92	1.73	Av. SHC Form 619 No. 77-23
Q-67	Quartzite										2.37						39.9		1.49	Q-3 of USGS Circular 132
SG-72	Sand & Gravel		2	7		35			88	10	2.90				2.55	111.4	31.2	0.88		Ma-4 of USGS Circular 132 Lab.No. 50952
SG-73	Sand & Gravel		1	3	10	24	45	73	89	6	2.45			2.56		110.8	31.3	0.97		Av. SHC Form 619 No. 77-15
SG-74	Sand & Gravel									2					2.55	112.0				Ma-9 of USGS Circular 132 Lab.No. 34768
VA-75	Volcanic Ash					4			29	52					2.46	60.5				VA-1 of USGS Circular 132
SG-76	Sand & Gravel		2	8		48			98	1	3.50				2.59	108.0	31.8	0.97		Ma-12 of USGS Circular 132 Lab.No. 64640
SG-77	Sand & Gravel		4	12		51			98	1	3.54				2.60	112.0	28.4	0.95		Ma-13 of USGS Circular 132 Lab.No. 64727
SG-78	Sand & Gravel	1	6	14	29	46	67	88	94	5	3.45			2.60		108.0	28.1	0.90		Av. SHC Form 619 No. 77-6
SG-79	Sand & Gravel	1	5	14		63			97	3	3.96				2.56	106.2	30.6	0.98		Ma-17 of USGS Circular 132 Lab.No. 64639
Source of Material: Sappa Formation-Qs																				
VA-52	Volcanic Ash					1	2	3	6	81										Av. SHC Form 619 No. 77-12
VA-53	Volcanic Ash						1	1	3	82				2.38		62.61				Composite Sample SHC Form 619 No. 77-14
Source of Material: Crete Formation-Qc																				
SG-41	Sand & Gravel	1	3	9	23	44	63	87	93	3	3.23			2.56		115.8	33.0	0.90		Av. SHC Form 619 No. 77-18
SG-43	Sand & Gravel		2	7		44			98	2	3.40				2.60	111.0	30.0	0.94		Ma-2 of USGS Circular 132 Lab.No. 44481
SG-47	Sand & Gravel	1	3	7	18	35	50	80	90	6	2.84			2.58		108.4	31.5	0.91		Av. SHC Form 619 No. 77-13
SG+48	Sand & Gravel		3	7	18	34	57	81	90	8			20.0	2.54			31.6	0.95	2.04	Av. SHC Form 619 No. 77-22
SG+49	Sand & Gravel	2	3	9	21	40	65	82	88	10			19.0	2.61			28.9	0.97	1.01	Av. SHC Form 619 No. 77-20
SG+50	Sand & Gravel		3	7	14	26	47	76	83	13			19.0	2.62			34.1	0.94	1.11	Av. SHC Form 619 No. 77-21
SG-55	Sand & Gravel	2	8	15		38			97	3	3.37				2.56	107.0	26.6	0.93		Ma-6 of USGS Circular 132 Lab.No. 64778
SG-56	Sand & Gravel	4	7	12		45			98		3.60				2.60	111.0	29.8	0.99		Ma-7 of USGS Circular 132 Lab.No. 44486
SG-59	Sand & Gravel		2	5	15	36	63	87	93	6	3.01			2.62		115.0	27.6	0.94		Av. SHC Form 619 No. 77-5
SG-60	Sand & Gravel		2	6		26			96	3	2.78				2.60	106.3				Ma-11 of USGS Circular 132 Lab.No. 64779
SG-63	Sand & Gravel																			Ma-16 of USGS Circular 132
SG-65	Sand & Gravel		5	18		82			94	5	4.29				2.56	102.4	30.4	0.92		Ma-15 of USGS Circular 132 Lab.No. 64637
SG-80	Sand & Gravel	5	9	16		49			95	4	3.62				2.58	110.5	28.0	0.95		Ma-14 of USGS Circular 132 Lab.No. 64726
Source of Material: Alluvium-Qal																				
SG+44	Sand & Gravel		3	9	23	45	68	88	93	6	3.29			2.54		114.9	31.8	0.90		Av. SHC Form 619 No. 77-17

Figure 17. Results of tests completed on samples taken from the various material source units in Rawlins County.