Temperature

Mean temperatures at Steamboat Springs and Craig have a strong seasonal correlation (fig. 20). Both curves have the same general shape but differ by 4 to 6 ˚F. This correlation indicates that factors that control temperature are more uniform in the area than factors that control precipitation.

The normally dry, cloudless conditions that occur at this altitude produce extreme seasonal and diurnal temperature fluctuations. Mean maximum daily temperatures in July range from 80 ˚F in Steamboat Springs to 85 ˚F in Craig. Mean minimum daily temperatures in January throughout the area are approximately -2 ˚F. Diurnal temperatures may fluctuate throughout a rangeof 40 ˚F or more at any time of the year.

Evaporation

Evaporation data for the study area are more limited than temperature or precipitation data. Only seven evaporation sites are maintained in the Colorado River watershed of western Colorado (table 2). Evaporation primarily is a function of available heat, solar insolation, humidity, and wind. At Hayden, the low humidity, intermittent winds, and small number of cloudy days result in a pan evaporation rate from May to October of about 42 in. (table 2). Using a pan coefficient of 0.7 (Kohler and others, 1959), lake evaporation is estimated to be about 29 in., well in excess of mean annual precipitation inmost of the study area. Because information at Hayden is available only for May to October, annual evaporation actually is larger. This results in a precipitation–evaporation deficit, which greatly decreases the volume of water available to recharge the aquifers. No wind and humidity data are available for the study area. In general, the relative humidity is low, increasing only during thundershowers and snowstorms. Actual wind effects are unknown.

SURFACE-WATER HYDROLOGY

Surface-water hydrology data are important to ground-water studies because knowledge of streamflow distribution and timing provides information about when and where recharge or discharge to streams may occur. Surface-water-chemistry data also provide information about ongoing surficial geochemical processes and about the chemical composition of discharging ground water.

Drainage Systems and Streamflow

Drainage systems and streamflow are affected by origin and geographic location of the stream. The Yampa River and the Williams Fork are the two major streams that drain the study area. These streams are perennial throughout the area and have a mean annual flow of 1,100 ft^3/s (Yampa River at Hayden) and 44 ft^3/s (Williams Fork at Pagoda). The steams are located near the northern and southern periphery of the area and flow nearly due west across existing structural trends: both streams probably are antecedant and superposed (Hunt, 1969). Most of

Table 2.—Pan-evaporation data from Colorado *River basin sites*
[Values in inches except where noted; --, no data]

Site Number (fig. 1)	Site Name	Altitude (feet)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	May-Oct. total	Source
1	Grand Junction	4,760	--	--	--	7.33	9.51	11.60	11.89	10.19	7.49	4.65	2.2	--	55.33	([1])
2	Grand Lake	8,288	--	--	--	--	6.18	8.14	8.34	7.14	5.44	3.63	--	--	38.87	([1])
3	Green Mountain Dam	7,740	~	--	--	--	5.71	6.48	6.95	6.12	4.60	3.23	--	--	33.09	([1])
4	Meredith	7,825	--	-.	--	--	7.79	8.47	9.16	7.51	5.63	3.56	--	--	42.12	([1])
5	Montrose	5,785	1.53	1.37	3.13	5.45	7.36	9.07	8.87	7.61	5.57	3.42	1.74	1.52	1.52	([1])
6	Hayden	6,346	--	--	--	--	5.8	7.1	8.8	8.0	6.1	6.1	--	--	41.90	([2])
7	Vallecito Dam	5,010	--	--	2.33	3.93	5.41	6.54	6.45	5.51	3.97	3.06	1.80	--	30.94	([1])
									Mean						40.59	
									Standard deviation						7.9	

[1]Data from National Oceanic and Atmospheric Administration (1890-1987).
[2]Data from U.S. Department of the Interior (1976).

the smaller tributary streams follow structural trends, although some streams flow across the structure (pl.1). Three tributary stream systems—western, central, and eastern—are unique because of differing structural settings.

The western system, which extends from the western study boundary to Hayden Gulch, is the simplest system. This area is drained by gulches that have formed on cuestas of the Mesaverde Group outcrop. Gullies are aligned subparallel to each other down the front and back of the cuesta. All western gulches begin along the cuesta ridges at altitudes less than 7,500 ft. Snow-melt runoff occurs only during the spring, generally rising, peaking, and receding within a few months (fig. 21, Stokes Gulch). This streamflow generally is small and occurs from March to July. Northward-draining gulches flow later in the year than do southward-draining gulches because of larger drainage areas, smaller gradients, and a northward aspect that delays snowmelt runoff. Gulches in the western area may provide recharge to the ground-water system only during the spring because they generally are dry by summer. Conversely, springs, seeps, and intermittent perennial base flow are evidence of ground-water discharge to some reaches of the gulches.

The central stream system drains the Sage Creek and Fish Creek anticline areas and the western side of the Tow Creek anticline (pl. 1). Within the area are three perennial streams—Dry Creek, Sage Creek, and Grassy Creek—in addition to numerous intermittent gulches. All streams originate in or near the study area, generally at altitudes less than 8,000 ft. Dry Creek is a subsequent stream draining the western flank of the Sage Creek anticline. Sage Creek drains the central and eastern parts of the Sage Creek anticline and flows across structural trends. Little streamflow data are available for these two streams. Two tributaries, Hubberson Gulch and Watering Trough Gulch, have 3 to 6 years of streamflow records that indicate ephemeral flow conditions. Grassy Creek drains most of the Fish Creek anticline and the western half of the Tow Creek anticline. Gain-loss measurements in Grassy Creek indicate that the upper reach of the creek gains flow from the outcrops of the Trout Creek Sandstone Member of the Iles Formation and from the Williams Fork Formation (fig. 22; table 3). Downstream from Grassy Creek station 4, which is at Routt County Road 29, the creek generally gains flow during the spring through summer months. The dryer climatic conditions during late summer and fall cause water levels in the alluvial aquifer and bedrock formations to decline, and this reach of Grassy Creek may lose flow during this time.

Streams in the eastern area differ from other streams in the study area. The eastern area is drained by four main streams—Fish Creek, Foidel Creek, Middle Creek, and Trout Creek—that converge south of Milner. Fish Creek, the northernmost stream, drains Dunckley Park, flows across structural trends in Fish Creek Canyon, and drains much of Twentymile Park. Fish Creek head-waters are above 10,000 ft on the northern side of the Dunckley Flat Tops. Mean annual flow at the gage in Fish Creek Canyon is about 13 ft^3/s. Partial records from four downstream gages indicate that Fish Creek is perennial, although base flow decreases downstream. Foidel Creek begins near Eckman Park at an altitude of about 7,600 ft and is the only creek in the eastern stream system that originates in the study area. The relatively small drainage area of Foidel Creek includes the southern part of Twentymile Park. Mean annual flow is 2.7 ft^3/s near

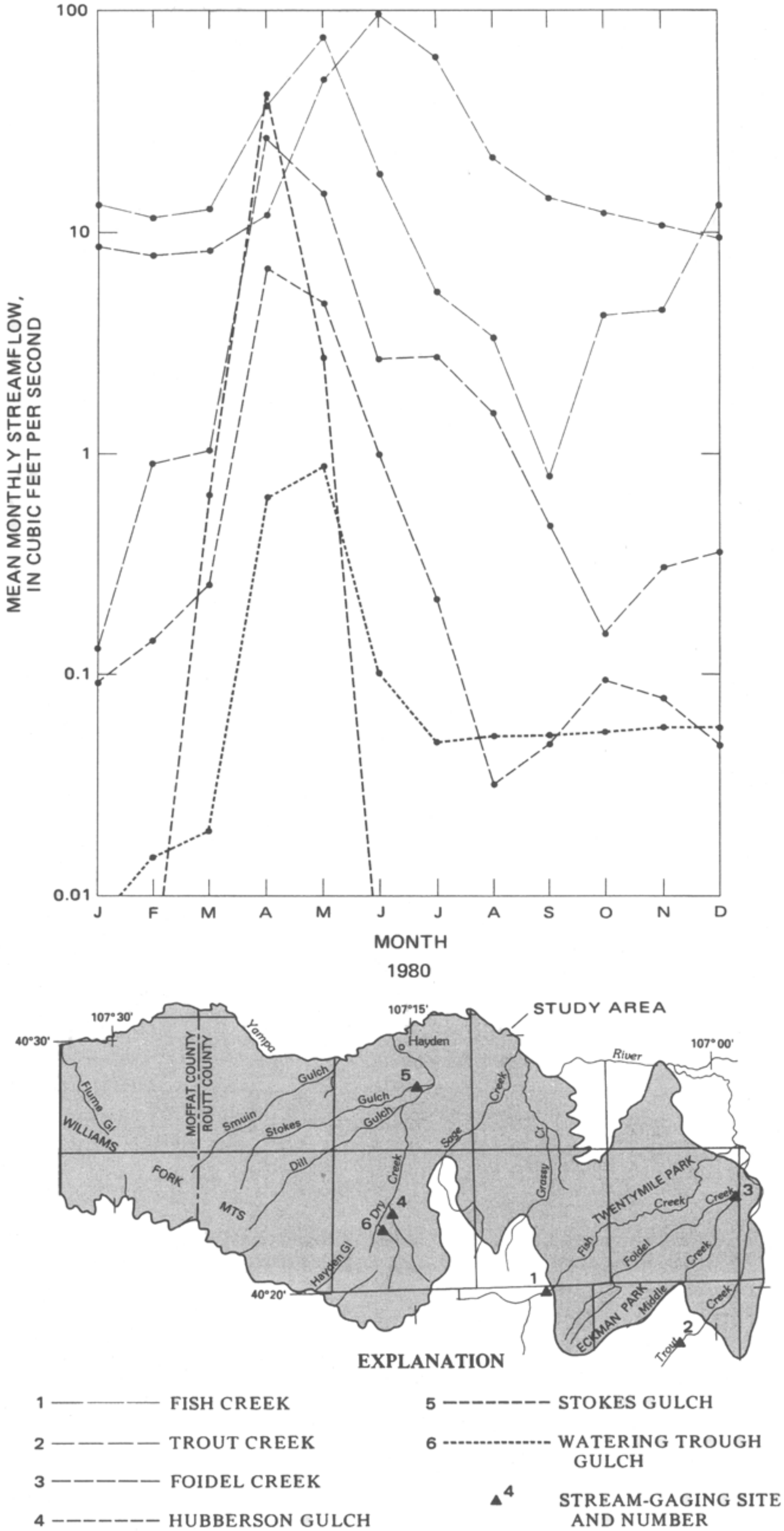

Figure 21.--Hydrographs of representative streams in the study area.

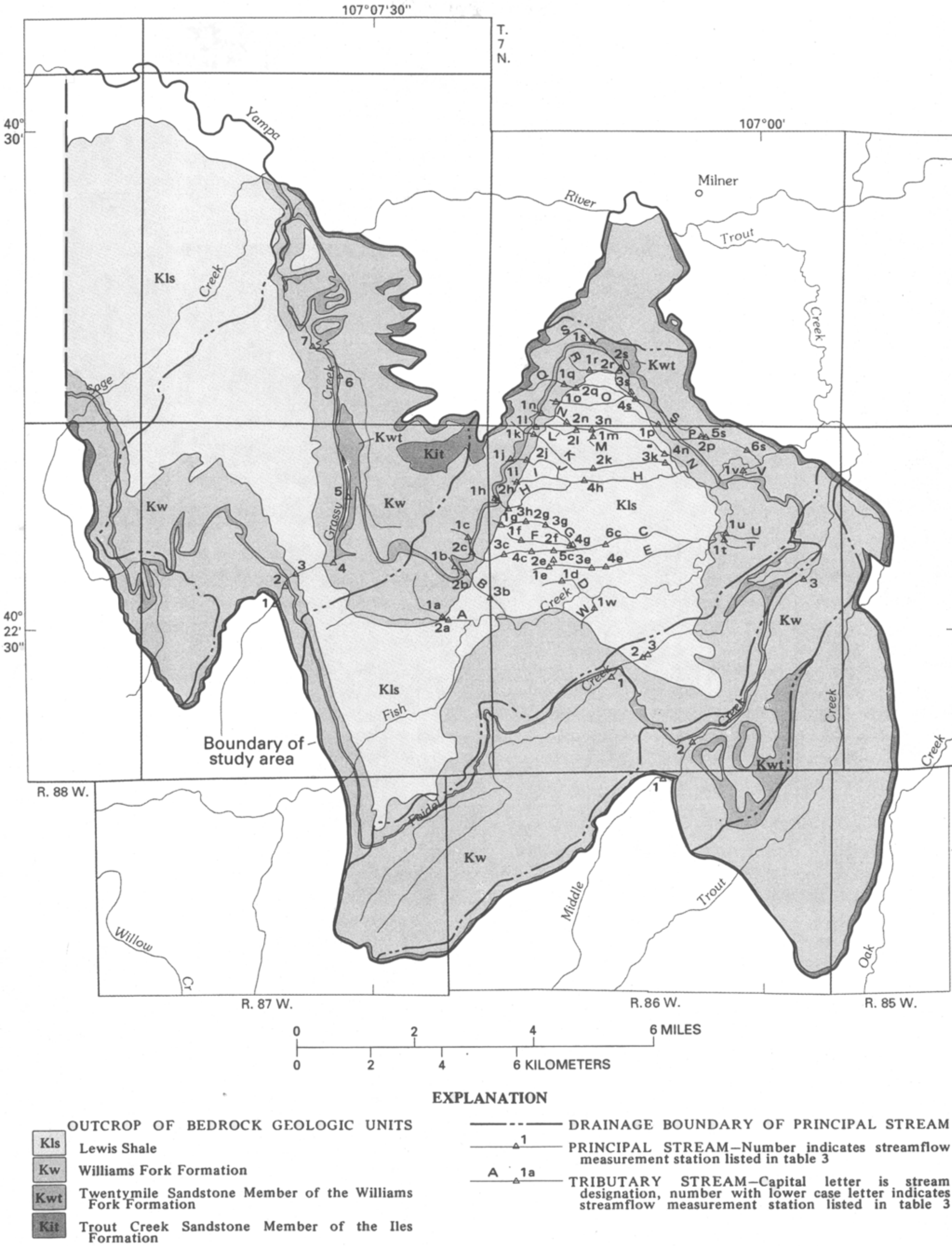

Figure 22.--Surface-water drainages and outcrops of bedrock geologic units in the eastern part of the study area.

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*

[µS/cm, microsiemens per centimeter; ˚C, degrees Celsius; ft^3/s, cubic feet per second; CP, current-meter measurement of poor quality; F, 3-inch cutthroat flume; CG, current-meter measurement of good quality; V, timed volume measurement; --, no data; NA, not applicable]

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Grassy Creek				
1	06-25-86	CP	--	--	1.4	NA	
2	|	CP	--	--	1.4	0.0	
3	|	CP	--	--	1.4	0.0	
7	|	CP	--	--	4.4	+3.0	
1	07-22-86	F	950	12.5	0.42	NA	Above outcrop of Trout Creek Sandstone Member of Iles Formation.
3	|	F	950	12.5	0.54	+0.12	Below outcrop of Twentymile Sandstone Member of Williams Fork Formation.
4	|	F	--	--	0.55	+0.01	
5	|	F	900	15.0	0.66	+0.11	
6	|	F	850	18.5	0.64	-0.02	
1	09-15-86	F	1,000	13.0	0.25	NA	
3	|	F	950	10.0	0.30	+0.05	
4	|	F	1,000	12.5	0.24	-0.06	
5	|	F	900	14.5	0.22	-0.02	
6	|	F	850	17.5	0.25	+0.03	
1	|	F	1,000	14.5	0.24	NA	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
				Foidel Creek			
1	06-26-86	CP	--	--	5	NA	
2	|	CG	--	--	4.85	NA	Change in flow not measurable
1	09-17-86	F	2,600	16.0	0.63	NA	
3	|	F	2,600	15.5	0.71	+0.08	
				Middle Creek			
1	09-17-86	F	650	13.5	0.52	NA	Above Trout Creek Sandstone Member outcrop.
2	|	R	800	16.5	0.52	0.0	Below Trout Creek Sandstone Member outcrop.
3	|	F	850	16.0	0.54	+0.02	Below Twentymile Sandstone Member outcrop.
				Fish Creek unnamed tributaries–A and B			
(A) 1a	08-14-86	NA	--	--	Seep	NA	
2a	|	V	1,600	18.5	0.064	0.064	
1a	09-15-86	NA	--	--	Seep	NA	
2a	|	V	--	--	0.062	0.062	
(B) 1b	07-23-86	V	--	--	0.004	NA	Above Twentymile Sandstone Member outcrop.
2b	|	V	1,000	18.0	0.015	+ 0.011	Below Twentymile Sandstone Member outcrop.
3b	|	NA	--	--	0.0	- 0.015	Stock pond intercepts flow.

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

<u>Fish Creek unnamed tributaries—A and B</u> —Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
(B) 1b	09-18-86	NA	--	--	Seep	NA	
2b	|	V	--	--	0.005	+ 0.005	
3b	|	NA	--	--	0.0	- 0.005	

<u>Fish Creek unnamed tributaries—C, D, and E</u>

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
(C) 1c	07-22-86	F	2,220	18.0	--	NA	Flume affected by submergence.
2c	|	F	2,200	15.0	0.10	NA	In Twentymile Sandstone Member outcrop.
3c	|	F	2,200	19.0	0.11	+0.01	Below Twentymile Member Sandstone
4c	07-21-86	F	--	--	0.11	0.0	
5c	|	F	--	--	0.14	+0.03	
6c	|	F	--	--	0.12	- 0.02	
3c	08-13-86	F	2,400	21.0	0.08	NA	
1c	09-17-86	F	2,200	14.0	0.06	NA	
2c	|	F	2,400	12.0	0.06	0.0	
3c	|	F	2,400	14.5	0.06	0.0	
4c	|	F	2,400	14.0	0.06	0.0	
5c	|	F	2,400	16.0	0.05	- 0.01	
6c	|	F	2,800	13.0	0.04	- 0.01	
(D) 1d	07-23-86	V	3,000	25.0	0.004	NA	
1d	08-14-86	NA	--	--	0.0	NA	
1d	09-17-86	NA	--	--	0.0	NA	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Fish Creek unnamed tributaries—C, D, and E—Continued				
(E) le	07-21-86	NA	--	--	0.0	NA	
2e	|	V	900	16.0	0.006	NA	Discharge from flowing well tributary to creek E.
3e	07-23-86	V	8,000	27.5	0.010	+0.004	
4e	07-21-86	NA	--	--	Seep	-0.004	
le	09-17-86	NA	--	--	0.0	NA	
2e	|	V	1,000	15.5	0.006	NA	Discharge from flowing well tributary to creek E.
3e	|	NA	--	--	0.0	-0.006	
4e	|	NA	--	--	0.0	NA	
			Fish Creek unnamed tributaries—F, G, H, and I				
(F) 1f	07-22-86	NA	--	--	0.0	NA	
2f	07-21-86	NA	--	--	0.0	NA	
1f	09-17-86	NA	--	--	0.0	NA	
(G) 2g	07-22-86	NA	--	--	0.0	NA	
3g	|	NA	--	--	0.0	NA	
4g	07-21-86	NA	--	- -	0.0	NA	
lg	09-17-86	V	1,000	10.0	0.002	NA	Above stock pond.
2g	|	NA	--	--	0.0	- 0.002	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Fish Creek unnamed tributaries—F, G, H, and I — Continued				
(H) 3h	07-22-86	V	--	--	0.038	NA	Below Twentymile Sandstone Member outcrop.
4h	│	F	950	24.0	0.06	+0.02	
3h	08-14-86	V	1,500	21.0	0.011	NA	
4h	08-13-86	F	850	23.0	0.04	+0.03	
1h	09-17-86	V	850	8.0	0.010	NA	Above Twentymile Sandstone Member outcrop.
2h	│	V	2,400	10.0	0.004	NA	Spring discharging from Twentymile Sandstone Member.
3h	│	V	1,500	7.0	0.021	+0.011	Below Twentymile Sandstone Member outcrop.
4h	09-16-86	V	1,000	20.0	0.010	- 0.011	
(I) 1i	07-22-86	NA	--	--	0.0	NA	
			Fish Creek unnamed tributaries—J,K, L, and M				
(J) 1j	07-22-86	NA	--	--	0.0	NA	Above Twentymile Sandstone Member outcrop.
2j	│	V	750	17.0	0.045	0.045	Below Twentymile Sandstone Member outcrop
2j	08-14-86	V	750	16.5	0.015	NA	
lj	09-17-86	NA	--	--	0.0	NA	
2j	│	V	720	7.0	0.010	+0.010	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Fish Creek unnamed tributaries—J, K, L, and M—Continued				
(K) 2k	07-22-86	NA	--	--	Seep	NA	
3k	|	NA	--	--	0.0	NA	
2k	08-13-86	NA	--	--	0.0	NA	
1k	09-17-86	NA	--	--	0.0	NA	Below Twentymile Sandstone Member outcrop.
2k	09-16-861	NA	--	--	0.0	NA	
3k	|	NA	--	--	0.0	NA	
(L) 2l	07-22-86	V	--	--	0.008	NA	
2l	08-13-86	V	--	--	0.003	NA	
2l	09-16-86	NA	--	--	Seep	NA	
1l	09-17-86	NA	--	--	0.0	NA	
(M)1m	07-22-86	V	500	27.0	0.018	NA	
1m	08-13-86	V	440	23.0	0.004	NA	
1m	09-16-86	V	450	18.0	0.004	NA	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			<u>Fish Creek unnamed tributaries—N, 0, P, Q, and R</u>				
(N) 2n	07-22-86	NA	--	--	Seep	NA	
3n	|	V	1,700	24.0	0.004	NA	Below stock pond.
4n	|	NA	--	--	0.0	- 0.004	Unmeasured tributary inflow occurs between stations 3n and 4n.
2n	8-13-86	NA	--	--	0.0	NA	
3n	|	NA	--	--	0.0	NA	
2n	09-16-86	NA	--	--	0.0	NA	
3n	|	NA	--	--	0.0	NA	
4n	|	NA	--	--	0.0	NA	
1n	09-17-86	NA	--	--	0.0	NA	
(0) lo	09-17-86	NA	--	--	0.0	NA	
(P) lp	08-13-86	NA	--	--	0.0	NA	
2p	|	NA	--	--	0.0	NA	
2p	09-16-86	NA	--	--	0.0	NA	
(Q 1q	08-14-86	NA	--	--	--	NA	Stock pond discharge is by seepage.
2q	|	V	600	18.0	0.024	NA	Thunderstorm evening of 8-13-86.
2q	09-16-86	V	700	15.0	0.010	NA	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Fish Creek unnamed tributaries—N, 0, P, Q, and R—Continued				
(R) 1r	09-l6-86	NA	--	--	0.0	NA	
2r	|	NA	--	--	0.0	NA	Springs discharge at R-S confluence .
			Fish Creek unnamed tributaries—S, T, U, V, and W				
(S) Is	08-14-86	NA	--	--	Seep	NA	Thunderstorm evening of 8-13-86.
3s	|	F	650	23.0	0.20	+0.20	Thunderstorm evening of 8-13-86.
4s	|	F	--	--	0.21	0.01	Tributary inflow occurs above station.
4s	08-13-86	F	580	21.0	0.06	NA	Prior to thunderstorm.
5s	08-12-86	F	660	15.0	0.08	+0.02	
6s	08-13-86	F	750	17.0	0.08	0.0	
1s	09-16-86	NA	--	--	0.0	NA	Beaver ponds between stations 1S and 2S.
2s	|	V	750	12.0	0.021	0.021	Above springs at R-S confluence.
3s	|	F	650	14.0	0.04	0.02	
4s	|	F	650	12.0	0.05	+0.01	Tributary inflow occurs above station.
5s	|	F	650	17.0	0.03	- 0.02	
6s	|	F	850	17.0	0.04	+0.01	

Table 3.--*Hydrologic data from gain-loss measurements in streams near Twentymile Park*—Continued

Station (fig. 22)	Date	Flow-measuring device	Specific conductance (MS/cm)	Temperature (˚C)	Flow (ft^3/s)	Change in flow (ft^3/s)	Remarks
			Fish Creek unnamed tributaries—S , T, U, V, and W—Continued				
(T) 1t	08-12-86	NA	--	--	0.0	NA	
1t	09-18-86	NA	--	--	0.0	NA	
(U) lu	08-12-86	V	--	--	0.006	NA	
1u	09-18-86	NA	--	--	0.0	NA	
(V) 1v	08-12-86	V	700	19.0	0.001	NA	
1v	09-18-86	NA	--	Seep		NA	
(W)1w	08-14-86	V	1,450	19.5	0.003	NA	
1w	09-18-86	V	1,600	10.0	0.005	NA	

the mouth of Foidel Creek. Base flow increases in the downstream reaches where the creek is perennial except during unusually dry years. An increase in streamflow of 0.08 ft^3/s was measured across the outcrop of Twentymile Sandstone Member (fig. 22, stations 1 and 3) on September 17, 1986 (table 3). Middle Creek flows into Foidel Creek in the eastern part of Twentymile Park. Middle Creek is similar to Foidel Creek but drains a larger area; its headwaters are above 8,400 ft in altitude. Runoff from Middle Creek peaks in the late spring and early summer. Mean annual flow is 4.4 ft^3/s near the mouth of Middle Creek. Streamflow measurements in Middle Creek on September 17, 1986, indicate minimal change in flow in a 5-mi reach of the creek between the outcrop of the Trout Creek Sandstone Member (station 1) and the downstream outcrop of the Twentymile Sandstone Member (fig. 22, station 3). Trout Creek is the largest stream draining the study area. From its headwaters at an altitude of 11,000 ft, it has a perennial base flow of 10 to 20 ft^3/s to its confluence with the Yampa River near Milner. Only the extreme southeastern part of the study area is drained by Trout Creek. Fish Creek and Middle Creek are confluent with Trout Creek near the eastern margin of the study area.

Streamflow gain-loss measurements made in numerous unnamed tributaries to Fish Creek (fig. 22) indicate that perennial flow occurs in some reaches of these streams. Most perennial flow is the result of ground-water discharge from the upstream outcrops of thick sandstone beds near the margins of the basin. Along the mountain front northwest of Twentymile Park water levels in the sandstones generally are above stream level. This is the result of recharge in the higher outcrops on either side of the stream valley. The resulting base flow may extend downstream beyond the mountain front on to the relatively impermeable strata of the Lewis Shale in Twentymile Park. In some streams, base flow may become tributary to Fish Creek, but, more commonly, the flow is lost to evapotranspiration along the channel or is captured in stock ponds. Most reaches of the tributary streams north of Fish Creek are ephemeral. In mid to late summer, the channels are dry or consist of alkali-encrusted desiccated mud or marsh. Although hydrostatic heads in the underlying bedrock aquifers may be 200 to 300 ft above land surface in parts of Twentymile Park, discharge from the aquifers to streamflow is not apparent except at a few uncontrolled flowing wells. Shale in the middle member of the Williams Fork Formation and in the Lewis Shale seems to form an effective confining layer that limits ground-water discharge to streamflow in Twentymile Park.

Springs are present throughout the study area and are an important source of surface water during low-flow periods. Discharge from most springs is diffuse and flows at a low rate. Springs are more prevalent in the western part of the study area, where they provide small quantities of water to intermittent streams in gulches.

Water Quality

Water quality in streams that drain the study area is affected markedly by the geologic materials within the drainage area. Surface-water flow and water-quality data have been collected at 21 sites in or near the study area (Maura, 1982, 1985; Turk and Parker, 1982). Eighteen of these sites (fig. 23; table 4) are on streams that drain stratagraphic intervals of (1) the lower Iles

Formation and the Williams Fork Formation, and (3) the Lewis Shale. Data from sites 1, 2, and 3 (table 4) represent runoff from geologic materials older than the Trout Creek Sandstone Member. These rocks generally are located at higher altitudes and outside of the study area. Water in streams that drain these geologic materials is a calcium bicarbonate type that generally has dissolved-solids concentrations ranging from 100 to 400 mg/L. This surface water is of better chemical quality than any other in the study area.

Data from sites 4 through 13 primarily represent runoff from the Trout Creek Sandstone Member and from the Williams Fork Formation. Rocks in this interval were deposited under a combination of marine, deltaic, and continental conditions. As a result, runoff is of a dissimilar chemical composition; generally, the water is either calcium magnesium bicarbonate or calcium magnesium sulfate. Three of the 10 sites in this group (sites 11, 12, and 13) are located downstream from large strip mines, and water quality may be affected by mine drainage. Dissolved-solids concentrations commonly range from 300 to 800 mg/L in streams unaffected by mining activities. At sites 11, 12, and 13, dissolved-solids concentration commonly range from 300 to 3,000 mg/L.

Streams that primarily drain the Lewis Shale or the shale units in the upper member of the Williams Fork Formation were sampled at sites 14 through 18. The marine sediments in these rock units markedly affect the surface-water chemistry. The streams in this group generally have a magnesium sodium sulfate water composition and dissolved-solids concentrations that commonly range from about 1,000 to about 8,000 mg/L.

GROUND-WATER HYDROLOGY

Lohman (1972) defines an aquifer as "...a formation...that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs." "...Significant quantities of water..." in one region for one application may be insignificant in other regions or for other applications. The water-yielding units that are classified as aquifers in this study generally produce such small sustained yields (about 0–10 gal/min) that they would not be considered aquifers for many water-supply applications. However, these water-yielding units are the principal source of water in the local bedrock formations; they cause inflow to mines, and they supply usable volumes of water to the few stock or domestic wells in the area. Therefore, in this report, these water-yielding units are classified as aquifers.

Depositional Environments

Coal and associated deposits of the Iles and Williams Fork Formations developed in marine and deltaic plain environments located close to the shoreline (Weimer, 1976). Marine deposits of mudstone and shale generally are thick and homogeneous. These deposits have low permeability and are classified as regional confining beds. Near-shore marine deposits grade upward into massive transitional sandstones. These extensive sandstones