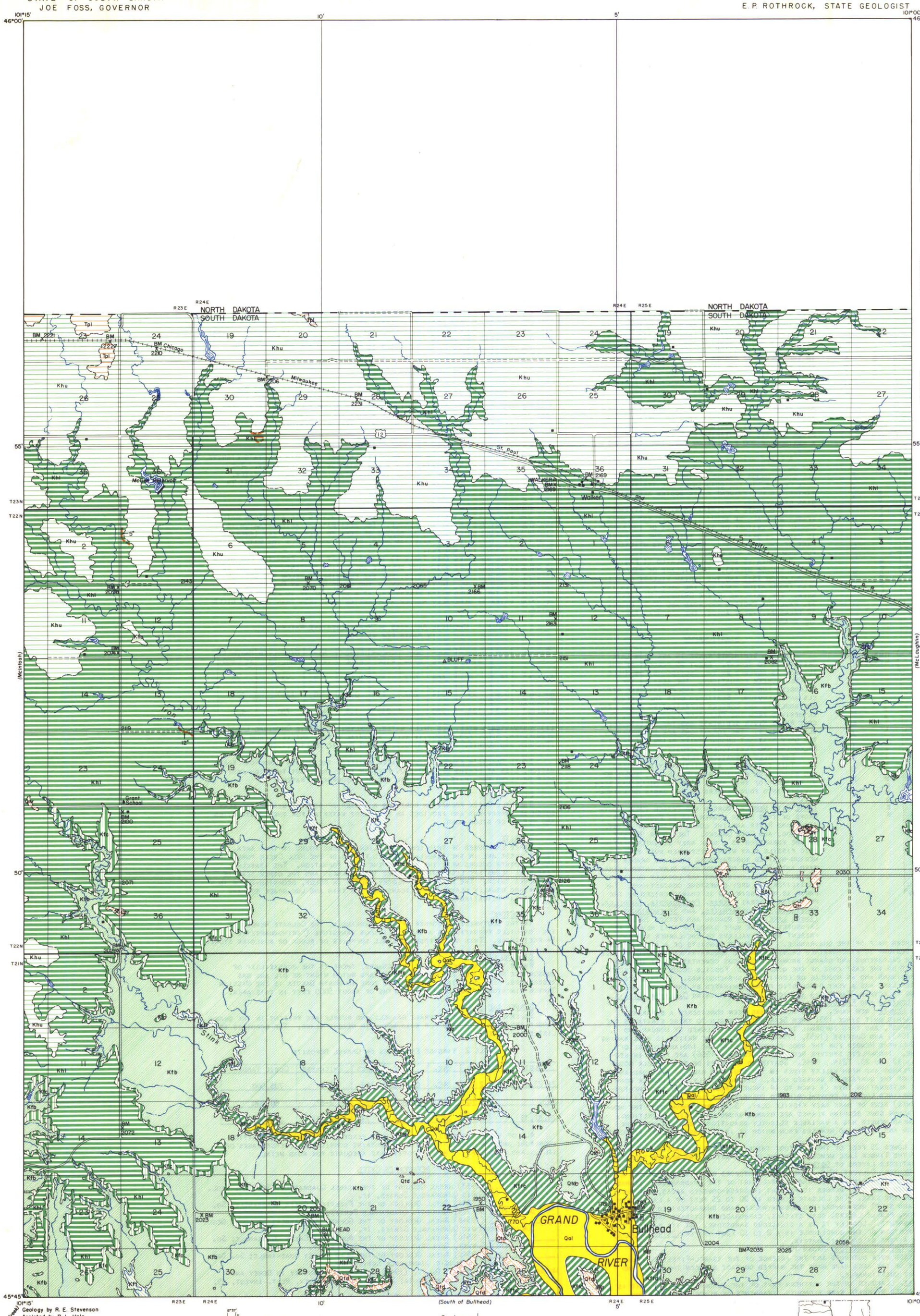
AREAL GEOLOGY
OF THE
BULLHEAD QUADRANGLE

STATE OF SOUTH DAKOTA
JOE FOSS, GOVERNOR

STATE GEOLOGICAL SURVEY
E.P. ROTHROCK, STATE GEOLOGIST



EXPLANATION

QUATERNARY

RECENT

Qal — Alluvium
(Floodplain deposits of silt, sand and clay in the major stream valleys. Local gravel lenses)

PLEISTOCENE

Qtr — Terrace Rubble
(Terrace deposits of clayey angular sand and gravel. Material mostly ironstone and of local derivation)

Qtd — Terrace Deposits
(High terrace deposits of sand and gravel characterized by abundant ironstone fragments)

TERTIARY

PALEOCENE

Tpl — Ludlow Formation
(Buff to grey fine grained cross-bedded subgraywacke with interbeds of gray to brown clays and silty clay. Local calcareous cementations)

CRETACEOUS

Hell Creek Formation

Khu — Upper Member
(Light grey to buff, fine to medium grained subgraywacke with orange limonitic and black ferromanganese concretions. Interbeds of grey to tan slightly bentonitic clay and silt)

Khl — Lower Member
(Buff to white cross-bedded, medium to fine grained, subgraywacke sand with orange limonitic and black ferromanganese concretions; brown to grey clay and bentonitic clay; brown peat-clay; and local lenticles of black, blocky lignite (0"-12"). Khli-Isabel-Firesteel facies: brown peat-clay and clay with local thin lignites (0"-5")

UPPER CRETACEOUS

Fox Hills Formation

Kfc — Colgate Member
(Grey, medium grained, cross-bedded subgraywacke sand and siliceous sandstone. Locally a basal 2 to 10 foot oyster bed is present)

Kfb — Bullhead Member
(Alternating beds of light grey to buff fine subgraywacke sand and dark gray fissile clays with few scattered molluscan fossils)

Kft — Timber Lake Member
(Buff medium to fine grained, subgraywacke sand with orange brown ferruginous cementations. Locally abundant molluscan fauna dominated by Tancredia)

Kftc — Trail City Member
(Intermixed and interbedded buff, fine to medium grained subgraywacke sand and dark grey fissile clay with scattered grey fossiliferous limestone concretions. Abundant fauna characterized by Sphenodiscus and Discoscaphites)

Contact
(dashed where approximately located)

⚒ Gravel Pit

x BM 2139
Bench Mark
(monument showing exact altitude above sea level)

x 2635
Spot Altitude

△ WALKER
Triangulation Station
(monument marking exact geographic location)

x 10"
Measured coal thickness

Geology by R. E. Stevenson
Assisted by R. L. Hale
Surveyed in 1956

Base Map by South Dakota State Geological Survey

Scale = 1/62500

½ 0 1 2 3 4 MILES

Vermillion, South Dakota
1956

APPROXIMATE MEAN DECLINATION 1956
TRUE NORTH
MAGNETIC NORTH

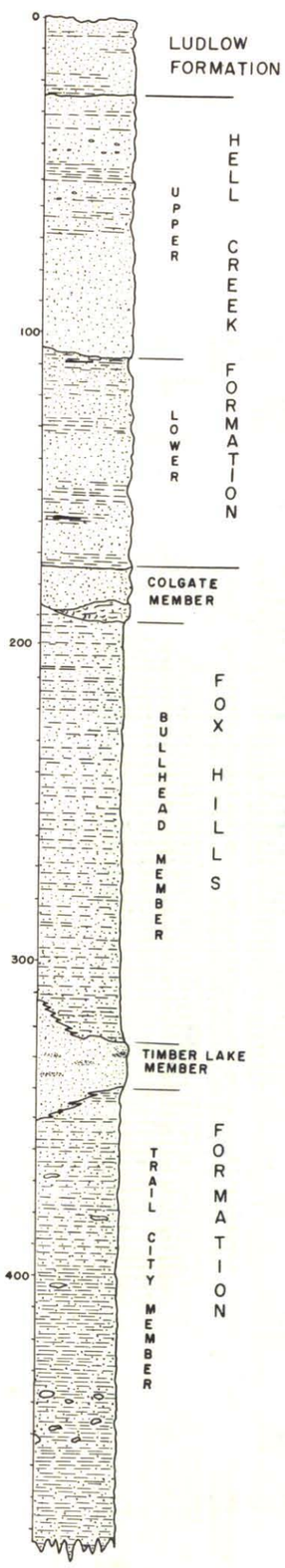
▮ Quadrangle Location

GEOLOGY OF THE BULLHEAD QUADRANGLE

By

Robert E. Stevenson

GENERALIZED COLUMNAR SECTION



INTRODUCTION

The mapping of this quadrangle was done in 1956 as a part of the State Geological Survey's coal resources program. Two coal-test holes were also drilled in 1956. The writer greatly appreciates the assistance of R. L. Hale in the field. The drilling was done by R. W. Martin and J. G. Larson.

LOCATION

The Bullhead Quadrangle lies along the North Dakota line in north-central Corson county. The area is approximately 110 miles northwest of Pierre and 160 miles northeast of Rapid City. It lies in the open Standing Rock Indain Reservation.

GEOGRAPHY

This quadrangle lies in a lightly populated region of prairie lands north of the Grand River with an estimated average elevation of 2100 feet and a maximum relief of 490 feet.

Topographically, the area is characterized by two distinct erosional features: (1) the first is a gently rolling high-level (2050-2180 feet altitude) erosion surface. Higher areas in the northwest corner of the quadrangle represent remnants of the old interstream divide; they are likewise the present day stream divide. This surface has a relief of about 200 feet. (2) the other topography is characterized by numerous steep-sided youthful valleys cutting back from the incised valley of the Grand River into the older high-level erosion surface. In this most recent erosion interval, the Grand River and its tributaries have cut their valleys a maximum of 300 feet below the high-level surface.

A large meander of the Grand River is present on the southern edge of the quadrangle, and all other major streams, Stink, Iron Dog, and Rock Creeks, in the quadrangle are its tributaries. All permanent water bodies are artificial reservoirs.

The climate is semi-arid with an average yearly rainfall of about 17½ inches and a mean annual temperature of 43° F. Most of the land is used for grazing stock, but in the northern part of the quadrangle, some land is utilized for small grain and forage crops.

The area is sparsely populated (1 family per 7½ square miles). The village of Walker (population 15±) and the Indian village of Bullhead (population 200) are the only towns in the area. The mainline of the Chicago, Milwaukee, St. Paul and Pacific Railroad and U. S. Highway 12 trend east-west across the northern part of the quadrangle.

STRATIGRAPHY

Exposed sediments range in age from Late Cretaceous to Recent. About 95 percent of the surface is covered by the Cretaceous Fox Hills and Hell Creek formations. The rest by the Paleocene Ludlow formation and Pleistocene gravels and alluvium. Scattered over the surface are boulders and cobbles representing a lag gravel derived from the Paleocene Tongue River, Oligocene White River sediments and the Pleistocene glacial tills. The formations are conformable, the only distinct unconformity being between the Paleocene and Pleistocene deposits.

Fox Hills Formation Meek and Hayden 1861.

This formation was originally described and named from exposures on Fox Ridge, about 60 miles south of this area. The Fox Hills has been divided into four members on the basis of lithology.

Trail City Member Morgan and Petsch 1945. Outcrops of this lower member can be found along the Grand River and the lower reaches of Stink, Iron Dog, and Rock Creeks. The lower 90 feet of the formation is a dark grey slightly bentonitic fissile clay with intermixed buff fine- to medium-grained subgraywacke sand and grades upward into 50 feet of sand with clay interlaminations. In the lower part are locally scattered fossiliferous, grey limestone concretions. The fauna is molluscan and is characterized by the following genera: Pteria, Protocardia, Cucullea, Gervillia, Discoscaphites, and Sphenodiscus.

Timber Lake member Morgan and Petsch 1945. Exposures of the buff sands of this member are present in the valleys of the larger streams in the southern half of the quadrangle. The member consists of a 14 foot bed of buff medium- to fine-grained cross-laminated subgraywacke or subquartzose sand with calcareous and orange brown ferruginous cementation; it thickens to 35 feet on the east edge of the quadrangle. Fossils occur both as scattered specimans and as nodular or lenticular sub-coquinas. In this region the Timber Lake has a very diagnostic fauna dominated by the heavy shelled burrowing pelecypod, Tancredia americana, and containing Callista, Pteria, Ostrea, Lunatia and Fagiscolaria.

Bullhead Member new name. This member has been considered a separate stratigraphic unit since 1931 when Searight referred to these strata as the "Banded Beds", and this informal terminology was followed by Morgan and Petsch (1945) and Curtiss (1953, 1954a, b, c, d). The writer is here naming it the Bullhead Member for the good exposures near the Indian village of that name. Incomplete syntype sections (Stevenson 1956) are found in sections 11, 12 and 23, T21N., R24E. Scattered outcrops of this member occur on the uplands and high valley sides in the southern half of the quadrangle, but most of the surface is grassed over. Lithologically, the member consists of alternating thin (1 inch to 14 inches) beds of light gray medium- to fine-grained locally cross-laminated subgraywacke sand and thin (1 inch to 9 inches) beds of dark grey fissile clay. Scattered throughout the member and along some bedding planes are orange-brown limonitic concretions. The Bullhead member has a variable slightly gradational contact with the underlying and overlying members from which it is distinguished by its clay strata.

The lower 25 feet of the 135 foot thick member is characterized by the fauna of the Timber Lake member. In the upper part of the member there are a few scattered layers of Ostrea glabra.

Colgate Member Calvert 1912. The sparse outcrops of this member form a narrow band zigzagging across the central part of the quadrangle. It has been assumed that this member is present in grass-covered areas, but this may not be the case. The Colgate member is 20 to 25 feet of a light grey "pepper and salt" medium-grained subgraywacke sand characterized by cross-lamination, pebble layers, clay streaks, carbonaceous streaks and scattered plant fragments. Locally it is a siliceous sandstone. At its base in the central portion of the quadrangle is a 2 to 10 foot oyster (Ostrea glabra) bed with a fine calcarenite matrix.

Hell Creek Formation Brown 1907.

Grassed over outcrops and the absence of the Isabel-Firesteel facies over most of the area have made the mapped contact between the upper and lower unit questionable.

Lower Unit. Exposed in the northern part of the quadrangle, this unit is characterized by white sand blowouts, fragments of black ironstone concretions and peat-clay beds. The lower Hell Creek unit is very heterogenous with interbedded and lensing buff to white cross-laminated medium-grained subgraywacke sands and silts, grey clayey sands, brown to gray clay and bentonitic clay, brown peat-clay, local lenticles of black blocky lignite (0-12 inches thick), and layers of orange to black limonitic ironstone and ferromanganese concretions. Scattered throughout the 75± feet of strata are a few dinosaur bones.

The Isabel-Firesteel lignite facies is represented here by a discontinuous brown peat-clay and gray clay zone (3-6 feet thick) with fragments of carbonized wood and local (0-5 inches) seams of black silty lignite.

Upper Unit. Sparse exposures are present in the northern and western thirds of the mapped area. The unit is principally light grey white or buff fine to medium subgraywacke sands. The sands are well cross-laminated and show layers of intermittent orange-brown limonitic and black ferromanganese concretions. There are numerous interbeds and lenses of dark grey to tan slightly bentonitic clay and silt containing scattered plant fragments. The unit is about 80 feet thick.

Ludlow Formation Lloyd and Hares 1915.

Grassed-over deposits on several knolls in the northwest corner of the map have been called Ludlow on the basis of similarity in lithology and stratigraphic position with the Ludlow in the adjacent McIntosh quadrangle (Stevenson 1957). The formation is a heterogeneous series of interbedded and lenticular white to grey fine cross-laminated subgraywacke sand with scattered cementations, grey to brown clays and silty clays and dark brown clays with plant fragments. Estimated thickness in this quadrangle is 35 feet.

Alluvial and Terrace Deposits

Pleistocene terrace sand and gravels fall into two compositional categories: (1) terrace remnants covered by rubble up to 6 feet in thickness associated with tributary streams (Rock and Stink creeks) and containing over 90 percent of angular locally derived material (mainly broken ironstone concretions and sandstone), and (2) terrace gravels up to seven feet in thickness associated with the Grand River and characterized by 50 to 70 percent angular locally derived material and 30 to 50 percent rounded granite, greenstone and limestone. These gravels occur on three terrace levels, 190 to 200 feet, 160 to 175 feet, and 135 to 145 feet above the Grand River.

An alluvium, high in clay content is present in the bottoms of the major drainage units.

STRUCTURE

The quadrangle is on the east flank of the Dakota (Williston) Basin resulting in a regional dip to the northwest of 12 feet per mile. Superimposed upon this surface are small normal and slump faults (displacement less than 35 feet), and possibly small gentle folds. Lack of outcrops and good key beds make the determination of tectonic features very difficult.

ECONOMIC GEOLOGY

This quadrangle lies on the southeastern edge of South Dakota's lignite area and consequently contains only a few thin low-grade lignites. The principal economic mineral resource in this semi-arid climate is water. Exploitable gravel deposits are also present and oil or gas may exist in subsurface.

WATER

The Fox Hills formation yields water for domestic use and stock watering throughout the entire quadrangle. The best water-bearing stratum is the Timber Lake sand which occurs at depths of zero to over 200 feet (average ± 90 feet). There is some artesian head, for in most wells the water rises 20-30 feet above the aquifer.

Chemical analyses (see Table 1) indicate that water from the Fox Hills is usually fairly soft with high sulfate and sodium content. Iron may be present in objectional quantities, but the fluoride is below the optimum content of 1.0 p.p.m. In the valley of the Grand River at Bullhead, the alluvium is the ground-water reservoir, at a depth of 17 to 25 feet. The alluvial water is generally harder and carries more iron than the Fox Hills water.

TABLE 1 Chemical Analyses of Representative Waters in Parts per Million

Sample	Iron	Magnesium	Sulfate	Sodium	Chloride	Fluoride	Nitrate	Dissolved Solids	Hardness as CaCO3
Walker[1]	Tr	4	664	672	35	None	0.8	939	76
Bullhead[2]	0.8	39	514	257	13	0.4	2.0	1210	407
Standard limits[3]	0.3	125	250		250	1.5	45	750	120

(1) Postmaster's well, Fox Hills water, analysis by State Chemical Laboratory, Vermillion, S.D., (2) Community well, alluvial water, analysis from Jochens (Tychsen and Vorhis, 1955), (3) U.S. Bureau Public Health (1946).

South Dakota's famous ground water aquifer, the Dakota sandstone formation, lies at depths of 2900-3000 feet in this area, but the high cost of deep drilling prohibits its general use as a source of water.

CLAY

The Hell Creek formation contains a number of beds of bentonitic clay which is impervious and provides an excellent material for the construction and repair of stock dams.

LIGNITE

Three exposures of thin low grade lignite were found in this area. Two of these are in the Isabel-Firesteel facies of the Hell Creek formation and the other occurs near the base of the same formation. The Isabel-Firesteel seams are less than 6 inches in thickness and the other seam is 12 inches thick. The lignite is blocky, black in color, brownish-black in streak and usually clayey. The seams are too thin and low grade to have present day potentialities.

SANDSTONE

In the southwestern corner of the quadrangle, the Colgate member of the Fox Hills formation is a hard siliceous sandstone ("orthoquartzite") 5± feet thick. This could provide small supplies of block or building stone.

OIL AND GAS

While there are no surface structures, there is the possibility of subsurface structures and sedimentary traps which might be oil and gas reservoirs. The principal productive zone in North Dakota is the Mission Canyon limestone which occurs at depths of about 5000 feet in this area.

GRAVEL AND SAND

Several deposits of terrace gravels and rubble are present in the quadrangle and have been used for road metal in recent years. The deposits are listed in Table 2.

TABLE 2 Yardage Estimates of Gravel Deposits

Section	Twp.	Rge.	Type	Acres	Thickness	Cubic Yards
21,23,25,26,27	21N.	24E.	Gravels	168	1½-6'	785,000
35	22N.	23E.	Rubble	12	2-6'	60,000
28,32,33	22N.	25E.	Rubble	73	2-3'	280,000

All of these deposits contain a high percentage (40+) of limonitic ironstone and the rubble in addition contains considerable percentages of silt, sand, and clay. These deposits are adequate for road metal.

REFERENCES CITED

Curtiss, R. E., (1953) Areal Geology of the Isabel Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

_____ (1954a) Areal Geology of the Firesteel Creek Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

_____ (1954b) Areal Geology of the Gopher Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

_____ (1954c) Areal Geology of the Worthless Creek Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

_____ (1954d) Areal Geology of the Glad Valley Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

Morgan, R. E. and Petsch, B. C., (1945) A Geological Survey in Dewey and Corson Counties, South Dakota; So. Dak. Geol. Survey, Rept. Invest. 49, 53p.

Searight, W. V., (1931) The Isabel-Firesteel Coal Area; So. Dak. Geol. Survey, Rept. Invest. 10, 35p.

Stevenson, R. E., (1956) Two Suggested Rules for Stratigraphic Nomenclature; Bull. Amer. Assoc. Petrol. Geol., vol. 39, p 2524-2525.

_____ (1957) Geology of the McIntosh Quadrangle; So. Dak. Geol. Survey, Geologic Quadrangle Series, 1p.

U.S. Bureau of Public Health (1946) Drinking Water Standards; U.S. Pub. Health Service Rpts., vol. 61, p 371-389.