AREAL GEOLOGY
OF THE
CHANCE QUADRANGLE

STATE OF SOUTH DAKOTA
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STATE GEOLOGICAL SURVEY
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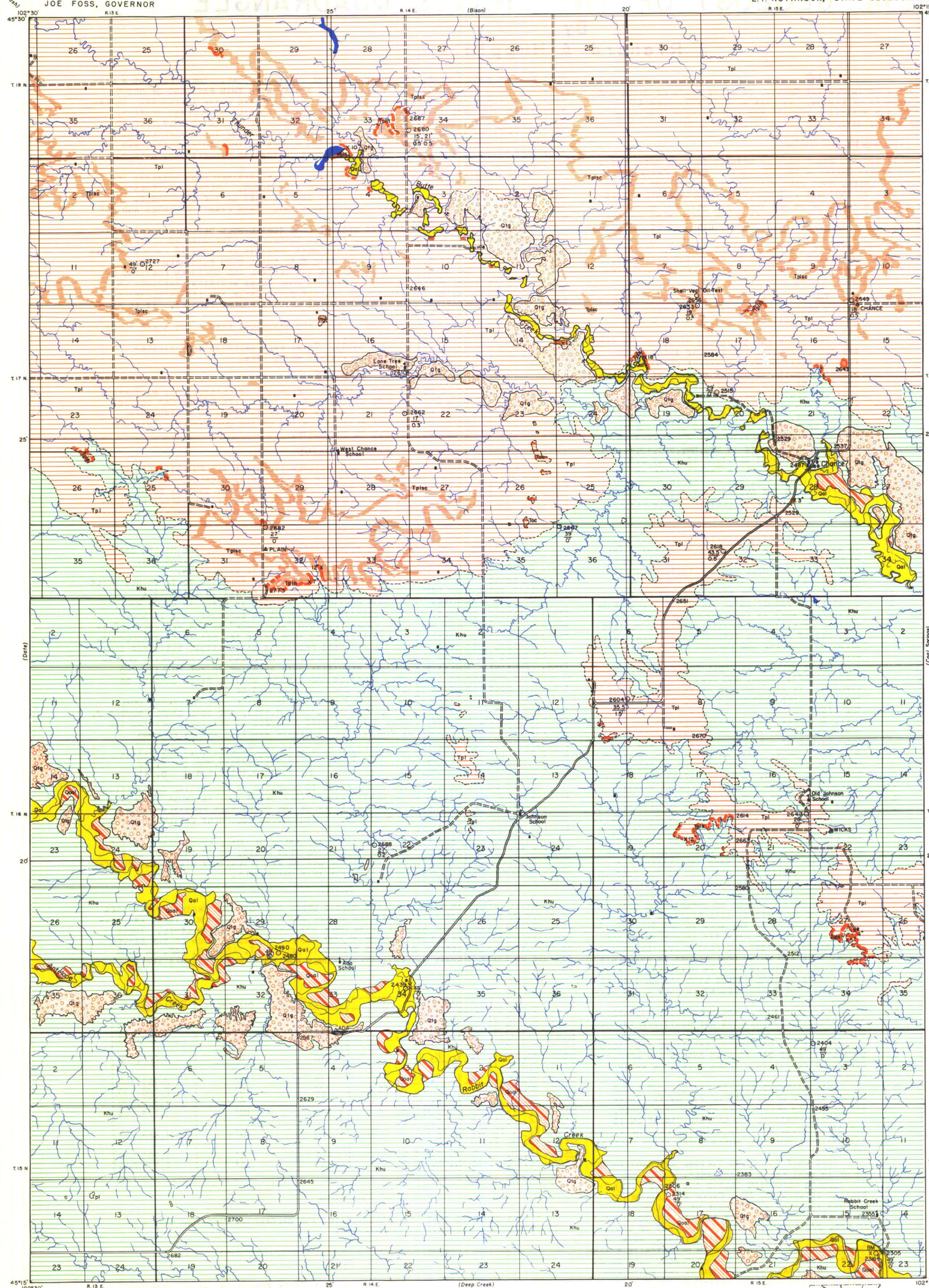


EXPLANATION

SEDIMENTARY ROCKS

QUATERNARY

RECENT

Qal — Alluvium
(Valley-bottom deposits of clay, silt, sand, and gravel in present streams.)

PLEISTOCENE

Qoal — Older Alluvium
(Alluvial terrace deposits above present floodplain.)

Qtg — Terrace Gravel
(Terrace deposits of sand and gravel 5'-20' thick.)

OLIGOCENE

Toc — Chadron Formation
(Pale greenish gray silica-cemented conglomerate and grit caps 9 buttes.)

TERTIARY

PALEOCENE

Tpl / Tplsc / Tplh / Tpls — Ludlow Formation
(Buff-gray fine-grained sandstone, sand, and interbeds of clay shale and silt. Brown laminae of plant debris locally abundant. Tplsc--Scotch Cap sandstone: Top sandstone is buff-brown limonitic stained, massive, ripple marked. Medium gray, dense, fine-grained limestone occasionally found overlying basal buff to brown lime-cemented sandstone. Tplh-Hillen coal: 1 coal bed, 1/2'-1 1/2' thick, black, blocky, iron-stained. Thin, 1"-2", discontinuous coals, "blackjack", peat-clays, and melanterite associated. Tpls-Shadehill coal: 3 thin coal, 5"-1 1/2' thick. "Blackjack", peat-clays, melanterite, and selenite gypsum associated. Coals may grade laterally into "blackjack" and/or peat-clay. Brown silt partings in upper coal. Upper part of formation missing. About 200' thick.)

CRETACEOUS

UPPER CRETACEOUS (Coal Springs) — Hell Creek Formation

Khu — Upper Hell Creek
("Somber beds" of lenticular bentonitic clay, silt, sand, and peat-clay. Marked stratification due to differences in grain sizes and colors. Well-developed cross-bedding. Mn-Fe, clay ironstone, and marcasite concretions, carbonized logs in situ, fragments of fusain, vitrain, and durain coal, and few discontinuous "blackjack". Few unarticulated dinosaur bones. About 400' exposed.)

CRETACEOUS

DRAINAGE

Intermittent Streams

Intermittent Lakes

CULTURE

Buildings
(House, church and school)

Roads and Trails

1684
Altitudes
(In feet above sea level)

x B.M 1706
Bench Marks
(Monuments marking points of known altitude.)

△ RENA
Triangulation Stations
(U.S. Coast & Geodetic and/or U.S. Geological Survey monuments marking points of exact geographic location.)

Operating
Abandoned
Coal mines and Gravel pits

2323 Top Hole ⊙ Altitude 36' Overburden 2' Thickness
Drill Holes

Shell Oil Co. ○ Veal No.1
Oil-test Borings

Dams
(Large, small earthen or cement.)

Geology by R.A. Hoppin and R.E. Curtiss
Assisted by E.E. Lutzen, D.L. Fairbanks, R.L. Hale, M.F. Nielsen, M.J. Tipton
Surveyed in 1953. Drafted by P. Rist.
Coal-Test Holes Drilled in 1954.

Base Map by South Dakota State Geological Survey.

Scale = 1/62500

0 1/2 1 2 3 4 MILES

Vermillion, South Dakota
1955

APPROXIMATE MEAN DECLINATION 1951
TRUE NORTH
MAGNETIC NORTH
19° 30'

■ Quadrangle Location

AREAL GEOLOGY OF THE CHANCE QUADRANGLE

By
Richard A. Hoppin

LOCATION

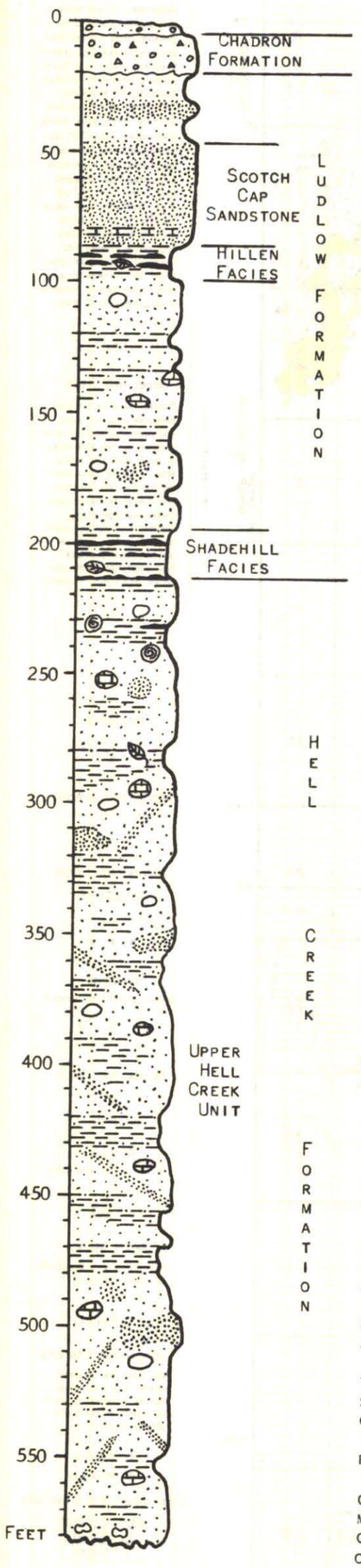
The quadrangle is situated in Perkins County, 1½ miles south of Bison and about 30 miles south-southwest of Lemmon. It lies between parallels 45°15' and 45°30' north latitude and meridians 102°15' and 102°30' west longitude and includes an area of approximately 210 square miles.

TOPOGRAPHY AND DRAINAGE

The drainage system is divided about equally between Thunder Butte Creek in the northeast half and Rabbit Creek in the southwest. Rabbit Creek and its main tributary, Antelope Creek, have very meandering courses and flow in valleys having steep walls up to 150' high. Locally, the valleys are a mile wide. The valleys are filled with alluvium for the most part, but bedrock is exposed in a few places at the surface. Thunder Butte Creek also follows a tortuous course, but its banks are rarely over 20 feet high and it has much less alluvial fill.

The divide between the two drainage systems averages about 2,775 feet altitude above sea level. Where the divide is capped by resistant sandstone, the south slopes are deeply cut by gullies and a line of cliffs 150-200 feet high forms a prominent topographic feature.

GENERALIZED COLUMNAR SECTION



The drainage pattern is dendritic and fairly dense. The streams are intermittent although Rabbit Creek may maintain a flow in wet years.

The south and southwest parts of the area are gently rolling and average about 2,500 feet in altitude with a relief of 50-100 feet. Several ridges and buttes rise above the average surface to heights of 200-300 feet. The east and central portions are dominated by flat-topped mesas averaging 2,775-2,800 feet in altitude. North of Thunder Butte Creek is a line of cliffs 150-200 feet above the creek.

The highest altitude is 2,880 feet above sea level on a butte in SW¼,NW¼,Sec.13,T.15N., R.13E. The lowest altitude is about 2,300 feet above sea level in Rabbit Creek in SE¼,NW¼, Sec.14,T.15N.R.15E. The relief is approximately 580 feet, and the average altitude of the quadrangle is about 2,590 feet above sea level.

STRATIGRAPHY

The outcropping stratigraphic units range in age from Upper Cretaceous to Recent. The major portion of the stratigraphic sequence consists of the Hell Creek formation (Upper Cretaceous age) and the Ludlow formation (Paleocene age). The basal portion of the Chadron (?) formation of the White River group (Oligocene age) is the caprock of several buttes. Pleistocene gravel terraces, Pleistocene-Recent alluvial terraces and Recent valley alluvium complete the exposed sedimentational record.

Upper Hell Creek, Hell Creek formation (Brown 1907). About 400 feet of this unit are exposed. It is comprised of interbedded and interlaminated bentonitic clay, silt, and sand. The light to dark gray and black clay is gumbo-like, slippery, and plastic when wet but becomes spongy and tough on drying. Thin beds and laminae of dark brown clay-peat and peat-clay are common. Sand and silt vary in color from all shades and combinations of gray, brown, and yellow. Stratification due to differences in grain size and color is marked. Grain sizes vary from medium-coarse to fine. Cross-bedding is well developed in many places.

In a bank on the east side of Rabbit Creek in NW¼,SE¼,Sec.34,T.16N.,R.14E., 20 feet above the stream, is a three-foot bed of coarse sand with irregular layers of "conglomerate". The pebbles are soft silty sand and clayey silt and range in size from one inch to two feet in diameter. Their outer surface is a layer of coarse sand cemented by iron and manganese.

This unit contains no conspicuous coal beds. The only bed of coal observed was in the southwest corner of the area in NW¼,Sec.18T.15N., R.14E. The seam is only six inches thick and contains "blackjack" and peat-clay. Elsewhere, black, dull and shiny coal occurs as fragments averaging one-fourth inch in diameter, or as thin lenses several inches long and an inch or so thick. These are present in only a few horizons.

Clay ironstone, manganese-iron, calcareous, and marcasite concretions are scattered throughout.

"Dikes" of calcareous sandstone are present locally. These dip at high angles and appear to represent cementation along joints or shear zones.

Discontinuous beds of "blackjack" occur mainly in the upper part of the unit. There are scattered occurrences of dinosaur bones.

Rapid vertical and lateral variation is typical. This, combined with the lack of a consistent coal horizon, makes correlation difficult.

This unit erodes to typical badlands topography in many parts of the area.

Ludlow formation (Lloyd and Hares 1915). The contact between the Hell Creek and Ludlow formations is drawn at the base of the lowest coal or strata correlated with it. In the south half of Sec. 27, T.16N., R.15E., five feet of laminated brown clay with lignitic streaks, thin "blackjack" and peat-clay with melanterite stain occur below a five-inch bed of flaggy dark brown coal. This coal changes towards the south and east to "blackjack" and peat-clay and finally to thin beds of purple and pink clay shale. The upper part of the formation is missing. About 200 feet are exposed. To the northwest, three thin beds of coal appear, and these form the Shadehill coal. The upper has a maximum thickness of one foot and is black and blocky with thin partings of brown silt. The lower beds are only a few inches thick and are quite irregular. Interbedded with the coal is brown and gray clay shale and silt with plant remains. These are slightly bentonitic in places. The Shadehill facies is only five to 10 feet thick in the quadrangle. Several small outliers of the Shadehill facies without coal appear to cap several buttes and ridges in the south-central and southwest parts of the area. Calcareous zones, marcasite concretions, gypsum crystals, and plant remains are common.

About 100 feet of gray and buff, medium- to fine-grained sand overlays the Shadehill. Minor interbeds of clay shale and silt occur. Calcareous-cemented horizons cap the line of cliffs in the east-central part of the quadrangle. Thin, brown laminae of plant debris are locally abundant. Thin lignitic lenses and aggregates are widely spread.

The Hillen facies contains two beds of coal (drill-hole determination) varying from one-half to one and one-half feet in thickness. The coal is black, blocky, and iron stained. The rest of the unit consists of about 18 inches of buff sand, locally calcareous, and brown and gray clay shale with plant remains.

The Scotch Cap sandstone is exposed in the central and northern portions of the area. The basal buff-colored, calcareous zone forms resistant cappings on the uplands surrounding the valleys of Thunder Butte Creek and its tributaries. Except for the calcareous lower portions, the unit is poorly exposed. It is probably 40-50 feet thick at most.

About 20-25 feet of predominantly silt and sandstone form a low scarp along the northeast border of the quadrangle.

Chadron formation (?) (Darton 1899). Thin, pale greenish gray silica-cemented conglomerate and grit form resistant butte caps.

STRUCTURE

The quadrangle is on the east flank of the Dakota (Williston) Basin. Surface altitudes on the Hell Creek-Ludlow contact and on the Hillen-Scotch Cap contact show a rise of 100-200 feet from the eastern part of the area to a structural "high" trending north-south in the western portion of the quadrangle. This low arch appears to plunge very gently to the north.

ECONOMIC GEOLOGY

This area contains some actual or currently-exploited and potentially-important mineral resources. Gravel terraces are quarried periodically. No coal is mined. Coal by-products, bentonitic clays, and sandstone may someday be of economic importance. A few small, isolated surficial deposits of manganese-iron concretions, containing about 51% metallic iron, are of no economic importance today.

COAL

Areal extent. The approximate boundaries of the Shadehill and Hillen coals are shown on the map. The boundaries were determined by natural exposures, 17 State Geological Survey coal-test holes, and topographic expression.

Thickness. The Shadehill coals range in thickness from two to 12 inches while the Hillen coals vary from one-half to one and one-half feet in thickness.

Physical character. The major portion of the coal is black in color and streak, blocky, brittle, slacks moderately on drying or exposure, and is non-coking. The coal beds may grade laterally into "blackjack" and/or peat-clay. Clay partings, gypsum, marcasite, melanterite, and iron oxide are scattered throughout.

Chemical character. Chemical analyses provide a satisfactory basis for comparing coals and determining the rank and grade of coal and its commercial qualities. Proximate analysis furnishes requisite data relative to the quality and combustion properties (moisture, volatile and gaseous matter, fixed carbon, or the chief heat-producing constituent, ash, and sulphur) of coal.

Coal samples ("trench" or channel) from the Shadehill coal outcrops, coal sample number 1, 18-inches thick, Sec. 18,T.17N., R.15E., and coal sample number 2, 15-inches thick, Sec. 30,T.18N., R.14 E., were analyzed as received, meaning the samples represent the coal as mined. The proximate analyses are as follows:

Sample	Moisture	Volatile Matter	Fixed Carbon	Ash	Sulphur	B.T.U.	Dry B.T.U.
1	35.74%	44.04%	7.89%	12.33%	0.95%	4,988	7,762
2	42.85%	42.47%	----	15.82%	0.46%	3,624	6,341

Economically, an air-dried coal, prior to domestic or commercial consumption, will increase the heating value considerably. (See Dry B.T.U. in above table.)

Character of overburden. The character of the overburden probably would not impose any difficulties to strip mining. Earth-moving equipment easily remove similar overburden in other areas.

Estimated coal reserves. The maximum thickness of coal, encountered on the surface and in 17 State Geological Survey coal-test holes, is 18 inches. This thickness is deemed insufficient for strip mining by present-day standards. Therefore, no coal tonnages were calculated for this quadrangle.

GRAVEL

Gravel occurs in terraces along Rabbit Creek and Antelope Creek. Thicknesses of about 20 feet of crudely stratified gravel and sand are common. There are several terrace levels, the highest being over 100 feet above stream level. These deposits constitute a volume of over 35,000,000 cubic yards. Much of the gravel is usable for road metal. A pit was opened in Sec. 3, T. 17N., R. 14E. in 1954 for use on State Highway 8. Estimated volumes for the larger terraces are as follows:

Location	Acres	Ave. Thickness	Cubic Yards
Secs. 21,22,27,28,34, T. 17 N., R. 15 E.	555	15'	13,431,000
Secs. 2,3,11,T. 17 N., R. 14 E.	404	5'	3,258,933
Secs. 4,5, T. 15 N., R. 14 E. Secs. 32,33, T. 16 N., R. 14 E.	310	6'	3,000,800
Secs. 2,3 T. 15 N., R. 14 E. Secs. 34,35, T. 16 N., R. 14 E.	134	10'	2,161,866
Secs. 20,21,28,29, T. 17 N., R. 15 E.	127	10'	2,048,933
Secs. 35,36, T. 16 N., R. 13 E.	189	6'	1,829,520
Secs. 13,14,23,24, T. 17 N., R. 14 E.	110	10'	1,774,666
Secs. 12,13, T. 15 N., R. 14 E. Sec. 18, T. 15 N., R. 15 E.	88	10'	1,419,733
Secs. 13,24, T. 16 N., R. 13 E. Secs. 18,19, T. 16 N., R. 14 E.	144	6'	1,393,920
Secs. 16,17, T. 15 N., R. 15 E.	83	10'	1,339,066

SANDSTONE

Silica-cemented grit and conglomerate, and calcareous sandstone could be used locally for foundations and rip-rap.

CLAY

Certain bentonitic clay beds in the Hell Creek formation can be used for sealing stock dams, thus conserving water.