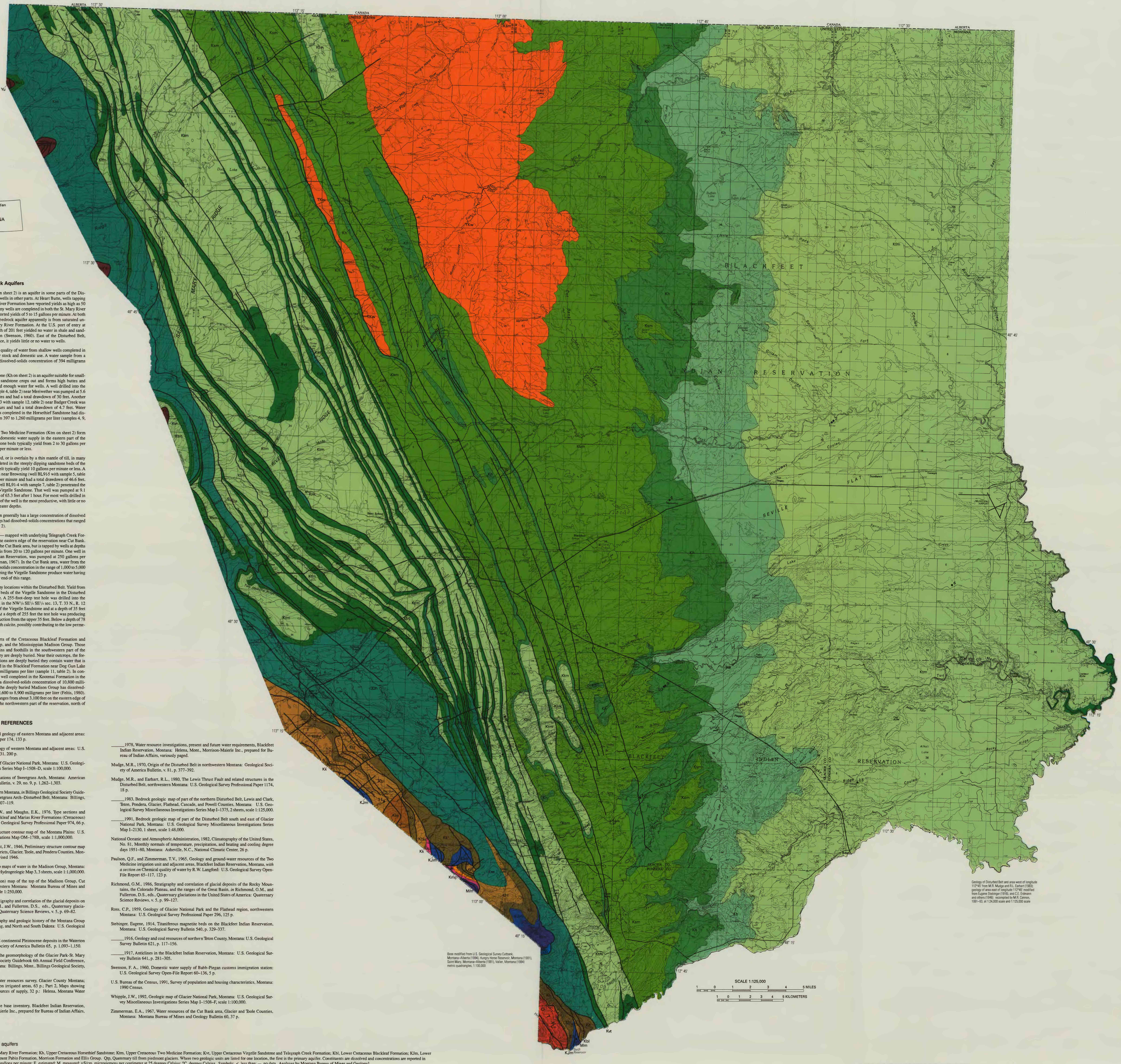
PREPARED IN COOPERATION WITH THE
BLACKFEET WATER RESOURCES DEPARTMENT



Geology of Disturbed Belt and area west of longitude 112°45' from M.R. Mudge and R.L. Earhart (1983); geology of area east of longitude 112°45' modified from Eugene Stebinger (1916), and C.E. Erdmann and others (1946); recompiled by M.R. Cannon, 1991–93, at 1:24,000 scale and 1:125,000 scale

Base modified from U.S. Geological Survey Cutbank, Montana–Alberta (1984), Hungry Horse Reservoir, Montana (1981), Saint Mary, Montana–Alberta (1981), Valier, Montana (1984) metric quadrangles, 1:100,000

Bedrock Aquifers

The St. Mary River Formation (Ksm on sheet 2) is an aquifer in some parts of the Disturbed Belt, but it yields little or no water to wells in other parts. At Heart Butte, wells tapping folded and fractured rocks of the St. Mary River Formation have reported yields as high as 50 gallons per minute. In the Browning area, many wells are completed in both the St. Mary River Formation and the overlying till and have reported yields of 5 to 15 gallons per minute. At both Heart Butte and Browning, recharge to the bedrock aquifer apparently is from saturated unconsolidated deposits overlying the St. Mary River Formation. At the U.S. port of entry at Piegan, test wells drilled to a maximum depth of 201 feet yielded no water in shale and sandstone beds of the St. Mary River Formation (Swenson, 1960). East of the Disturbed Belt, where the formation is exposed at land surface, it yields little or no water to wells.

In the Heart Butte and Browning areas, quality of water from shallow wells completed in the St. Mary River Formation is suitable for stock and domestic use. A water sample from a typical domestic well near Browning had a dissolved-solids concentration of 394 milligrams per liter (sample 3, table 2).

Where saturated, the Horsethief Sandstone (Kh on sheet 2) is an aquifer suitable for small-yield stock and domestic wells. Where the sandstone crops out and forms high buttes and rimrock, it generally is dry or does not yield enough water for wells. A well drilled into the Horsethief Sandstone (well BL91-1 with sample 4, table 2) near Meriwether was pumped at 5.6 gallons per minute for 2 hours and 40 minutes and had a total drawdown of 30 feet. Another well in the Horsethief Sandstone (well BL91-3 with sample 12, table 2) near Badger Creek was pumped at 5 gallons per minute for 1.5 hours and had a total drawdown of 4.7 feet. Water samples collected from 2 springs and 2 wells completed in the Horsethief Sandstone had dissolved-solids concentrations that ranged from 397 to 1,260 milligrams per liter (samples 4, 9, 10, and 12 on table 2).

Sandstone beds of the lower part of the Two Medicine Formation (Ktm on sheet 2) form an extensive aquifer that is widely used for domestic water supply in the eastern part of the reservation. Wells completed in those sandstone beds typically yield from 2 to 30 gallons per minute, with most wells yielding 15 gallons per minute or less.

The Two Medicine Formation is exposed, or is overlain by a thin mantle of till, in many areas within the Disturbed Belt. Wells completed in the steeply dipping sandstone beds of the Two Medicine Formation in the Disturbed Belt typically yield 10 gallons per minute or less. A well drilled into the Two Medicine Formation near Browning (well BL91-5 with sample 5, table 2) was pumped for 1.5 hours at 5.5 gallons per minute and had a total drawdown of 46.6 feet. Another well drilled in the Disturbed Belt (well BL91-4 with sample 7, table 2) penetrated the Two Medicine Formation and probably the Virgelle Sandstone. That well was pumped at 9.1 gallons per minute and had a total drawdown of 65.5 feet after 1 hour. For most wells drilled in the Disturbed Belt, the upper 100 to 150 feet of the well is the most productive, with little or no additional well yield gained by drilling to greater depths.

Water from the Two Medicine Formation generally has a large concentration of dissolved solids. Water samples from 6 wells and springs had dissolved-solids concentrations that ranged from 646 to 1,840 milligrams per liter (table 2).

The Virgelle Sandstone (Kvt on sheet 2—mapped with underlying Telegraph Creek Formation) is the most widely used aquifer on the eastern edge of the reservation near Cut Bank. The Virgelle Sandstone does not crop out in the Cut Bank area, but is tapped by wells at depths of 170 to 450 feet. Yield to wells commonly is from 20 to 120 gallons per minute. One well in Cut Bank, 1 mile east of the Blackfeet Indian Reservation, was pumped at 250 gallons per minute for 9 hours and 40 minutes (Zimmerman, 1967). In the Cut Bank area, water from the Virgelle Sandstone generally has a dissolved-solids concentration in the range of 1,000 to 5,000 milligrams per liter, although most wells tapping the Virgelle Sandstone produce water having a dissolved-solids concentration in the lower end of this range.

The Virgelle Sandstone crops out at many locations within the Disturbed Belt. Yield from wells tapping the steeply dipping sandstone beds of the Virgelle Sandstone in the Disturbed Belt generally is 2 to 15 gallons per minute. A 255-foot-deep test hole was drilled into the Virgelle Sandstone northeast of Starr School in the NW¼ SE¼ SE¼ sec. 13, T. 33 N., R. 12 W. The test hole was started on an outcrop of the Virgelle Sandstone and at a depth of 35 feet was producing about 3 gallons per minute. At a depth of 255 feet the test hole was producing 3.4 gallons per minute, with most of the production from the upper 35 feet. Below a depth of 78 feet, fractures in the sandstone were filled with calcite, possibly contributing to the low permeability of the formation.

Other water-bearing rocks include parts of the Cretaceous Blackleaf Formation and Kootenai Formation, the Jurassic Ellis Group, and the Mississippian Madison Group. Those rocks are exposed only in the high mountains and foothills in the southwestern part of the Blackfeet Indian Reservation; elsewhere, they are deeply buried. Near their outcrops, the formations yield fresh water. Where the formations are deeply buried they contain water that is more saline. A 150-foot-deep well completed in the Blackleaf Formation near Dog Gun Lake had a dissolved-solids concentration of 267 milligrams per liter (sample 11, table 2). In contrast, a water sample from a 2,693-foot-deep well completed in the Kootenai Formation in the NE¼ NW¼ sec. 11, T. 34 N., R. 6 W. had a dissolved-solids concentration of 10,800 milligrams per liter (USGS data files). Water in the deeply buried Madison Group has dissolved-solids concentrations in the range of about 2,600 to 8,900 milligrams per liter (Feltis, 1980). Depth to the deeply buried Madison Group ranges from about 3,100 feet on the eastern edge of the reservation to more than 14,000 feet in the northwestern part of the reservation, north of Chief Mountain (Feltis, 1984).

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Table 2. Quality of water in bedrock aquifers

[Geologic unit: Ksm, Upper Cretaceous St. Mary River Formation; Kh, Upper Cretaceous Horsethief Sandstone; Km, Upper Cretaceous Two Medicine Formation; Kvt, Upper Cretaceous Virgelle Sandstone and Telegraph Creek Formation; Kbl, Lower Cretaceous Blackleaf Formation; KJm, Lower Cretaceous and Upper and Middle Jurassic Mount Pablo Formation, Morrison Formation and Ellis Group. Qtp, Quaternary till from piedmont glaciers. Where two geologic units are listed for one location, the first is the primary aquifer. Constituents are dissolved and concentrations are reported in milligrams per liter. Abbreviations: gal/min, gallons per minute; E, estimated; M, measured; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius. Symbols: <, less than; —, no data. Analyses by Montana Bureau of Mines and Geology]

Sample number	Location	Geologic unit	Site type	Date sampled	Discharge (gal/min)	Discharge method	Onsite specific conductance (µS/cm)	Onsite pH	Water temperature (°C)	Calcium	Magnesium	Sodium	Potassium	Bicarbonate	Sulfate	Chloride	Fluoride	Silica	Dissolved solids	Nitrate, as nitrogen	Iron	Manganese	Zinc	Comments
1	SW¼SW¼NW¼ sec. 30, T. 34 N., R. 7 W.	Ktm	Well	06-09-92	—	—	2,400	7.3	9.0	240	130	140	5.0	300	1,100	13	0.49	9.2	1,840	11	0.032	0.002	0.043	Domestic well, small yield
2	NE¼SW¼NW¼ sec. 30, T. 34 N., R. 7 W.	Ktm	Spring	06-09-92	3	M	1,520	7.5	9.5	100	66	160	5.7	440	490	17	.49	7.9	1,100	6.2	<.003	<.002	.052	Discharge to stock tank
3	NW¼SE¼SE¼ sec. 27, T. 33 N., R. 11 W.	Ksm, Qtp	Well	07-29-92	15	E	660	8.0	8.5	27	23	86	1.1	320	85	2.2	.36	8.3	394	<.10	<.003	.002	.005	Domestic well
4	NW¼NW¼NW¼ sec. 22, T. 33 N., R. 9 W.	Kh	Well	05-08-92	5.6	M	2,040	8.4	9.5	3.1	1.4	530	.80	1,050	24	150	2.7	7.4	1,260	.20	.017	.005	<.006	Test well BL91-1
5	NW¼SE¼SE¼ sec. 9, T. 32 N., R. 11 W.	Kvt, Ktm	Well	05-07-92	5.5	M	1,400	8.2	7.5	11	4.8	330	1.1	740	140	8.1	.50	7.8	872	.19	.014	.028	.009	Test well BL91-5
6	NW¼SE¼SE¼ sec. 7, T. 32 N., R. 6 W.	Ktm	Spring	06-11-92	3	E	1,470	8.5	8.5	11	11	290	1.9	180	450	35	1.0	5.8	931	7.8	<.003	<.002	<.008	Discharge to stock reservoir
7	SE¼SW¼SE¼ sec. 36, T. 31 N., R. 11 W.	Ktm, Kvt	Well	05-06-92	9.1	M	1,540	7.9	8.5	37	15	290	2.0	270	530	13	.40	8.2	1,030	.14	.015	.071	.018	Test well BL91-4
8	NE¼SW¼SE¼ sec. 24, T. 31 N., R. 11 W.	Ktm	Spring	08-08-90	.9	M	1,070	—	13.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Discharge to stock tank
9	NW¼SE¼SE¼ sec. 9, T. 31 N., R. 9 W.	Kh	Spring	07-11-91	2.4	M	795	7.2	9.5	54	40	55	2.8	350	120	6.4	.24	8.3	469	.69	<.004	<.002	.009	Used for stock water
10	NE¼SW¼SE¼ sec. 9, T. 31 N., R. 9 W.	Kh	Spring	07-11-91	5	M	1,110	7.1	8.5	59	40	130	3.0	420	240	8.0	.39	7.6	691	.28	<.004	<.002	.012	Used for stock water
11	NW¼SW¼SW¼ sec. 13, T. 30 N., R. 12 W.	Kbl	Well	07-28-92	7.5	M	458	7.5	6.5	59	15	20	1.2	290	8.6	12	.38	8.9	267	<.10	.430	.520	.003	Domestic well, flowing
12	SE¼NE¼NW¼ sec. 17, T. 30 N., R. 9 W.	Kh	Well	05-06-92	5	M	611	7.6	10.5	63	43	14	1.7	300	110	4.6	.40	9.5	397	.60	.012	<.002	.018	Test well BL91-3
13	NW¼NE¼NE¼ sec. 8, T. 30 N., R. 7 W.	Ktm	Spring	07-12-91	15	E	1,010	7.5	8.0	64	46	93	3.3	350	250	7.4	.42	7.9	646	.58	.007	<.002	.004	Fisher spring
14	SW¼SE¼SE¼ sec. 22, T. 28 N., R. 10 W.	KJm	Spring	08-09-90	20	E	430	—	9.0	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Multiple discharge points

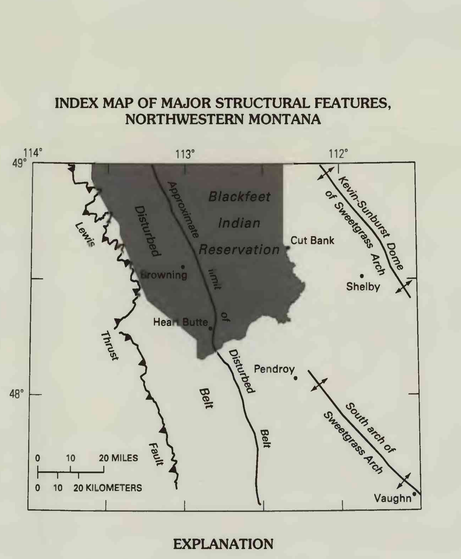
CORRELATION OF MAP UNITS

Map unit	Group	Series	System
TKw		Paleocene and Upper Cretaceous	Tertiary and Cretaceous
Ksm	Montana Group	Upper Cretaceous	Cretaceous
Kh	Montana Group	Upper Cretaceous	Cretaceous
Kb	Montana Group	Upper Cretaceous	Cretaceous
Ktm	Montana Group	Upper Cretaceous	Cretaceous
Kvt	Montana Group	Upper Cretaceous	Cretaceous
Km	Colorado Group	Upper Cretaceous	Cretaceous
Unconformity			
Kbl (Kbk)	Colorado Group	Lower Cretaceous	Cretaceous
Unconformity			
Kk		Lower Cretaceous	Cretaceous
Unconformity			
Kmp (KJm)		Lower Cretaceous	Cretaceous
Unconformity			
Je	Ellis Group	Upper and Middle Jurassic	Jurassic
Unconformity			
Mm	Madison Group		Mississippian
Unconformity			
Du			Devonian
Unconformity			
Cu			Cambrian
Unconformity			
Yu	Ravalli Group of Belt Supergroup	Middle Proterozoic	Proterozoic

DESCRIPTION OF MAP UNITS

Unit	GEOLOGIC DESCRIPTION	EXTENT	WATER-BEARING CHARACTERISTICS
TKw	WILLOW CREEK FORMATION (PALEOCENE AND UPPER CRETACEOUS)—Variegated mudstone with some thin beds of sandstone. Upper part of the Willow Creek Formation is bright reddish-brown mudstone in beds as thick as 3 feet, interbedded with gray, gray-green, and tan-gray mudstone (Mudge and Earhart, 1983). Lower part of Willow Creek Formation is variegated mudstone, dominantly grayish green, gray, and locally tan, pinkish gray, purple, and red brown. Some thin interbeds contain irregular-shaped, tufa-like nodules that probably contain barite. Thin, gray, poorly sorted fine- to medium-grained sandstone beds locally. Weathers to badland topography where outcrops are extensive. At least 770 feet thick in north part of mapped area	The Willow Creek Formation crops out in the north-central part of the reservation mostly east of the Disturbed Belt. The area of outcrop extends from near Sharp Lake northward to the International Boundary. From Houseman Hill northward, much of the formation is covered by unconsolidated deposits, including pediment and terrace gravel, alluvium, and till deposited by continental ice sheets	The Willow Creek Formation generally is not an aquifer, although a few wells are reported to yield from 1 to 10 gal/min. Overall, the formation is not favorable for stock or domestic water supplies
Ksm	ST. MARY RIVER FORMATION (UPPER CRETACEOUS)—Mostly greenish-gray to grayish olive mudstone interbedded with thin beds of fine-grained sandstone. Some poorly indurated, gray-brown to tan-gray, crossbedded sandstone beds fill small channels within the formation. Thin (3 feet) bed of carbonaceous shale, near the base of the St. Mary River Formation, commonly is overlain by a thin (3 feet) oyster bed (Mudge and Earhart, 1983). The St. Mary River Formation weathers to badland topography. Thickness is about 980 feet in the northern part of the reservation (Stebinger, 1916). The St. Mary River Formation is similar in lithology to the Two Medicine Formation; both consist of nonmarine sedimentary rocks	The St. Mary River Formation is exposed as a wide north-south band of outcrops through the central part of the reservation. Outcrops in the western part of this band are extensively deformed by southwestward dipping thrust faults. The St. Mary River Formation underlies the towns of Browning, Blackfoot, and Heart Butte. It is well exposed along Cut Bank Creek south of Sharp Lake and along U.S. Highway 89, in roadcuts north of the Two Medicine River. Till from piedmont glaciers (unit Qtp) mantles most of the bedrock surface south of Cut Bank Creek	Mudstone units within the St. Mary River Formation do not yield water. Sandstone units yield from 2 to 50 gal/min, with the larger yields from folded and fractured rocks underlying glacial drift. In general, the formation yields little water to stock or domestic wells
Kh	HORSETHIEF SANDSTONE AND HORSETHIEF–BEARPAW TRANSITION UNIT (UPPER CRETACEOUS)—The Horsethief Sandstone is gray to gray-brown, fine- to medium-grained marine sandstone, commonly crossbedded. Titaniferous magnetite sandstone locally is present in the upper 20–40 feet of the formation (Mudge and Earhart, 1983). Large calcareous concretions locally are present in the middle part. The Horsethief Sandstone is as thick as 165 feet and it forms prominent bluffs and ridges. The Horsethief–Bearpaw transition unit is dark-gray marine mudstone, interbedded with thin, fine- to medium-grained sandstone (Cobban, 1955). The sandstone beds are thicker and more abundant in the upper part. The unit is as thick as 400 feet in northern areas and it thins southward	East of the Disturbed Belt, the Horsethief Sandstone forms a conspicuous band of outcrops that trend north-south, mostly in the townships of R. 9 W. Within the Disturbed Belt are numerous northwest-trending outcrops formed by thrust faults. Cliffs of Horsethief Sandstone are prominent west of Buffalo Lake, along the Two Medicine River in T. 31 and 32 N., R. 9 W., and along Badger Creek in T. 30 N., R. 9 W. The Horsethief–Bearpaw transition unit is well exposed on the north side of the Two Medicine River, one mile east of U.S. Highway 89	Where saturated, the Horsethief Sandstone generally yields from 5 to 15 gal/min to stock or domestic wells. Many springs, with flow rates of 2 to 5 gal/min, discharge from the Horsethief Sandstone. The transition unit generally is not an aquifer
Kb	BEARPAW SHALE (UPPER CRETACEOUS)—The Bearpaw Shale is mostly dark-gray marine shale with ferruginous concretions, some bentonite beds, and thin layers of sandstone (Cobban, 1955). Selenite (gypsum) crystals are common on many weathered surfaces. The Bearpaw Shale is nearly 400 feet thick north of the Two Medicine River; it thins southward to about 225 feet along Blacktail Creek, where it is much sandier and contains beds of fine-grained, crossbedded sandstone as thick as 15 feet	The Bearpaw Shale is exposed as a north-south trending band of outcrops in the townships of R. 8 W. and R. 9 W. The soft shale typically erodes easily and forms gently rolling hills and smooth slopes. The Bearpaw Shale is well exposed along U.S. Highway 89 in roadcuts on the north side of Badger Creek	The Bearpaw Shale is not an aquifer in the northern and central parts of the reservation. In the southern part of the reservation, between Blacktail Creek and Birch Creek, sandstone beds in the Bearpaw Shale might produce small quantities of water
Ktm	TWO MEDICINE FORMATION (UPPER CRETACEOUS)—Nonmarine mudstone with some sandstone. Upper and middle parts mostly gray-green to gray mudstone with reddish-gray, red-brown, and purple interbeds. Fossils are common in the upper 490 feet, including dinosaur bones and pelecypods. The lower 560 feet contains many thick beds of gray- to greenish-gray sandstone interbedded with gray-green, olive-drab, and gray mudstone (Mudge and Earhart, 1983). Sandstone beds in the lower part are poorly indurated, fine- to medium-grained, massive to thinly bedded, and locally as thick as 165 feet. Thin coal beds are present at the top and base of the formation and in a zone about 250 feet above the base (Stebinger, 1916). The Two Medicine Formation has a maximum thickness of about 2,200 feet. Where outcrops are extensive, the Two Medicine Formation erodes into badland topography, as does the St. Mary River Formation	The Two Medicine Formation crops out in much of the eastern part of the reservation. Large exposures are located along the lower reaches of Birch Creek, Badger Creek, Two Medicine River, and Cut Bank Creek. Sandstone beds typical of the lower part of the formation are exposed along Cut Bank Creek, downstream from Cut Bank. Numerous outcrops also are present in the Disturbed Belt in the western part of the reservation. Steeply dipping beds of the Two Medicine Formation are well exposed along the Two Medicine River, where the Browning–Heart Butte road crosses the river	Mudstone in the upper Two Medicine Formation produces little or no water. Sandstone beds in the lower Two Medicine Formation typically yield from 2 to 30 gal/min and are widely used for domestic water supply in the eastern part of the reservation
Kvt	VIRGELLE SANDSTONE AND TELEGRAPH CREEK FORMATION (UPPER CRETACEOUS)—The Virgelle Sandstone is light-gray, moderately thick-bedded, fine-grained marine sandstone (Mudge and Earhart, 1983). Locally, it contains crossbedded, iron-impregnated beds that weather to form large concretions. Dark brownish-gray, resistant titaniferous magnetite sandstone as thick as 20 feet is present at the top of the formation. The Virgelle Sandstone is 165 to 200 feet thick and it forms conspicuous hogbacks and escarpments. The Telegraph Creek Formation is a transitional unit between the underlying Marias River Shale and the overlying Virgelle Sandstone. It is similar to the transitional unit between the Bearpaw Shale and the Horsethief Sandstone (Mudge and Earhart, 1983). The Telegraph Creek consists mainly of gray mudstone interbedded with fine-grained sandstone. Sandstone beds are thicker toward the top of the formation and locally are crossbedded and ripple marked. The thickness of the Telegraph Creek Formation ranges from about 120 to 165 feet (Erdmann and others, 1946)	Nearly horizontal beds of the Virgelle Sandstone and Telegraph Creek Formation crop out near the confluence of Cut Bank Creek and the Two Medicine River. Steeply dipping beds of Virgelle Sandstone are exposed in road cuts along U.S. Highway 89 at Kiowa	The Virgelle Sandstone is a major source of ground water in the Cut Bank area, where wells yield as much as 250 gal/min. In the western part of the reservation where the Virgelle Sandstone is steeply dipping and bounded by thrust faults, wells typically yield 2 to 15 gal/min. The Telegraph Creek Formation yields water to springs and some wells in areas east of the reservation, but is not a significant source of ground water in the reservation
Km	MARIAS RIVER SHALE (UPPER CRETACEOUS)—Chiefly dark-gray, marine mudstone from about 900 to 1,200 feet thick. The Marias River Shale is divided into four members (not mapped) which are, in descending order, the Kevin, Ferdig, Cone, and Floweree Members (Cobban and others, 1976)	The Marias River Shale crops out only in the Disturbed Belt in the western part of the reservation. It is well exposed along the Two Medicine River east and southeast of East Glacier Park. A thin mantle of till from piedmont glaciers overlies the bedrock surface in most areas	Marine mudstone of the Marias River Shale generally produces no water or a small quantity of water that is too mineralized for domestic use
Kbl	BLACKLEAF FORMATION (LOWER CRETACEOUS)—Gray, marine mudstone and interbedded sandstone. The Blackleaf Formation is divided into four members (not mapped) which are, in descending order, the Bootlegger, Vaughn, Taft Hill, and Flood Members (Cobban and others, 1976). Only the Vaughn and Flood Members are present in the southwestern part of the reservation, where the formation is about 718 feet thick (Mudge and Earhart, 1991)	The Blackleaf Formation crops out around Dog Gun Lake and in roadcuts along U.S. Highway 2 southwest of East Glacier Park	Near outcrops, sandstones of the Blackleaf Formation yield water suitable for stock and domestic use
Kk	KOOTENAI FORMATION (LOWER CRETACEOUS)—Gray-green and maroon mudstone and many greenish-gray sandstone beds. The sandstone is mostly poorly sorted, fine to coarse grained, and commonly crossbedded (Mudge and Earhart, 1991). Lenticular beds of conglomerate are present locally at bases of some of the sandstone units. Brown, iron-stained nodules are common in the mudstone beds. A brownish gray limestone unit present near the top of the formation contains lenses of gastropod and pelecypod shells. The Kootenai Formation is from 640 to 980 feet thick	The Kootenai Formation crops out near the mountain front in the southwest part of the reservation and is well exposed along Railroad Creek south of the town of East Glacier Park. In the Cut Bank area, sandstone of the Kootenai Formation is an important source of oil and gas	Sandstone of the Kootenai Formation typically yields 2 to 10 gal/min to shallow wells in the southwestern part of the reservation
Kbk	BLACKLEAF AND KOOTENAI FORMATIONS (LOWER CRETACEOUS)—Shown where parts of both formations are present but are too thin to map separately		(See descriptions of Blackleaf and Kootenai Formations, above)
Kmp	MOUNT PABLO FORMATION (LOWER CRETACEOUS)—Nonmarine limestone, mudstone, and sandstone in upper part, mudstone interbedded with sandstone in middle part, and sandstone and conglomerate in lower part (Mudge and Earhart, 1983). The Mount Pablo Formation is about 177 feet thick (Mudge and Earhart, 1991)	Crops out only near the mountain front along the southwestern boundary of the reservation	Water yielding potential is unknown. Water wells are not known to be completed in this formation because of the remote locations of outcrops and the great depth to the formation over most of the reservation
KJm	MOUNT PABLO FORMATION, MORRISON FORMATION, AND ELLIS GROUP (LOWER CRETACEOUS AND UPPER AND MIDDLE JURASSIC)—The Upper Jurassic Morrison Formation is not mapped separately; it is only about 16 feet thick in the southwest of the mapped area (Mudge and Earhart, 1991). Much of the Morrison Formation was removed by erosion prior to Cretaceous sedimentation	Crops out only near the mountain front along the southwestern boundary of the reservation. Exposed along the north shore of Swift Reservoir	Limestone yields as much as 20 gal/min to springs north of the dam at Swift Reservoir
Je	ELLIS GROUP (UPPER AND MIDDLE JURASSIC)—The Ellis Group is divided into three formations (not mapped) which are, in descending order, the Swift, Rierdon, and Sawtooth Formations. They have a combined thickness of about 460 feet in the vicinity of Swift Reservoir (Cobban, 1945). The Swift Formation consists of very fine-grained to fine-grained sandstone and shale. The Rierdon Formation consists mostly of gray shale with thin beds of hard limestone. The Sawtooth Formation consists of siltstone, gray shale, and very fine-grained sandstone (Mudge and Earhart, 1991)	Crops out only near the mountain front along the southwestern boundary of the reservation	Water yielding potential is unknown. Water wells are not known to be completed in this group because of the remote locations of outcrops and the great depth of burial over most of the reservation. The Ellis Group produces oil and nonpotable water in oil fields east of Cut Bank
Mm	MADISON GROUP (MISSISSIPPIAN)—The Madison Group is divided into two formations; the upper formation is the Castle Reef Dolomite and the lower is the Allan Mountain Limestone (Mudge and Earhart, 1991). It consists mostly of limestone and dolomite. The Madison Group is about 1,345 feet thick in the Birch Creek Basin south of Swift Reservoir	The Madison Group is exposed only in the mountains along the southwestern boundary of the reservation. It crops out on Heart Butte and at Swift Dam. In the Cut Bank area, the top of the Madison Group is at a depth of about 3,100 to 3,500 feet. The Madison Group is an important source of oil and gas	Yields saline water in deep wells in the Cut Bank area. Water wells are not known to be completed in the Madison Group in outcrop areas near the southwestern boundary of the reservation
Du	THREE FORKS, JEFFERSON, AND MAYWOOD FORMATIONS, UNDIVIDED (UPPER AND MIDDLE DEVONIAN)—These formations consist mainly of limestone and dolomite and have a combined thickness of about 985 feet (Mudge and Earhart, 1991)	These formations crop out on the south flanks of Heart Butte	Water yielding potential of these rocks is unknown. Water wells are not known to be completed in them because they crop out in high mountains and foothills where currently there is no demand for ground water
Cu	CAMBRIAN ROCKS—Consist of as much as 490 feet of dolomite, shale, and limestone (Mudge and Earhart, 1991)	Cambrian rocks are exposed in the southwest part of the reservation in the vicinity of Haywood Creek	Water yielding potential of these rocks is unknown
Yu	MIDDLE PROTEROZOIC ROCKS—Proterozoic rocks include two formations, the Greyson Formation and the Altyn Formation, and they are present only on mountain peaks above the Lewis Thrust Fault. The Greyson Formation consists mainly of argillite and siltite, whereas the Altyn Formation consists mainly of limestone and dolomite	The Greyson Formation caps the summits of Napi Point and Divide Mountain. The Altyn Formation is exposed on Chief Mountain, Sherburne Peak, Napi Point, and Divide Mountain	Water yielding potential of these rocks is unknown

INDEX MAP OF MAJOR STRUCTURAL FEATURES, NORTHWESTERN MONTANA



EXPLANATION

Thrust fault—Sawteeth on upper plate

Fold—Anticline showing crestline; arrows show direction of dip of limbs

MAP SYMBOLS

Fault—Northwest trending faults are thrust faults with upper plate on western side of fault. Northeast trending faults are normal faults or tear faults

Contact—Approximately located

Water sample location and number

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Bedrock geology

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By
M.R. Cannon
1996