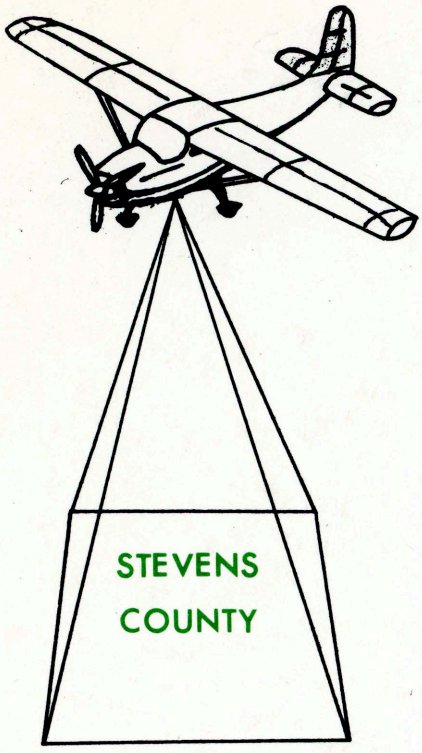

CONSTRUCTION MATERIALS INVENTORY

KGS
D1246
no.16

Report No. 16

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

CONSTRUCTION MATERIALS INVENTORY OF STEVENS 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

1970

Construction Materials Inventory Report No. 16

the **WHY ?**

WHAT ?

HOW ?

of This Report

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

> *Construction material includes 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 material may be found.*

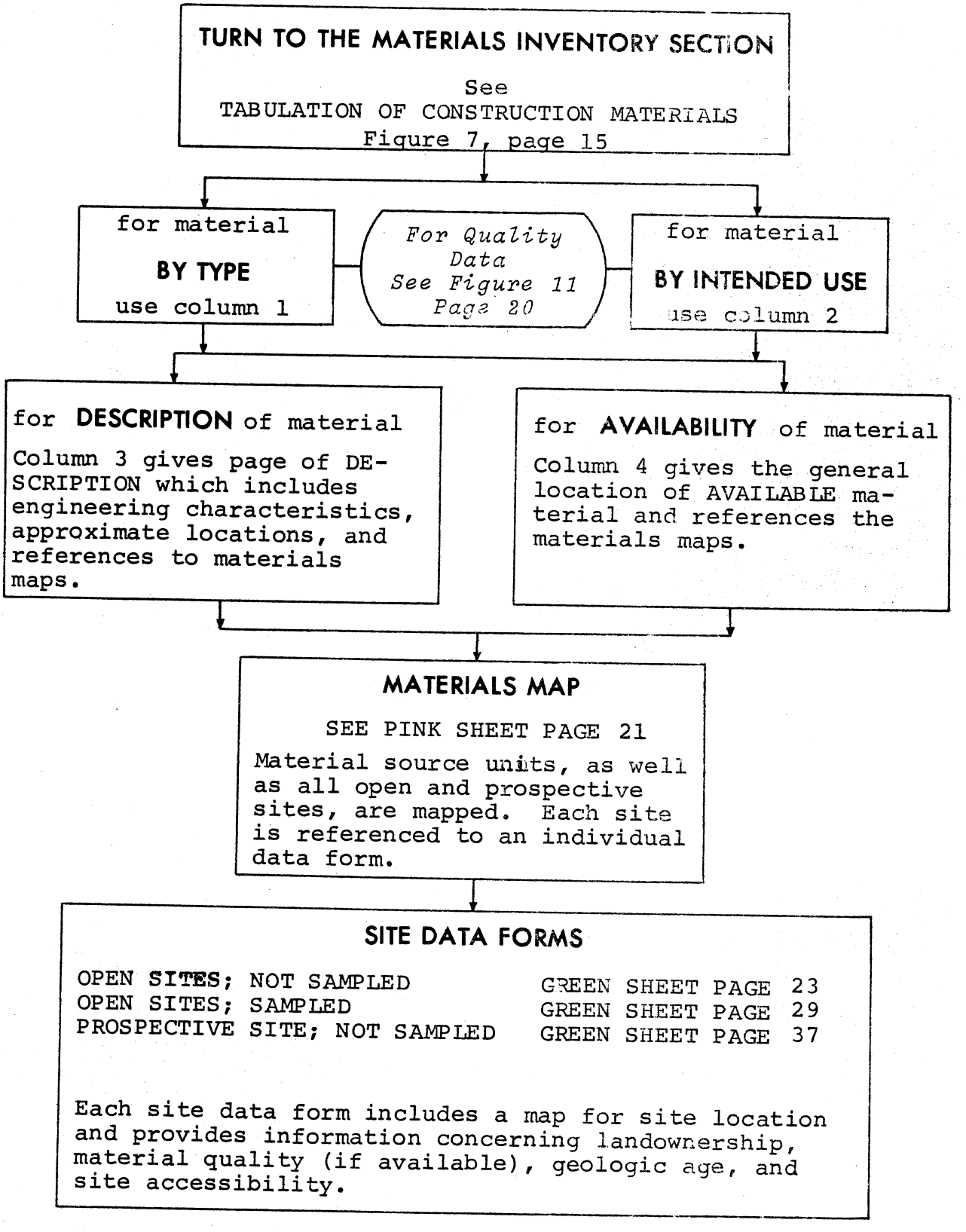
The diagram opposite shows how the MATERIALS INVENTORY SECTION may be used to evaluate and locate mapped sites.

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 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 material sources in the geologic units throughout Stevens County.

TO LOCATE AND EVALUATE

A MAPPED SITE OF CONSTRUCTION MATERIAL IN STEVENS COUNTY



CONTENTS

PREFACE

This report is one of a series compiled for the Highway Planning and Research Program, "Materials Inventory by Photo Interpretation." The program is a cooperative effort of the Federal Highway Administration and the State Highway Commission of Kansas, 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 needs.

Prior to this time, no extensive or county-wide materials investigation had been completed in Stevens County. However, two reports, McLaughlin (1946) and Frye and Leonard (1952) provided geological information. 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 G. B. Sigsbee, Sixth Division Materials Engineer and B. A. Owen, Stevens County Engineer for verbal information on material resources of the county.

This report was prepared under the guidance of J. D. McNeal, State Highway Engineer; the project engineer, R. R. Biege, Jr., Engineer of Location and Design Concepts; and G. M. Koontz and A. H. Stallard of the Location and Design Concepts Department.

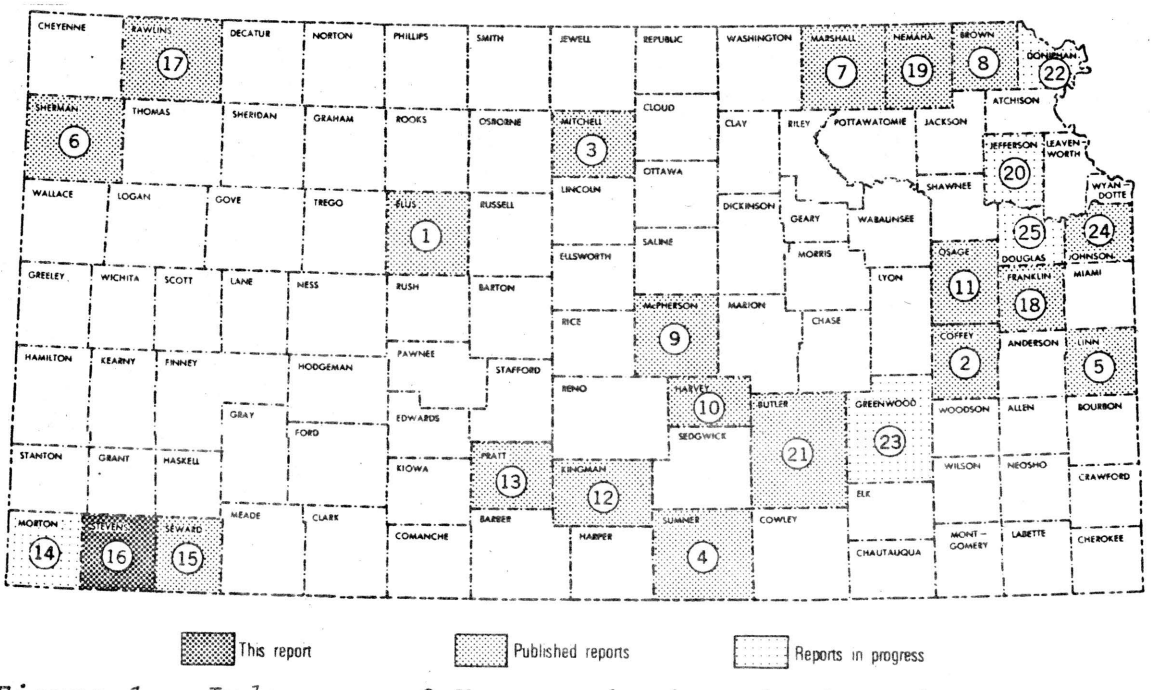


Figure 1. Index map of Kansas showing the location of Stevens County along with the report number and location of counties for which reports have been or are being completed.

ABSTRACT

The construction material resources of Stevens County are all unconsolidated deposits of Quaternary age. They include the Grand Island Formation, Sappa Formation, Dune Sand, Loess, and Alluvium and Terrace Deposits.

The Grand Island, the oldest exposed formation, is the major source of construction material. It is a source of granular material usable in most phases of road construction. The Sappa Formation, which overlies the Grand Island, is composed mostly of clay-bound silt, but contains scattered accumulations of caliche gravel and irregular zones of volcanic ash. When located, caliche may be an economical source of light type surfacing material and volcanic ash may be utilized for mineral filler.

Loess covers a large area in the northern one-third of the county and has been utilized for subgrade and as embankment. It may be valuable as slope material for the development of a turf.

Dunes are spread over most of the southern two-thirds of Stevens County. Although most Dune Sand is considered useless for materials purposes, a high plasticity index soil suitable for base course binder may be produced in select areas.

Alluvium and Terrace Deposits occupy the Cimarron River valley area that traverses the northeast corner of the county. These deposits are partly derived from the Grand Island and contain materials similar to this bed, though the Alluvium may have a finer texture.

Geo-engineering problems are a minimum in Stevens County because of the nearly flat terrain, semi-arid climate, and the relatively low plasticity index surface material. One problem is with the Cimarron River. During flood stage, it scours both horizontally and vertically, causing rapid meandering and deep erosion. On several occasions bridges and fills have been washed out in floods. Other erosional problems are with backslopes and ditches of roads cut through the Dune Sand and Grand Island Formation.

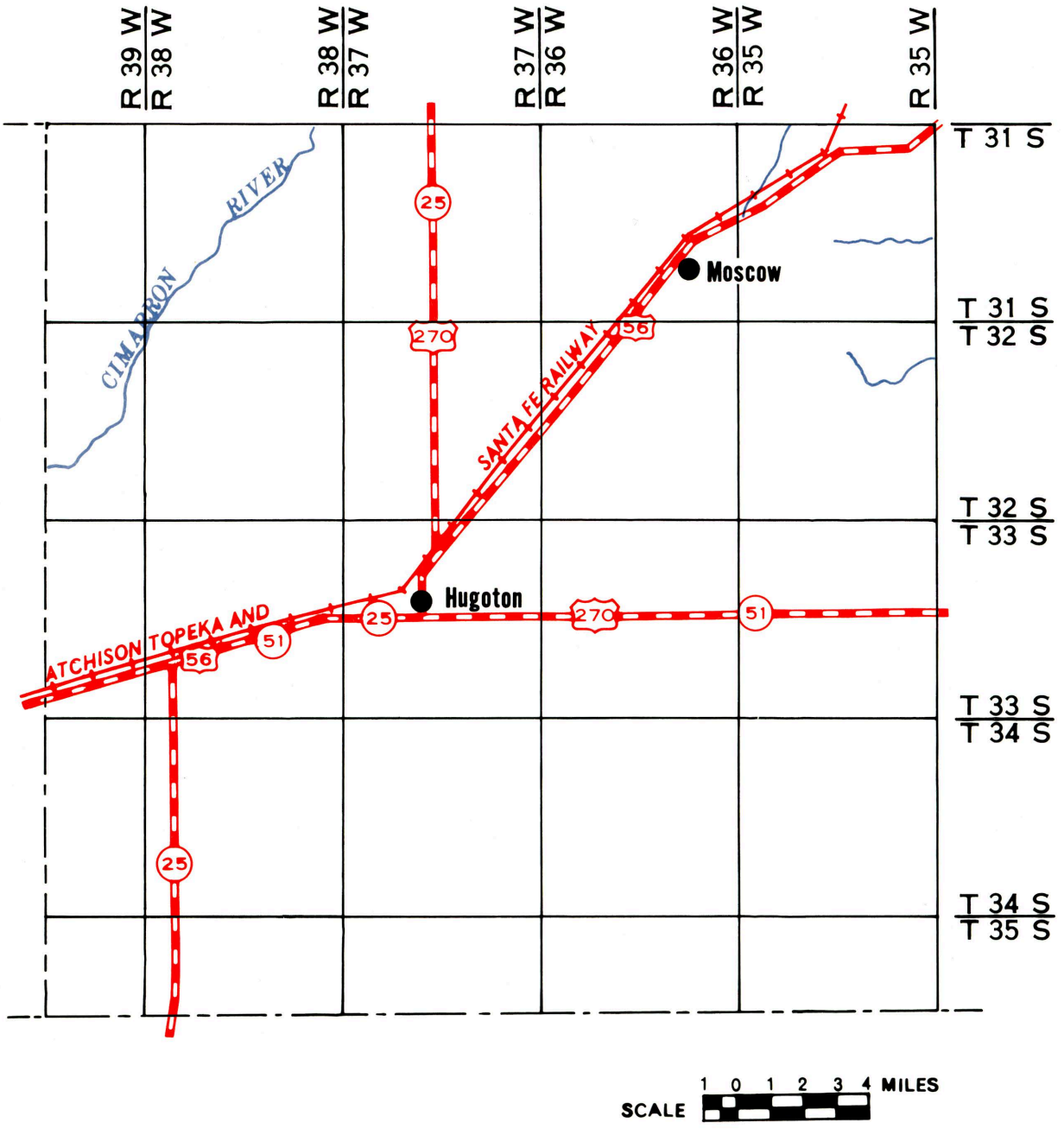


Figure 2. Drainage and major transportation facilities in Stevens County.

FACTS ABOUT STEVENS COUNTY

Stevens County is located in southwestern Kansas and lies in the High Plains physiographic division of Kansas. It covers an area of 728 square miles and had a population of 4,353 in 1970, according to the Kansas State Board of Agriculture.

The Atchison, Topeka, and Santa Fe railroad traverses the county from the northeast to the southwest passing through Hugoton, the largest city. U.S. highways 56 & 270 along with State highways 25 & 51 cross the county. The county road system is not well developed due to the low population in rural areas. Figure 2 illustrates drainage, railroads, and major highway locations.

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.

During phase one, relevant information concerning geology, soils, and construction material of the county was reviewed and the general geology was determined. Quality test results of samples taken in Stevens County were then correlated with the various geologic units and unconsolidated deposits.

Phase two consisted of study and interpretation of aerial photographs taken by the Kansas Highway Commission at a scale of one inch equals 2,000 feet. Figure 3 illustrates aerial photographic coverage of Stevens County. Geologic source beds and all

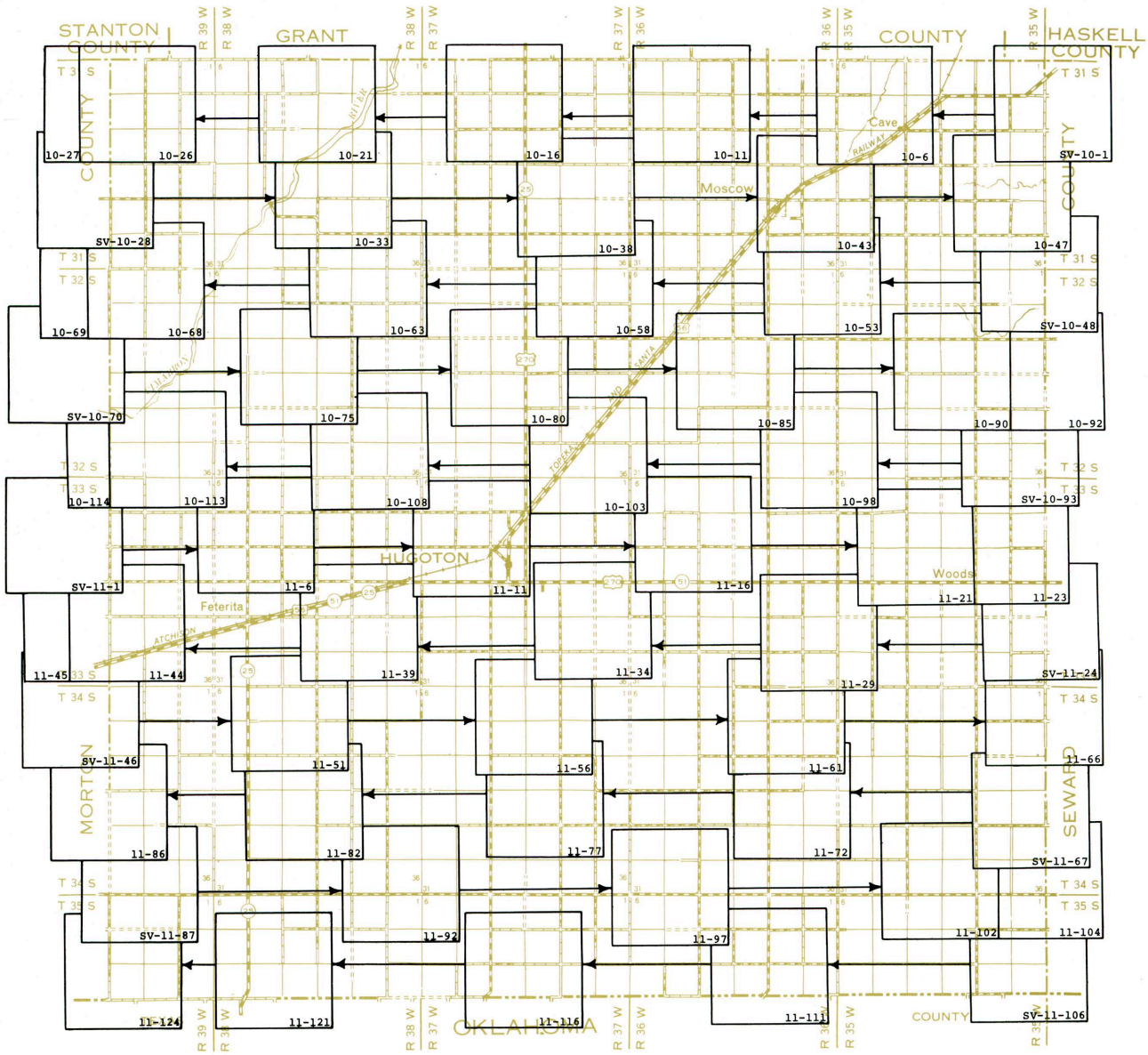
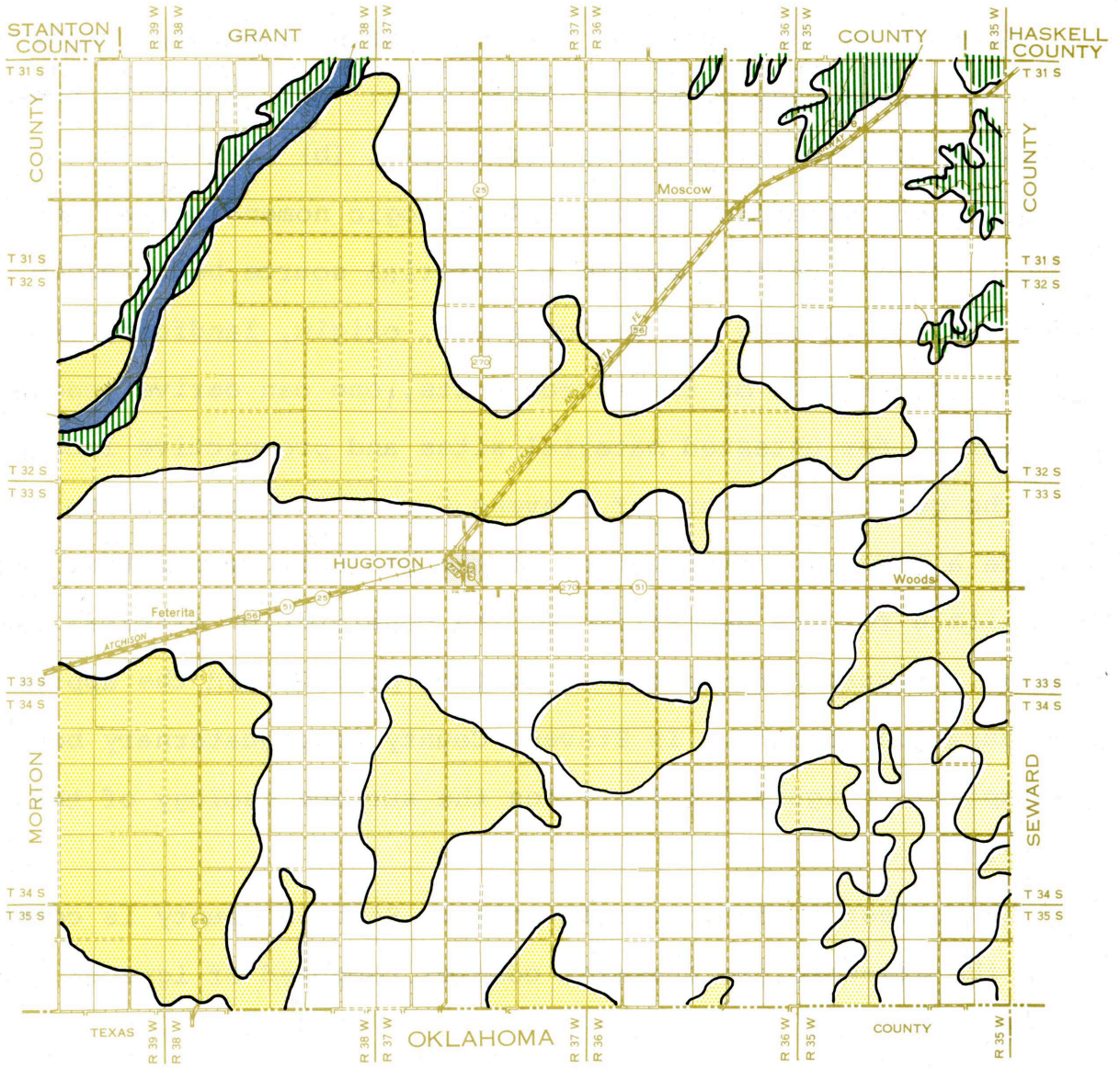


Figure 3. AERIAL PHOTOGRAPHIC COVERAGE MAP for Stevens County. The numbers refer to photographs taken by the Photogrammetry Section of the State Highway Commission of Kansas, on October 11, 12, 1966. Aerial photographs are on file in the Photogrammetry Laboratory, State Office Building, Topeka, Kansas.

open material sites were mapped and classified on aerial photographs. All material sites were then correlated with the geology of the county.

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

GEOLOGY SECTION



General Geology of Stevens County.

LEGEND

Alluvium

Loess

Dune Sand

Sappa and Grand Island Formations

GENERAL GEOLOGY

GEOLOGY is the basis for this materials inventory. Knowledge of the geology makes it possible to: (a) ascertain the general properties of the material source, (b) identify and classify each according to current geologic nomenclature, and (c) 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 material sites and prospective locations.

The geologic history of Stevens County is presented to provide a general understanding of the geologic events that were responsible for the deposition of the construction material resources. Figure 4 shows the major time periods and the approximate duration of each. In Stevens County only Quaternary beds are exposed. Figure 5 illustrates the surface geology of the county.

The oldest buried geologic unit in Stevens County is comprised in the Pre-Cambrian basement complex composed of igneous and metamorphic rock.

The absence of Silurian and Devonian rocks over much of southwest Kansas indicates the area was probably a landmass during part of these periods and (or) the sediments were removed by subsequent erosion near the end of the Mississippian time period. Most Paleozoic sediments underlying Stevens County are marine limestone, shale, and sandstone; however, the upper portion of the Permian is composed of red siltstone and silty shale with a few evaporites.

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.	Sand and gravel; volcanic ash; agricultural soils; water.
	TERTIARY	59,000,000	Silt, sand, and gravel; fresh-water limestone; volcanic ash; bentonite; diatomaceous marl; opaline sandstone.	Sand and gravel; volcanic ash; diatomaceous marl; water.
MESOZOIC	CRETACEOUS	70,000,000	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	25,000,000	Sandstone and shale, chiefly subsurface.	
	TRIASSIC	30,000,000		
PALEOZOIC	PERMIAN	25,000,000	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	25,000,000	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	30,000,000	Mostly limestone, predominantly cherty.	Chat and other construction materials; oil, zinc, lead, and gas.
	DEVONIAN	55,000,000	Subsurface only. Limestone and black shale.	Oil.
	SILURIAN	40,000,000	Subsurface only. Limestone.	Oil.
	ORDOVICIAN	80,000,000	Subsurface only. Limestone, dolomite, sandstone, and shale.	Oil, gas, and water.
	CAMBRIAN	80,000,000	Subsurface only. Dolomite and 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.

Figure 4. Geologic timetable.

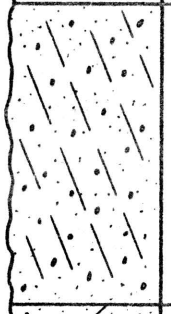
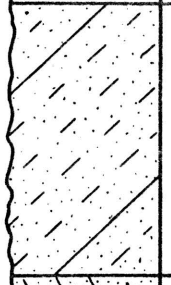
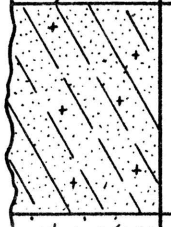
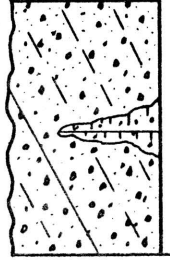
Graphic Legend	Thickness	System	Series	Stage	Formations	Generalized Description	Construction Materials
	0 to 70'±	Quaternary	Pleistocene	Recent and Wisconsinan	Alluvium and Terrace Deposits	Fine and medium sand with arkosic gravel and some silt; tan-brown in color.	Aggregate Base Course Material Road Surfacing Material
	0 to 60'±				Dune Sand	Fine to medium sand with minor amounts of silt and clay; light tan-brown in color.	Aggregate Base Course Material Mineral Filler
	0 to 40'±			Illinoisan Sangamonian and Wisconsinan	Loess	Clayey silt, tan in color with zones and nodules of caliche.	None
	100'±			Kansan and Yarmouthian	Sappa Formation	Clayey silt and fine sand with extremely heavy accumulation of caliche; tan-brown in color. Contains irregular beds of Pearlette volcanic ash.	Road Surfacing Material Mineral Filler
					Grand Island Formation	Fine, medium and coarse sand and arkosic gravel with minor amounts of silt and clay; tan-brown in color. Contains irregular cemented zones.	Aggregate Base Course Material Road Surfacing Material

Figure 5. A generalized geologic column of the surface geology in Stevens County.

The red beds and evaporites indicate a terrestrial environmental trend.

Uplift in eastern United States ended the Paleozoic and initiated the Mesozoic Era. This era is comprised of the Triassic, Jurassic, and Cretaceous Systems. No Triassic or Jurassic rocks are found in the subsurface of Stevens County but Cretaceous sediments have been encountered in the northern portion. Jurassic rocks are exposed to the west in Morton County. It is assumed that a considerable amount of Mesozoic sediments were deposited in this area and all but the Cretaceous Dakota Formation were removed by subsequent erosion.

The Cenozoic Era began with the uplift of the present day Rocky Mountains. Sediments laid down during this era make up the surface deposits of Stevens County. The oldest Cenozoic deposits in the county belong to the Ogallala Formation of Tertiary age. The Ogallala, an ancient alluvial fan from the Rocky Mountain area, underlies the surface of the complete county. As the Tertiary Period came to a close, cooler climates came to the county. This climatic change along with structural unrest marked the beginning of the Quaternary Period.

With the climatic change, ice accumulated on the polar ice caps in North America and started its flow southward. The age of repeated glacial and interglacial cycles is termed *Pleistocene Epoch*. The glacial ages (Nebraskan, Kansan, Illinoisan, and Wisconsinan) represent periods of major glacial advancement and the interglacial ages (Aftonian, Yarmouthian, and Sangamonian) represent times of relative glacial stability. Figure 6 is a geologic time-

table which shows the division of the Quaternary Period and the approximate length of each. Only the Nebraskan and Kansan glaciers reached Kansas, but neither advanced into Stevens County. However, the sequence of glaciation played a controlling role in the development of Pleistocene deposits in the area.

Nebraskan age deposits have not been recognized on the surface in Stevens County. Undoubtedly deposits of this age were laid down, but were removed and (or) reworked at a later time.

During Kansan time large quantities of water derived from the Continental glacier and Alpine glaciers in the Rocky Mountains moved through the major drainage channels of the state.

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 6. Geologic timetable of the Quaternary Period.

Degradation occurred during glacial advancement and aggradation took place with the retreat of the ice when stream velocities subsided. In Stevens County the Kansan Stage consists mostly of silt, sand, and gravel of the Grand Island Formation.

The Sappa Formation was deposited on the Grand Island during late Kansan time. This unit is a water-lain, clay-bound silt and fine sand. It also contains irregular accumulations of secondary calcium carbonate termed *caliche*. Although volcanic ash was deposited during this time, no deposits were identified in Stevens County.

The Illinoisan glacier advanced no further south than southern Illinois, but associated climatic conditions caused the initial development of the present drainage system of Stevens County. Also, wind-deposited, clay-bound silt termed *Loess* accumulated in the northern part of the county and low terraces were formed along the Cimarron River.

During Wisconsinan time additional terraces of low relief were formed along the Cimarron River. Also, Loess was deposited on the stream divide areas in the northern part of the county.

During Recent time, the alluvial floodplain has been sculptured into its present form and much of the Dune Sand topography, in the southern two-thirds of the county, has developed. Numerous undrained depressions are found in the Dune Sand and Loess covered areas.

GENERAL GEO-ENGINEERING CONDITIONS

Few geo-engineering problems are encountered in Stevens County because of: (1) absence of bedrock exposures, (2) abundance of granular material, (3) presence of low plasticity index soils, (4) availability of relatively pure water, and (5) a semi-arid climate.

Most surface geologic units have been utilized in road construction. Although Loess may have high plasticity indices, it is not detrimental in road construction due to the low annual precipitation.

Much of the sandy material will not support vegetation well, with Dune Sand being a maintenance problem, especially in cuts.

Because of the semi-arid climate, ground-water problems are not severe. They may exist where impervious layers of silt and clay prevent downward percolation of surface water which forms a perched water table.

During flood stage, the Cimarron River scours both horizontally and vertically, causing rapid meandering and deep erosion. On several occasions bridges and fills have been washed out. Even though piling has required bearing, deep scour may undermine the support. H-beam piling should be preferred over pipe or concrete due to the deeper penetration into unconsolidated material.

Ground-water is produced primarily from the Grand Island Formation. The Ogallala generally yields water to wells deeper than 150 feet. All water may be used in Portland Cement concrete.

MATERIALS INVENTORY SECTION

GENERAL INFORMATION

Construction material in Stevens County may come from four sources: Grand Island Formation, Sappa Formation, Dune Sand, and Alluvium and Terrace Deposits. The Grand Island, Sappa, and Alluvium and Terrace Deposits are sources of granular material. The Pearlette Ash zone in the Sappa, when located, may be an excellent source of mineral filler. Binder soil can be obtained from select locations in the Dune Sand topography. Overall, the production of construction material is from areas along the Cimarron River where the overburden is thin.

The Grand Island is the major source of construction material in the county. This unit may be processed for concrete and bituminous aggregate, base course, shoulder, and light type surfacing material. The Alluvium and Terrace Deposits contain material similar to the Grand Island except the texture is generally finer. Caliche, produced from the Sappa Formation in certain areas, is a potential light type surfacing material.

Most deposits of material are produced by dry methods. There was one pumping operation from the Cimarron River, but it has been abandoned.

CONTENTS OF CONSTRUCTION
MATERIALS INVENTORY SECTION

TYPE and geologic source	USE	DESCRIPTION	AVAILABILITY
SAND AND GRAVEL Grand Island Formation	Light type surfacing. Base course aggregate. Shoulder material. Concrete aggregate. Bituminous aggregate.	16	Northern one-third of the county along the Cimarron River. Most prominent in the northwest portion of the county. Plates I, II, and III.
Sappa Formation *(Caliche)*	Light type surfacing. (Not utilized to date)	16	Northern one-third of the county along the Cimarron River. However possible accumulations in the Dune Sand area (mostly near the Cimarron River) where the sand is thin exposing or nearly exposing the underlying caliche-ladened Sappa Formation. Plates I, II, and III.
Alluvium and Terrace Deposits	Light type surfacing. Base course aggregate. Shoulder material. Concrete aggregate. Bituminous aggregate.	17	Northwest one-fourth of the county in the immediate stream bed area of the Cimarron River. Plates I and III.
MINERAL FILLER Sappa Formation *(Pearlette Ash Zone)*	Mineral filler. (Not utilized to date)	19	Not recognized to date in Stevens County but may be found in the northern one-third near the Cimarron River. Plates I, II, and III.
CLAY BOUND SILT Loess	Embankment, subgrade, and slope material.	19	Northern one-third of the county on stream divide area. Plates I, II, III, and IV.
BINDER SOIL Dune Sand	Base course binder. (Not utilized to date)	19	Select locations in the southern two-thirds of the county. Plates I through VI.

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

DESCRIPTION OF CONSTRUCTION MATERIAL

Sand and Gravel

Grand Island Formation

The Grand Island Formation is an alluvial floodplain deposit of Kansan age. Although the unit may cover a large portion of the county, it is exposed only along the Cimarron River where erosion has removed the overburden.

This unit is composed of tan-colored silt, sand, and arkosic gravel and is the best source of material available in the county. When processed, this material is suitable for bituminous and concrete mixes. The raw material may be used in base course, shoulder, and light type surfacing material. All Grand Island material is produced by dry methods in Stevens County (figure 8). Quality test information shows the Los Angeles wear ranges from 30.8 to 35.6 percent and a soundness loss ratio from 0.98 to 0.99. No information was available on abosrption but it probably does not exceed 1.0 percent. Additional test information on the unit is shown in chart form in figure 11 (page 20).

The Grand Island was mapped in conjunction with the Sappa inasmuch as the two units could not be differentiated. This map unit is shown on plates I, II, and III.

Sappa Formation (Caliche)

The Sappa Formation overlies the Grand Island but is not a well-defined bed. The thickness probably does not exceed 25 feet. Like the Grand Island, the Sappa may be found exposed in a thin band along the Cimarron River.

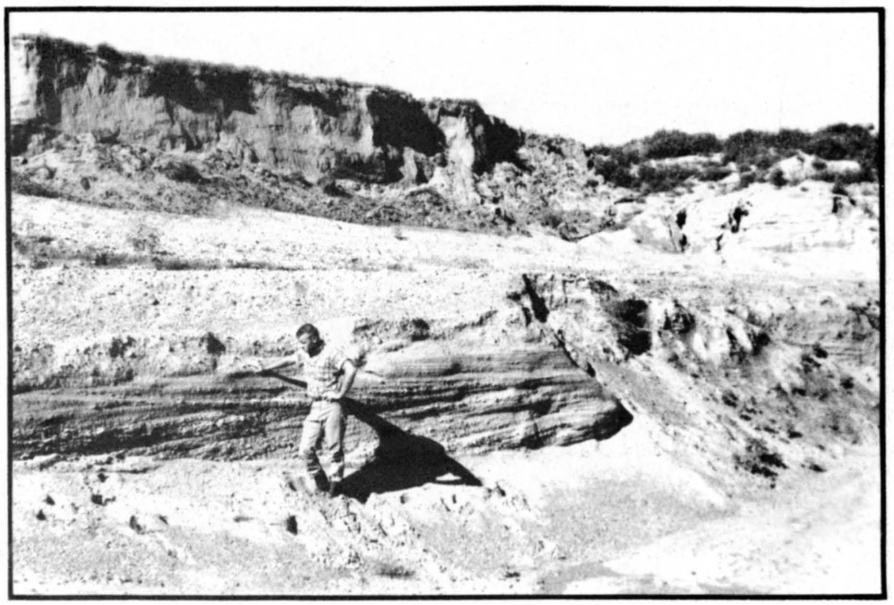


Figure 8. Open pit in the Grand Island Formation in northwest Stevens County, SE¼ sec. 27, T32S, R39W.

This formation is composed primarily of tan-brown colored, clay-bound silt and fine sand and may contain zones of Pearlette volcanic ash and caliche. The Sappa Formation underlies portions of the Dune Sand topography and where the sand is thin, caliche in the Sappa may be produced. These *windows* are probably most numerous near the Cimarron River. No quality information is available on the caliche, but it probably can be used only for light type surfacing material. Outcrops of the Grand Island-Sappa Formation map unit are shown on plates I, II, and III.

Alluvium and Terrace Deposits

The Alluvium and Terrace Deposits lie in the immediate areas of the Cimarron River (figure 9). The material is composed of silt, sand, and arkosic gravel similar to the Grand Island Formation; however, the texture of the alluvial material is generally finer.

Figure 9. Alluvial sand and gravel on the Cimarron River.

Pumping operations for sand and gravel production have been tried along the Cimarron, but were not successful due to the fine texture of the material and the presence of clay seams. Dry production methods are usually used; however, it is necessary to process large quantities of material to obtain the desired gradation.

Available quality test results on the Alluvium in Stevens County show a Los Angeles wear range of 29.0 to 34.3 percent, a soundness loss ratio of 0.97 to 0.99. The absorption on one sample was 0.70 percent. Additional test information is shown in chart form in figure 11 (page 20). The Alluvium and Terrace Deposits map unit is shown on plates I and III.

Mineral Filler

Sappa Formation (Pearlette Ash Zone)

The Sappa Formation, previously described as a possible source of caliche gravel, may also be a source of volcanic ash. The *Pearlette Ash Zone*, when uncontaminated, has a plastic index of 0 and is an important source of mineral filler.

Although the highly dispersed, irregular ash deposits were not identified in Stevens County, they probably exist. However, production of ash may be difficult because of thick overburden. The Sappa Formation is shown in conjunction with the Grand Island Formation on plates I, II, and III.

Clay-Bound Silt

Loess

Wind-deposited, clay-bound silt termed *Loess* covers a large part of the northern one-third of Stevens County. It is included in this report because of the large area it covers.

This material is utilized for embankment and subgrade construction. It is also desirable for slope material where the development of a turf is desired. Loess is shown on material map plates I, II, and IV.

Binder Soil

Dune Sand

Sand dunes cover most of the southern two-thirds of Stevens County (figure 10). Dunes are composed of tan-colored, fine sand

Figure 10. Typical Dune Sand topography in Stevens County.

and silt, with some clay binder. Fine sand is the most prominent material type.

Most dunes are too coarse for use as mineral filler. However, select locations may yield a clay-bound silt and fine sand suitable for base course binder. To date, material has not been utilized for this purpose in Stevens County.

No quality or gradation tests are available on this material. Dune Sand is shown on all material map plates.

Site No.	Material Type	Percent Retained								Wash	G.F.	P.I.	L.L.	Sp.Gr. Sat.	Wt./Cu.Ft.	% Wear	Soundness Loss Ratio	%Absorption	Source of Data
		3/4	3/8	4	8	16	30	50	100										
Source of Material: Grand Island Formation-Qsgi																			
SG+7	Sand and Gravel	6	9	16	31	52	73	91	96	3.0	3.74			2.58	117.0	35.6	0.99		1 Quality Sample, Lab. No. 45036
SG+6	Sand and Gravel	7	17	24	31	42	62	88	95	2.4	3.66			2.62	121.5	30.8	0.99		1 Quality Sample, Lab. No. 50851
SG+9	Sand and Gravel	4	9	15	22	33	54	82	96	5.2	3.16			2.58	116.1	32.9	0.98		av. 12 Holes, SHC Form 619 No. 95-4
Source of Material: Alluvium-Qal																			
SG+4	Sand and Gravel	5	14	26	38	53	73	91	98	2.0	3.98		15	2.62	121.6	29.4	0.99		Hole 4, SHC Form 619 No. 95-2
SG+8	Sand and Gravel	7	16	26	34	45	51	85	95	3.0	3.62			2.61	114.5	34.3	0.97	0.70	1 Sample on 619 No. 95-4
SG+5	Sand and Gravel	16	39	55	64	73	83	92	98	0.6	5.20			2.62	130.5	29.0	0.99		1 Quality Sample, Lab. No. 65990

Figure 11. Results of tests completed on samples of material from the Grand Island Formation and Alluvium in Stevens County.