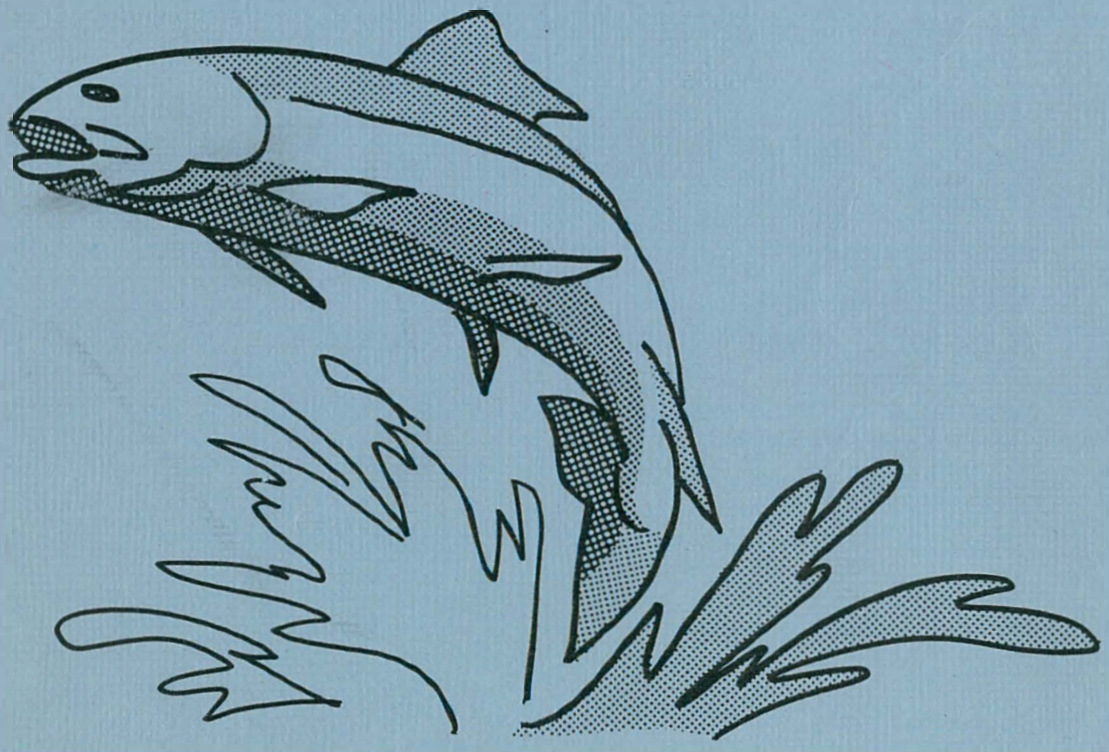
Preliminary Ground Water Investigations of Division of Wildlife Fish Hatcheries

Prepared for Colorado Division of Wildlife

by

Candace L. Jochim and Will Wright



Colorado Geological Survey

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INTRODUCTION

This study was conducted by the Colorado Geological Survey for the Colorado Division of Wildlife. The objective was to identify potential ground water sources at twelve of the Division's fish-rearing units. In addition, an estimate of the expected depth to water, potential yield, and water quality is given.

The data gathered, compiled, and interpreted for the study has been largely limited to existing information. The principal sources of this information were: 1) the registered well permits and records on file at the Division of Water Resources, 2) the geologic literature; primarily maps and open file reports, 3) prior studies conducted by this office, 4) water quality information from the computerized Storet data base maintained by the Denver Region EPA, and 5) a very brief field reconnaissance of the twelve sites. This information was integrated and interpreted to produce the recommendations given for each unit. The geology as interpreted from the literature was compared with driller's logs from the registered well records. This process required discretion due to the lack of geological knowledge and non-standard terminology of most drillers. However, even with these limitations, we believe that a useful approximation of subsurface conditions at each hatchery location is described in the report. Recognizing that some of the compiled data is incomplete or inaccurate, we wish to underscore the point that this report can only be an approximation of hydrogeological conditions at the respective units.

It should be emphasized that geology is fundamentally a field science, and very little site-specific field work has been conducted as yet. The logical next step for many of these locations would be the initiation of more detailed field geologic mapping. In addition to mapping, other techniques could be employed to increase the probability of success of any planned expansion activities. These techniques would include reconnaissance by remote sensing techniques such as color infra-red photography for the identification of seeps and springs, and air photo interpretation for structural and geomorphological assessment. In addition, some sites are prime candidates for geophysical investigations. Geophysics can often assist in identifying aquifer properties, especially saturated thickness. Even though detailed studies in advance of drilling would involve the expenditure of additional money, they can be very cost effective. Such exploration can result in fewer unsuccessful wells, lower development cost, and more productive wells.

BELLVUE AND WATSON FISH HATCHERIES

SUMMARY OF FINDINGS

Potential Aquifers

1. Fountain Fm.
2. Lykins Fm.
3. Satanka Fm.
4. Jelm Fm.
5. Ingleside Fm.
6. Bellvue fault

Depth to water

1. Fountain; 10-20 ft
2. Lykins; 30-50 ft
3. Satanka; 10-30 ft
4. Jelm; 35-40 ft
5. Ingleside; 25-45 ft
6. Fault; unknown

Potential Yields

1. Fountain; 1-20 gpm
2. Lykins; 10-500 gpm
3. Satanka; 10-50 gpm
4. Jelm; 400 gpm
5. Ingleside; 10-15 gpm
6. Fault; unknown

Water Quality

The computerized search of existing data revealed three sample locations from this area. The quality of this water appears to be good. In addition to this information, U.S. Geological Survey Water Supply Paper 1669-X contains a plate with Stiff diagrams plotted for the area. These diagrams represent the concentrations of major dissolved species, and they too indicate that the subsurface water in the area would pose no problem to hatchery use.

RECOMMENDATIONS

The Bellvue Fish Hatchery is located on the Lykins Fm., which does not usually produce large quantities of water. The presence of relatively good wells in the formation can be explained by the geologic structure.

The driller's logs indicate the three most productive wells in the Lykins penetrate into a brownish-gray sandstone. This is probably the Lyons Fm. which does not usually produce water.

It is our interpretation that the Lyons is acting an an impermeable bedrock upon which water is perching.

Normally, the Lykins Fm. which rests upon the Lyons contains a lot of shale and is not a good producing formation. However, we suspect that as a result of the intense folding and faulting that has occurred in the area (as evidenced by the hogback) good fracture porosity has been created in the formation.

The Lykins receives recharge from the creek crossing its outcrop south of the hatchery and from precipitation.

It may be possible to drill more wells along the contact area between the Lyons and the Lykins formations. However, the wells should not be located too close together. Too many wells may exceed the recharge capacity of the area.

Another and perhaps better source of water is the Jelm Fm. which is a sandstone known for producing good quantities of water. Well no. 19, located in the Jelm, shows good yields (see Table 1). The Jelm appears to cross the east edge of the hatchery property. The Watson Hatchery might also be able to locate a well in the Jelm Fm.

A third possibility is the Bellvue Fault which forms the east boundary of the Jelm Fm. and in fact may be responsible for most of the recharge in the Jelm. The fault zone crosses the alluvial valley of the Cache La Poudre River which is probably the fault's main source of recharge. The fault zone is located approximately one eighth mile east of the hatchery.

The Watson Fish Hatchery is located on the Fountain Fm., which usually produces small quantities of water. The river alluvium atop the Fountain Fm. does not appear to be very thick in this area and would not provide much water.

The most likely source of additional water for this hatchery would be the Bellvue Fault which crosses the river valley to the north (see geologic map). Fault zones frequently produce water of good quality if they have adequate sources of recharge. In this case, the fault zone crosses the alluvial valley of the Cache La Poudre River which should provide a very good and constant source of recharge.

Before attempting to locate a well in the fault zone, the fault should be very carefully mapped since fault zones are usually not very wide, although they are deep.

GENERAL GEOLOGY

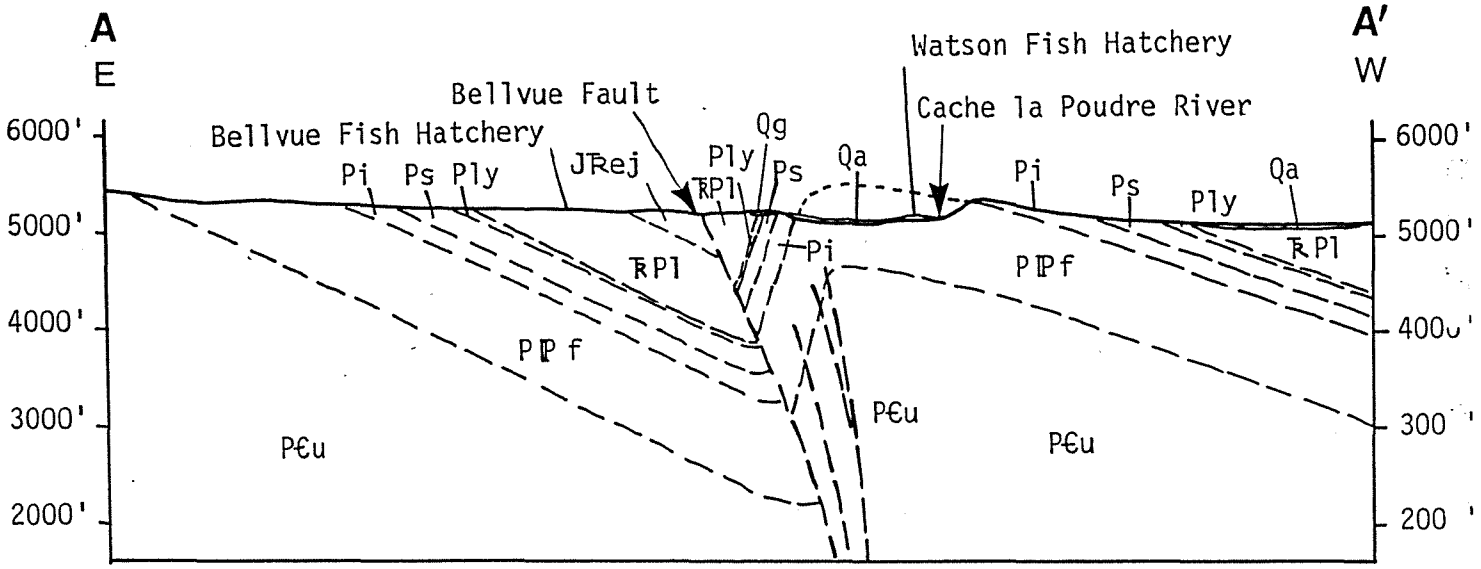
The Bellvue and Watson fish hatcheries are located in the hogback area west of Fort Collins near the communities of LaPorte and Bellvue.

The formations in the hogback are sedimentary and have been highly faulted and folded (see cross section).

The Watson hatchery is situated on an alluvial deposit resting directly on eroded Fountain Formation. The Fountain at this point was folded and then eroded away so the beds to the east dip east at about 20 degrees while the beds on the west side of the river have been overturned and dip west at about 85 degrees. The Fountain Fm. is overlain by the Ingleside Fm. which has been eroded away over the river bed area.

The Bellvue Fault runs between the Bellvue and Watson fish hatcheries (see surface geology map).

The Bellvue Fish Hatchery is situated on alluvium resting directly on eroded Lykins Fm. and partially on the Jelm Fm. Beds of the Lyons and Satanka formations crop out to the west of the hatchery.



EXPLANATION

Qa	alluvium
Qg	gravels
JRej	Entrada and Jelm Fms.
RPl	Lykins Fm..
Ply	Lyons Sandstone
Ps	Satanka Fm.
Pi	Ingleside Fm.
PPf	Fountain Fm.
P€u	Precambrian undifferentiated

Figure 1. General geologic cross-section, Bellvue and Watson Hatcheries; from U.S.G.S. Laporte Open File Report.

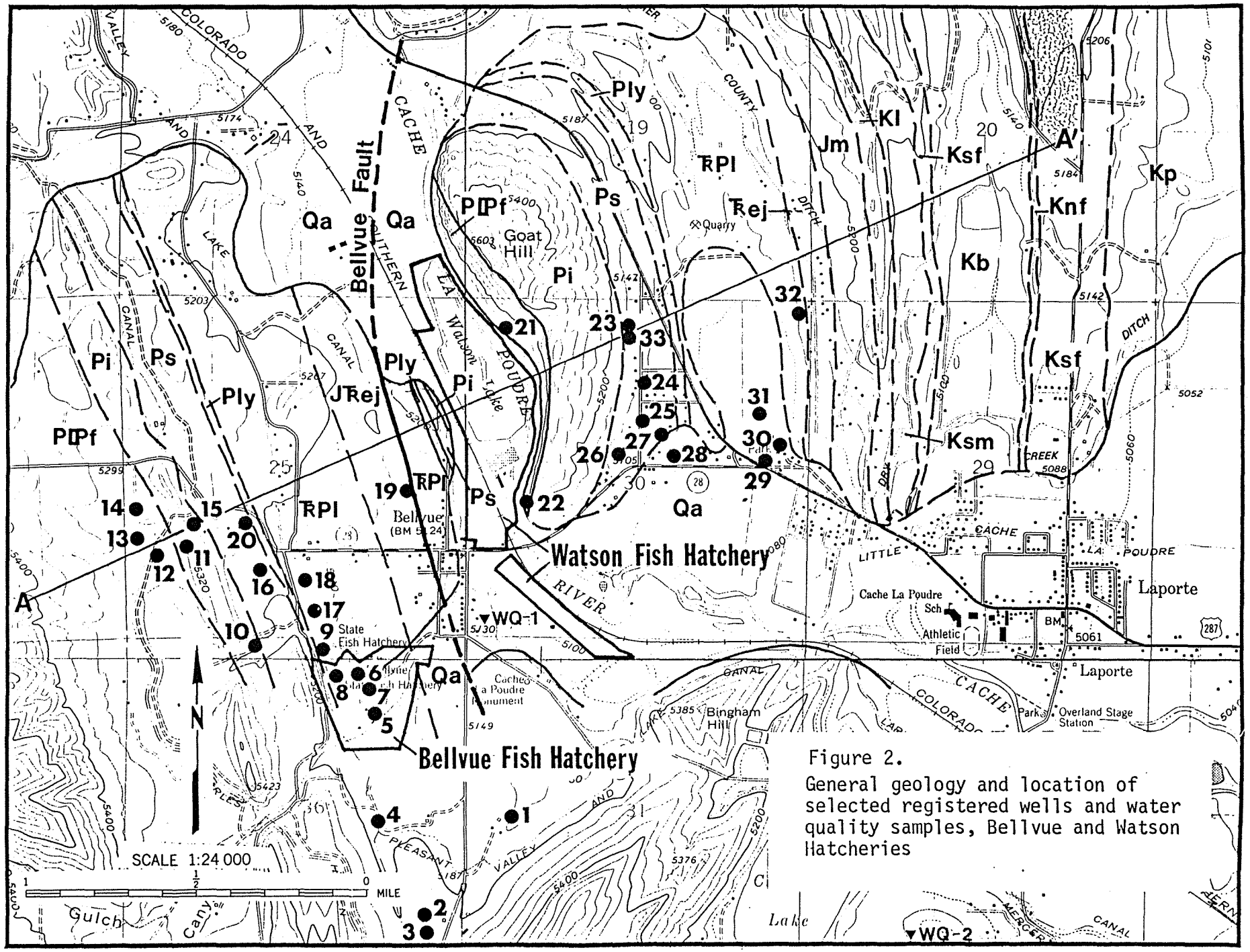


Figure 2.
General geology and location of selected registered wells and water quality samples, Bellvue and Watson Hatcheries

Table 1

BELLVUE AND WATSON FISH HATCHERIES

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	1-35-017204	69W	8N	31	NWSW		12	43	25-43	5	? Morrison
2	1-35-077381	70W	8N	36	SESE		15	65	30-65	20	Lykins ?
3	1-35-024775	70W	8N	36	SESE		50	82	59-82	27	Satanka ?
4	1-35-054144	70W	8N	36	NWSE		10	125	———	30	Satanka
5	1-35-032274	70W	8N	36	NWNE		20	100	50-100	10	Lykins
6	1-35-005116F	70W	8N	36	NWNE		300	150	48-148	6	Lykins
7	1-35-010583F	70W	8N	36	NWNE		500	150	70-150	6	Lykins
8	1-35-024771	70W	8N	36	NWNE		200	150	50-150	6	Lykins
9	1-35-044224	70W	8N	36	NWNE		50	140	70-140	20	Lykins
10	1-35-055005	70W	8N	36	NWNW		15	65	25-65	20	Ingleside
11	1-35-006153	70W	8N	25	SWSW		10	60	43-60	34	Ingleside
12	1-35-012809	70W	8N	25	NWSW		2	100	9-18	11	Fountain
13	1-35-030963	70W	8N	25	NWSW		20	43	———	19	Fountain
14	1-35-031529	70W	8N	25	NWSW		1	140	———	54	Fountain
15	1-35-046360	70W	8N	25	NWSW		9	127	———	6	Ingleside
16	1-35-039585	70W	8N	25	SESW		60	123	———	25	Satanka
17	1-35-010994	70W	8N	25	SWSE		15	42	23-41	27	Lykins
18	1-35-011821	70W	8N	25	SWSE		10	52	34-52	16	Lykins
19	1-35-013591R	70W	8N	25	NESE		400	45	35-40	15	Jelm
20	1-35-039415	70W	8N	25	NESW		30	117	67-117	40	Satanka
21	1-35-038725	69W	8N	30	NWNW		15	35	———	10	Fountain
22	1-35-014240	69W	8N	30	NWSW		5	50	———	22	Fountain
23	1-35-013083	69W	8N	30	NENW		7	72	27-36	19	Satanka
24	1-35-070127	69W	8N	30	SWNE		10	75	———	30	Satanka
25	1-35-105595	69W	8N	30	SWNE		25	30	10-30	10	Satanka
26	1-35-009740	69W	8N	30	SENW		15	50	———	15	Satanka
27	1-35-001764	69W	8N	30	SWNE		10	44	24-44	16	Satanka
28	1-35-021215	69W	8N	30	SWNE		10	24	———	6	Satanka
29	1-35-006924	69W	8N	30	SENE		20	90	50-90	6	Lykins
30	1-35-004874	69W	8N	30	SENE		13	54	———	8	Lykins
31	1-35-075476	69W	8N	30	SENE		15	40	———	22	Lykins
32	1-35-080001	69W	8N	30	NENE		8	80	20-80	10	Lykins
33	1-35-000947	69W	8N	30	NENW		2	70	———	—	Satanka

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
1-35-017204

(FT)	
0-13	Soil or sandy clay
13-43	Shale ?
43-?	Blue shale

(2)
1-35-077381

(FT)	
0-4	Loose dirt
4-65	Red sandstone

(3)
1-35-024775

(FT)	
0-9	Topsoil
9-11	Boulders
11-25	Clay
25-28	Sandstone
28-32	Clay
32-40	Clay, sandstone
40-75	Sandstone
75-82	Brown sandstone
82-100	Sandstone

(4)
1-35-054144

(FT)	
0-8	Dirt
8-55	White sandstone
55-125	Red sandstone

(5)
1-35-032274

(FT)	
0-5	Clay & sandstone
5-85	Shale
85-100	Sandstone

(6)
1-35-005116F

(FT)	
0-8	Clay
8-85	Red shale
85-90	Gray shale
90-151	Brownish-gray sandstone

(7)
1-35-010583F

(FT)	
0-8	Clay
8-85	Red shale
85-90	Gray shale
90-151	Brownish-gray sandstone

(8)
1-35-024771

(FT)	
0-8	Clay
8-85	Red shale
85-90	Gray shale
90-151	Brownish-gray sandstone

(9)
1-35-044224

(FT)	
0-5	Clay & sandstone
5-90	Shale
90-100	Sandstone
100-130	Fine grained quartzitic sand
130-140	Red to tan sandstone

(10)
1-35-055005

(FT)	
0-14	Dirt
14-65	Red sandstone

(11)
1-35-006153

(FT)	
0-3	Topsoil
3-14	Red sandstone
14-60	Hard sandstone/into shale

(12)
1-35-012809

(FT)	
0-6	Soil
6-14	Red rock
14-16	Sandstone
16-100	Red rock

(13)
1-35-030963

(FT)	
0-1	Soil
1-43	Red rock

(14)
1-35-031529

(FT)	
0-6	Soil
6-140	Red rock

(15)
1-35-046360

(FT)	
0-3	Soil
3-107	Red sand rock
107-127	Red clay & sandrock

(16)
1-35-039585

(FT)	
0-1	Topsoil
1-5	Clay
5-78	Sandrock
78-123	Red sand rock

(17)
1-35-010994

(FT)	
0-3	Red shale
3-41	Red rock

(18)
1-35-011821

(FT)	
0-52	Broken red rock

(19)
1-35-013591R

(FT)
No lithology recorded

(20)
1-35-039415

(FT)	
0-20	Brown sand rock
20-26	Blue clay & sand
26-69	Red sand rock & clay
69-117	Red sand rock

(21)
1-35-038725

(FT)	
0-1	Soil
1-35	Red rock

(22)
1-35-014240

(FT)	
0-9	Soil & broken rock
9-50	Red rocks

(23)
1-35-013083

(FT)	
0-4	Topsoil
4-67	Red sandstone

(24)
1-35-070127

(FT)	
0-4	Topsoil
4-30	Hard red sandstone
30-75	Hard red sandstone with soft streaks

(25)
1-35-105595
(FT)

0-2	Topsoil
2-30	Red sandstone

(26)
1-35-009740
(FT)

0-1	Soil
1-50	Red rock

(27)
1-35-001764
(FT)

0-44	Red sand & sandstone

(28)
1-35-021215
(FT)

0-4	Soil
4-24	Red rock

(29)
1-35-006924
(FT)

0-12	Chunk rock & clay
12-27	Slate
27-34	Yellow sandstone
34-60	Gray sandstone
60-90	Red stone

(30)
1-35-004874
(FT)

0-4	Soil
4-54	Red rock

(31)
1-35-075476
(FT)

0-6	? Red ?
6-40	Red sandstone

(32)
1-35-080001
(FT)

0-18	Red shale
18-80	Red sandstone

(33)
1-35-000947
(FT)

0-1	Broken red rock
1-70	Red rock

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_____LaPorte Quadrangle, 1962, Colorado - Larimer Co. 7.5 minute series, (topographic), scale 1:24,000.

CHALK CLIFF FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Stream alluvium and outwash gravels

Depth to Water

1. Alluvium; 35-40 feet

   With the exception of one registered well no data are available for the site - well records were incomplete.

Potential Yields

1. Alluvium; 10-30 gpm

   In the area surrounding the site there are only a few registered wells. The yields from this limited sampling are moderate - 10 to 30 gpm. However, this may be a consequence of usage and/or allocation, as opposed to geologic favorability.

Water Quality

The chemical analyses for this area show waters of very good quality. Their use should present no problems for the Chalk Cliff Hatchery.

RECOMMENDATIONS

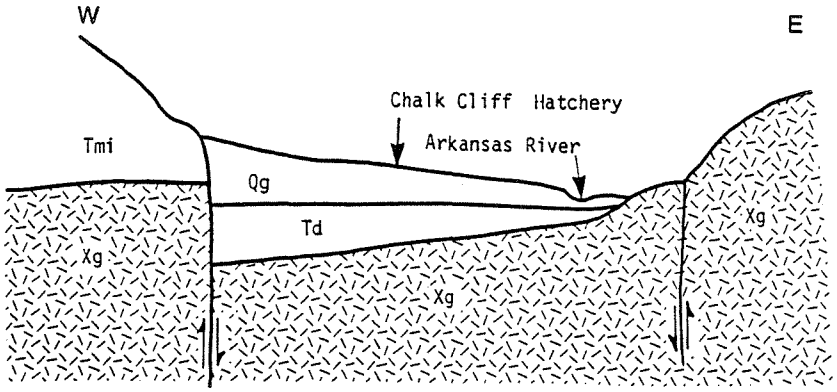
The lithologic control available for this hatchery was rather limited. However, based on a preliminary field reconnaissance of the area, the alluvial/glacial outwash material under and around the site appears to be quite thick. Even though the flow from Chalk Creek is greatly reduced during the winter and early spring, the creek may be losing enough water to the alluvial material during periods of higher flow to form a substantial "reservoir" of ground water beneath the hatchery site. This potential supply of water may be enough to make a significant contribution to the hatchery

requirements during the leaner winter months. Because of the paucity of existing data, this is more of a subjective interpretation rather than a statement of fact. In view of this, a small diameter test hole should be installed at the driest time of the year in order to get a quantitative figure for the true amount of water available.

Another possibility for obtaining more water at this hatchery is to procure the return flows of hot springs water from the Mt. Princeton Resort and the greenhouse facilities west of the hatchery. Currently this water is being returned to the creek after usage. If the return flow was diverted to the hatchery, it could flow under gravity to the facility. Undoubtedly it would require cooling, but the ambient temperatures during the winter months should facilitate this.

GENERAL GEOLOGY

The hatchery at Chalk Cliff rests on a deposit of relatively young stream, terrace, and outwash gravels. Beneath the gravels is the Dry Union Formation, a thick sequence of siltstones, sandstones and conglomerates deposited as colluvial and alluvial fill into the Upper Arkansas Graben from the surrounding highlands during the Miocene and Pliocene. Basement rock in the area consists of Precambrian metamorphics.



EXPLANATION

Qg	Gravels
Td	Dry Union Fm.
Tmi	Intrusives (middle Tertiary)
Xg	Granite

Figure 3. General geologic cross-section, Chalk Cliff Hatchery

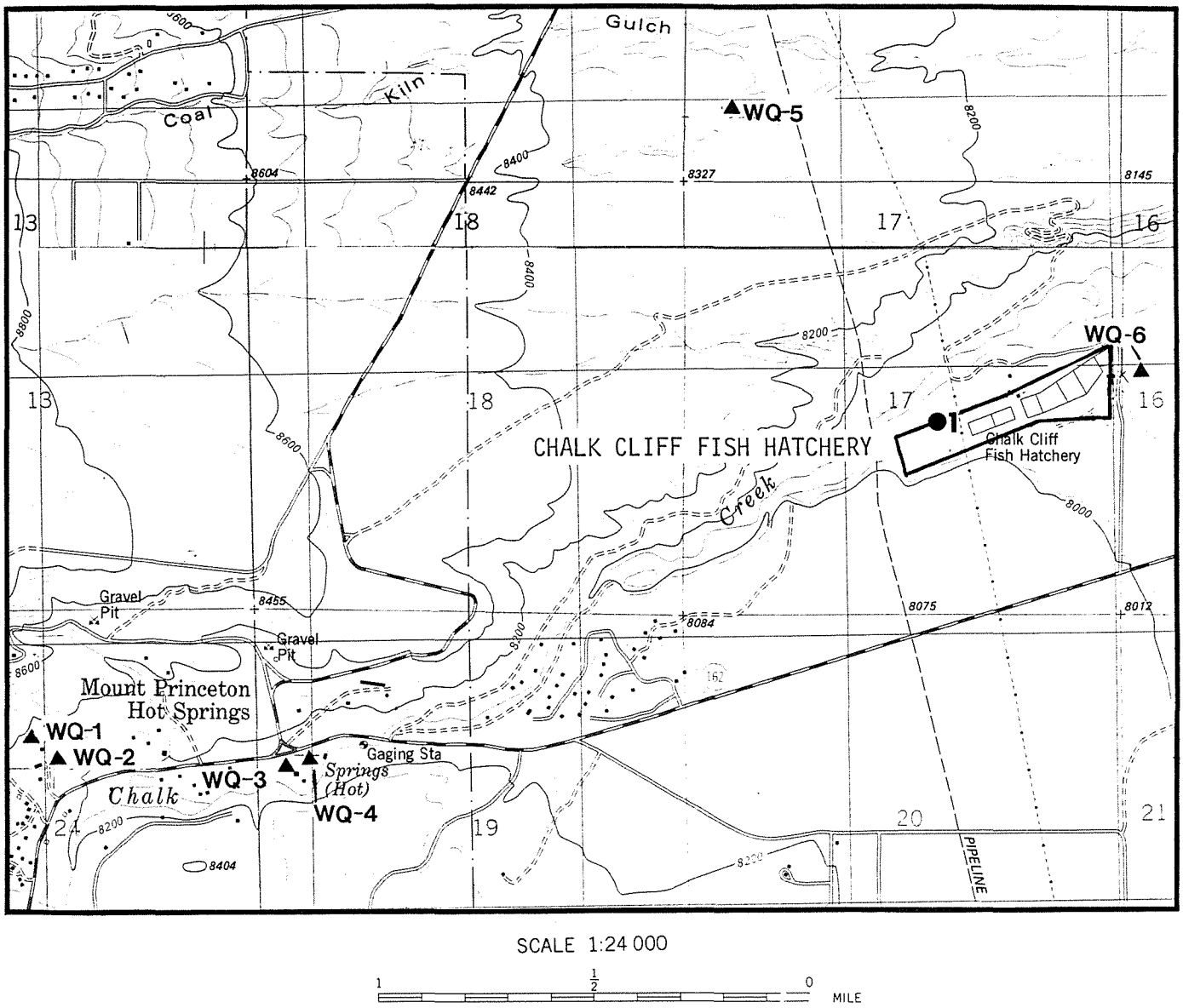


Figure 4. Location map of selected registered wells and water quality samples, Chalk Cliff Hatchery

Table 1

CHALK CLIFF FISH HATCHERY

Information from registered well records

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	2-08-007063	78W	15S	17	NWSE		10	35	10-35	—	Alluvium

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
2-08-007063

(FT)	
0-8	Loose rocks
8-35	Sand, gravel, clay

REFERENCES

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_____1983, Buena Vista East Quadrangle, Colorado - Chaffee Co. 7.5 minute series (topographic), scale 1:24,000.

_____1983, Nathrop Quadrangle, Colorado - Chaffee Co. 7.5 minute series (topographic), scale 1:24,000.

_____1983, Mount Antero Quadrangle, Colorado - Chaffee Co. 7.5 minute series (topographic), scale 1:24,000.

CRYSTAL RIVER FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Gravels (includes stream/river alluvium, terrace gravels, pediments, and debris fans).
2. Morrison/Dakota
3. Eagle Valley/Maroon Fms.

Depth to Water

1.	Gravels;	30-140 ft
2.	Morrison/Dakota;	30-45 ft
3.	Eagle Valley/Maroon Fms;	no information

Potential Yields

1.	Gravels;	190-1335 gpm
2.	Morrison/Dakota;	20-30 gpm
3.	Eagle Valley/Maroon Fms.;	?15-20 gpm

Water Quality

From the selected wells listed in the appendix, the general quality of well water in this area is acceptable.

Even though several area wells show elevated concentrations of iron and total dissolved solids, adverse concentrations would probably not be encountered at the hatchery since recharge from the Crystal River is the principal source of water.

RECOMMENDATIONS

The Crystal River Hatchery is located in a very favorable geologic setting for ground water development. The valley in which the unit is located contains a great deal of porous and permeable alluvial material as valley fill along the Crystal River. This material holds a large amount of ground water, as demonstrated by the two high capacity wells on the premises completed in

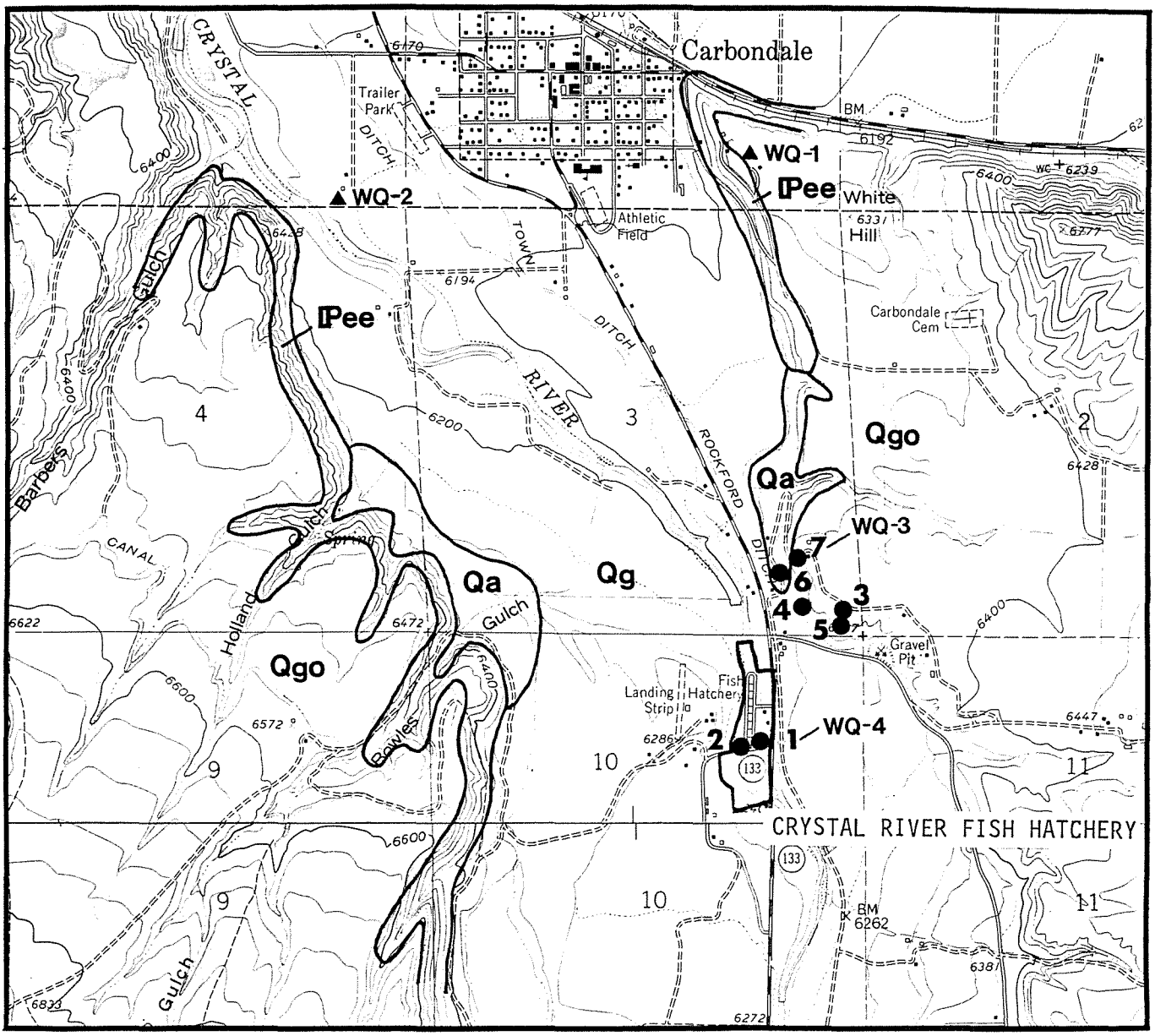
the river gravels. Since the head is unaffected on the new well while pumping the old well, a mere 20 feet away, it is clear that the alluvial material is capable of high sustained yields of water. The smaller production from the new well almost certainly is related to completion methods --depth of saturated aquifer penetrated, sizing of slots and gravel pack, pump capacity, etc. At any rate, D.O.W. staff should realize that because of the very small separation between the wells, when both are operating it is effectively one well since the cone of depression of each will be essentially identical. If operated singly, the unused well should be useful for a backup against mechanical failure or when added capacity is needed. If future wells are planned they should be as widely separated as possible from existing wells to optimize the total production available. Some geological and geophysical work in locating and testing future wells would assist greatly in achieving hatchery goals in developing large ground water production capacity at the lowest possible cost.

There is an apparent discrepancy regarding the thickness of valley-fill gravels at this site. Drillers logs indicate a thickness of 20 ft. to 25 ft. of gravel while our interpretation and that of other geological studies such as Olander, et al, 1974 would indicate 85 ft. or more. The bedrock interpretation of drillers could be from very large boulders encountered. At any rate this is an excellent location for expanded groundwater production. Using available information the best location for a new well would be across the side road and up valley from the existing wells. Some geophysical profiling by surface methods would be a good investment in pinpointing the location for future drilling and testing.

GENERAL GEOLOGY

The Crystal River Fish Hatchery is located next to the Crystal River south of Carbondale. The geology in the area is fairly complex. The river valley appears to run down the axis of an asymmetrical anticline, with Maroon and Minturn formations forming most of the river bedrock.

The hatchery is situated on alluvium and outwash gravels. The alluvium appears to rest directly on eroded upturned beds of Jurassic and Cretaceous age. Probably the Morrison and Dakota formations. To the west of the hatchery in the river beds are probably older beds of the Eagle Valley and Maroon formations. The Eagle Valley Evaporite crops out as cliffs along the river's edge and increasingly younger formations crop out westward toward the Grand Hogback. The river flood plain and the surrounding mesa tops are veneered with thick deposits of Pleistocene age terrace and pediment gravels. There are also debris fans located at the mouths of various streams feeding into the river.



EXPLANATION

Qa	Alluvium
Qg	Young gravels
Qgo	Old gravels
Pee	Eagle Valley Evaporite

Figure 5. General geology, locations of selected registered wells, and water quality samples, Crystal River Hatchery

Table 1

CRYSTAL RIVER FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	5-49-015807F	88W	8S	10	SENE		1335	85	25-85	45	Gravels
2	5-49-015808F	88W	8S	10	SWNE		190	40	?20-40	30	Gravels
3	5-23-003929	88W	8S	3	SESE		20	220	205-220	—	Gravels
4	5-23-078631	88W	8S	3	SESE		20	145	110-145	110	Gravels
5	5-23-093007	88W	8S	3	SESE		20	176	156-176	131	Gravels
6	5-23-113338	88W	8S	3	SESE		30	45	35-45	30	Gravels
7	5-23-044484	88W	8S	3	SESE		6	95	81-95	54	Mancos ?

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
5-49-015807F

(FT)	
0-25	Boulders, gravel & sand
25-30	Cap rock, hard, sandy
30-60	Sand rock, medium
60-70	Sandy lime, hard
70-85	Lime, very hard

(2)
5-49-015808F

(FT)	
0-20	Boulders, gravel & sand
20-40	sand rock, very hard & altered

(3)
5-23-003929

(FT)	
0-42	Top soil & doby
42-110	Boulders & gravel
110-130	White clay
130-140	Yellow clay
140-170	Blue clay
170-198	Blue & White clay
198-220	Brown Sand

(4)
5-23-078631

(FT)	
0-75	Boulders & gravel
75-145	Brown lime
	H_2O fracture 130 ft

(5)
5-23-093007

(FT)	
0-95	Overburden
95-144	Boulders, clay & gravels
144-176	Sand & gravels

(6)
5-23-113338

(FT)	
0-45	Boulders & gravel

(7)
5-23-044484

(FT)	
0-18	Overburden
18-48	Boulders & gravels
48-79	Gravels & sand
79-95	Black shale

REFERENCES

Olander, H. C., et al., 1974, Roaring Fork and Crystal River Valleys: An environmental and engineering geology study. Eagle, Garfield, Gunnison and Pitkin Counties, Colorado. Colorado Geological Survey, Environmental Geology No. 8.

Tweto, O., et al, 1978; Geologic map of the Leadville 1° X 2° Quadrangle, Northeastern (Northwestern) Colorado; U.S. Geological Survey Miscellaneous Investigation Series Map No. I-999.

U.S. Geological Survey, Carbondale Quadrangle, 1961, Colorado - Garfield Co. 7.5 minute series, (topographic), scale 1:24,000.

DURANGO FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium
2. Mancos shale

Depth to Water

1. Alluvium; 30-60 ft
2. Mancos; 40-60 ft (water is probably coming from a fracture system)

Potential Yields

1. Alluvium; 20-60 gpm
2. Mancos; 3-10 gpm

Water Quality

The data base search for this area revealed four sample locations. The two samples from alluvium had water of a good quality. Since any additional water for the hatchery would probably be extracted from the alluvium this water would also be expected to have good quality.

RECOMMENDATIONS

The only accessible water-bearing unit in the immediate vicinity of the Durango Fish Hatchery is the river alluvium. The thickness of the alluvium under the hatchery site is unknown. However, it is up to seventy feet thick to the northeast, and domestic wells are yielding up to 50 gpm. A commercial well might be able to produce considerably more.

Beneath the alluvium is Mancos Shale. The Mancos is notoriously "tight" and in the rare instances when water is obtained from this formation, it is only a few gallons per minute.

GENERAL GEOLOGY

The Durango Fish Hatchery is located in the town of Durango. The town is situated in the Animas Valley which was shaped by fluvial and glacial action. The valley bottom is filled with glacial debris of Pinedale and Bull Lake ages (Pleistocene) deposited by the Animas Glacier.

The town itself is located on glacial outwash and alluvium of Pinedale and Neoglacial age. These deposits consist of boulders, gravel, sand, and clay. The alluvium rests directly on eroded Mancos Shale. The Mancos is primarily a dark-gray marine shale with occasional beds of limestone or sandstone. It is about 1900 feet thick in the area. This formation is considered 'tight'. When water is produced from the Mancos it usually originates in fracture systems.

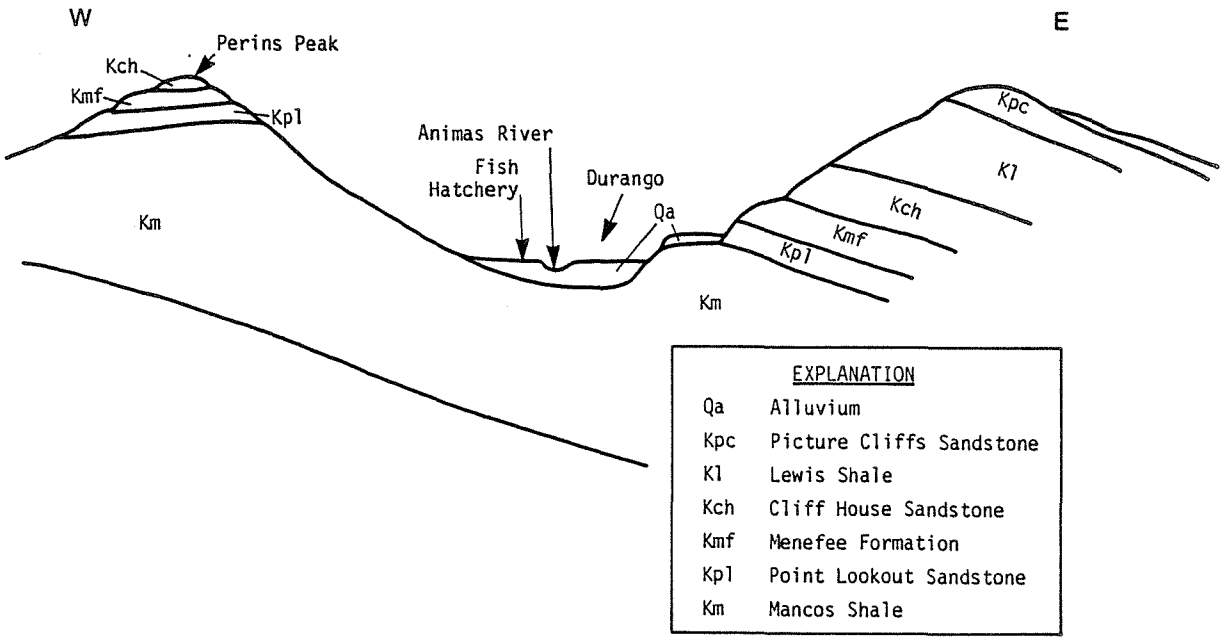


Figure 6. General geologic cross-section, Durango Hatchery

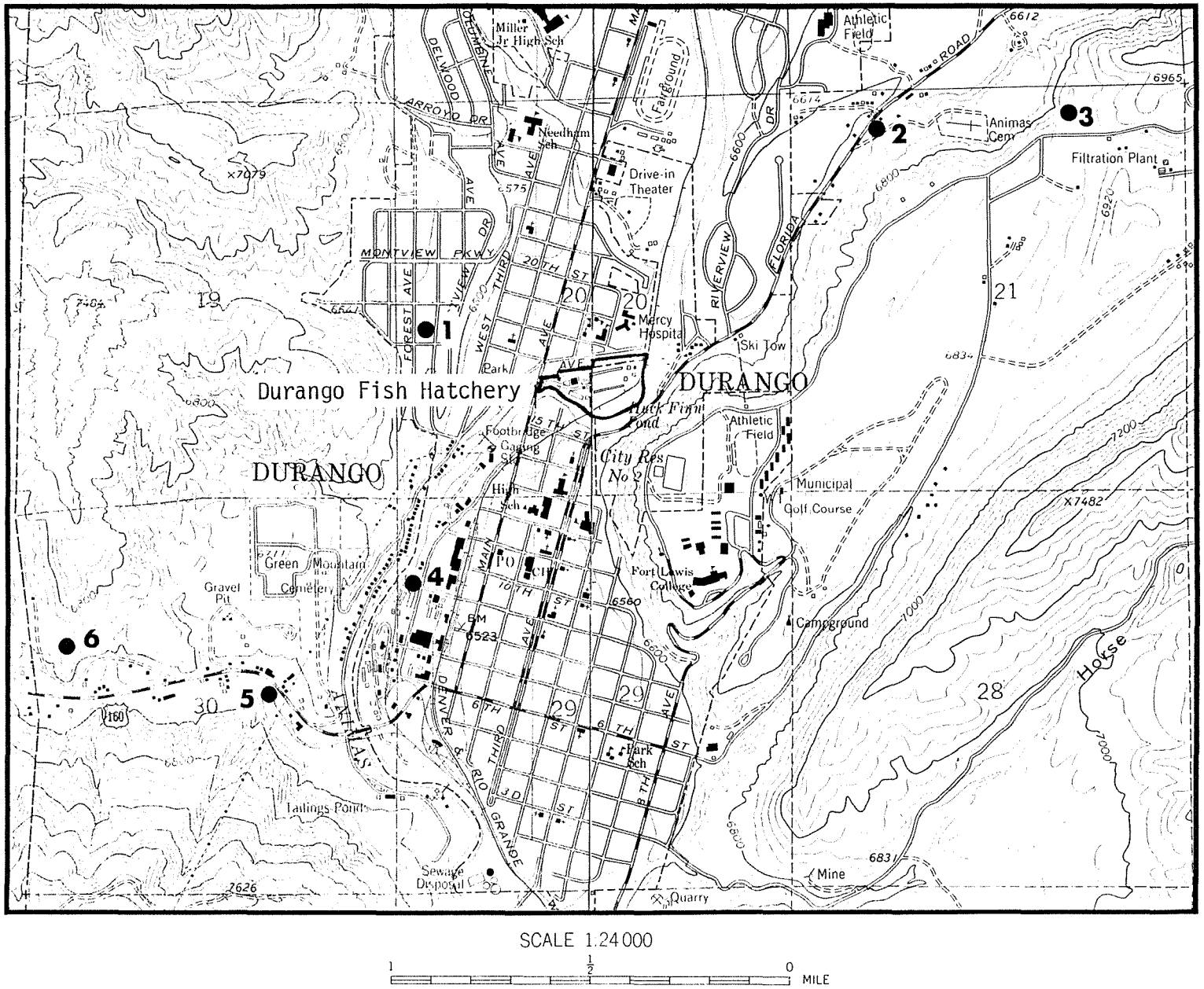


Figure 7. Location map of selected registered wells, Durango

Table 1

DURANGO FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	7-34-001812	9W	35N	20	NWSW		50	37	-	10	Alluvium ?
2	7-34-002282	9W	35N	21	NWNW		20	63	43-63	60	Alluvium
3	7-34-021945F	9W	35N	21	NWNE		40	72	65-69	47	Alluvium
4	7-34-012289F	9W	35N	29	SWNW		3	305	30-40	38	Mancos Sh.
5	7-34-007254	9W	35N	30	SWNE		10	60	40-60	50	Mancos Sh.
6	7-34-013666F	9W	35N	30	SWNW		60	52	25-40	32	Alluvium

DRILLERS LITHOLOGY

(As recorded in well records)

(1)
7-34-001812

(FT)	
0-4	?
4-18	Boulders
18-37	Blue Shale

(2)
7-34-002282

(FT)	
0-11	Top Soil
11-30	Boulders
30-58	Debris
58-63	Boulders

(3)
7-34-021945F

(FT)	
0-70	Boulders and Gravel
70-72	Shale

(4)
7-34-012289F

(FT)	
0-20	Boulders
20-128	Hard Shale
128-130	Very Hard Sand
130-305	Hard Shale

(5)
7-34-007254

(FT)	
0-7	Boulders
7-60	Shale

(6)
7-34-013666F

(FT)	
0-8	Soil
8-35	Boulders
35-40	Gravel
40-52	Shale

REFERENCES

Kilgore, Lee W., 1955, Geology of the Durango Area, La Plata County, Colorado: In Four Corners Geological Society (1st) Field Conference, p. 118-124.

New Mexico Geological Society Guidebook, Nineteenth Field Conference: San Juan-San Miguel-La Plata Region, 1968, p. 28-32.

Richmond, Gerald ., 1965; Quaternary Stratigraphy of the Durango Area, San Juan Mountains, Colorado, In Geological Survey Research 1965: U.S. Geological Survey Professional Paper 525C, p. C137-C143.

Steven, T. A., 1974; Geologic map of the Durango Quadrangle, southwestern Colorado, U.S. Geological Survey Miscellaneous Investigations Map No. I-764.

U.S. Geological Survey, Durango East Quadrangle, 1963, Colorado - La Plata Co. 7.5 minute series, (topographic), scale 1:24,000.

_____Durango West Quadrangle, 1963, Colorado - La Plata Co. 7.5 minute series, (topographic), scale 1:24,000.

FINGER ROCK FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Bear River alluvium
2. Brinker Creek alluvium
3. Entrada Sandstone (?)
4. Mancos Shale

Depth to Water

1. Bear R. alluvium; 38 ft
2. Brinker Cr. alluvium; 20 ft (estimated)
3. Entrada; Unknown
4. Mancos; Unknown, but information obtainable from hatchery wells.

Potential Yields

1. ? data limited to one domestic well of 12 gpm, but probably good.
2. No data - probably good
3. No data
4. No data - probably quite low

Water Quality

The survey of available water chemistry analyses did not contain any measurements from the site area. As a generalization, shales produce a ground water quite high in dissolved solids. In addition, concentrations of trace metals and salts in shale units are usually high, with a resulting decrease in water quality. The two potential alluvial deposits would probably have water of good quality. The Entrada Sandstone deep beneath the site generally produces good quality water throughout the state. However, it may be too deep for economic development.

RECOMMENDATIONS

The current water supply for this hatchery occurs as springs emerging at the contact between the Mancos Shale and the alluvial gravel deposits

resting on the shale. These cobbly deposits to the north, northwest, and west of the site might contain more springs that could be captured for hatchery use. Inspection of this contact and the surrounding terrain was not possible due to an access problem - the landowner adjacent to the hatchery is rather hostile to "government", fish hatcheries included.

The possibility of installing a well on the site premises does not look favorable because the Mancos Shale is generally several thousand feet thick, making an attempt to reach a deeper unit such as the Entrada Formation cost prohibitive. However, the actual thickness of the shale under the hatchery was not determined. Field mapping, combined with geophysical investigations or drilling would be of great help in determining the thickness of the shale, and thus the feasibility of a deep well.

Alternatively, down slope and north of the site, parallel to the highway, a fault is suspected along the axis of Chimney Creek. If land access and water rights are not immediate barriers, this should be investigated since faults are often major avenues for ground water flow. However, the maximum acceptable power cost of lifting water a minimum of 120 feet from the well intake to the hatchery should be estimated before any further investigations regarding a possible fault are initiated.

GENERAL GEOLOGY

The Finger Rock Fish Hatchery is located on top of the Mancos Shale. This unit is quite thick - usually about 5,000 ft. It's thickness at the site is unknown. The volume of accessible ground water from this unit would probably be quite low.

Directly north of the hatchery lies a large area of alluvial gravels. Starting at a distance of about one eighth mile from the hatchery these gravels continue northward for two to two and one-half miles. Their lateral extent is also about two miles. Although there are no well control points from this area, it could probably serve as a source of ground water for the Finger Rock Hatchery. This material is referred to as the Bear River alluvium on the previous page.

Up drainage from the hatchery and approximately one and one-half miles southwest along Brinker Creek, an older gravel deposit is located. This alluvial material extends more or less along the axis of Brinker Creek for three miles, and normal to the stream axis about one-half mile from either side. Like the Bear River alluvium, these gravels could probably serve as a ground water source.

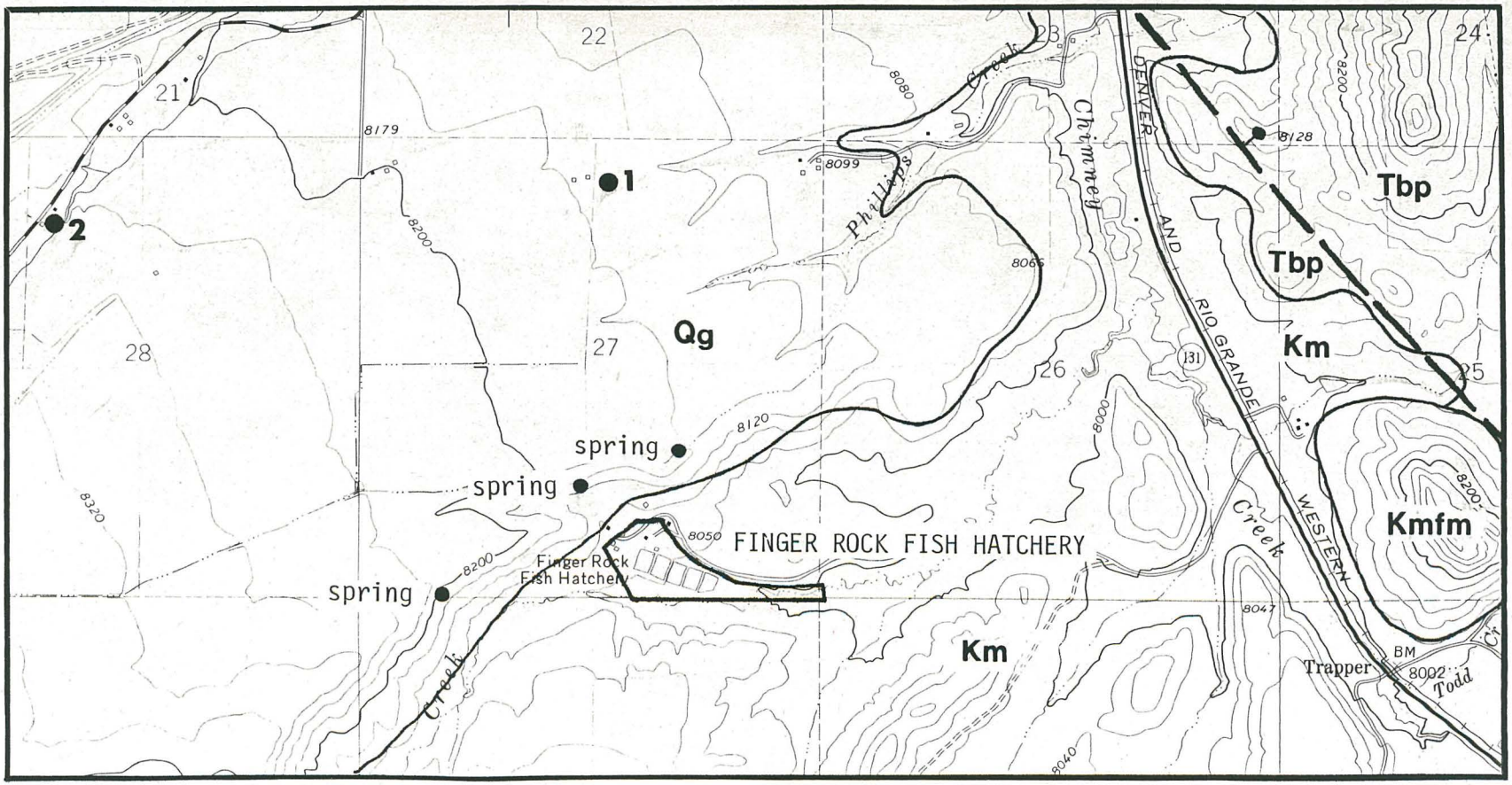


Figure 8. General geology and water well locations, Finger Rock Hatchery

Table 1

FINGER ROCK FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	6-54-045679	85W	2N	27	NWNE		10	30	-	10	Alluvium ?
2	6-54-037199	85W	2N	28	NENW		12	50	-	38	Alluvium
*	6-54-012935F	85W	2N	18	SESE		2700	2515	2440-2500 (?)	—	Entrada (?)

* Not shown on well location map

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
6-54-045679
(FT)

0-30	No Lithology recorded

(2)
6-54-037199
(FT)

0-18	Dirt & rock
18-38	Gravel & shale
38-50	Gravel

(*)
6-54-12935F
(FT)

0-540	Niobrara
540-1555	Frontier
1555-1970	Dakota
1970-2040	Morrison
2040-2445	Curtis
2480-2515	Sand, pink to white, clear quartz (Flows water)

REFERENCES

Tweto, Ogden, 1976, Geologic map of the Craig 1° X 2° Quadrangle, northwestern Colorado: U.S. Geological Survey, scale 1:250,000. U.S. Geological Survey Miscellaneous Investigations Series Map I-972.

U.S. Geological Survey, 1972, Trapper Quadrangle, Colorado - Routt Co., 7.5 minute series (topographic), scale 1:24,000.

GLENWOOD SPRINGS FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium
2. Eagle Valley Evaporite
3. Fault Zone
4. Complex of sedimentary, and metamorphic rocks

Depth to water

1. Alluvium; very shallow

The alluvium in this stream valley is very thin and can be very mobile depending upon stream velocity. It would probably not make a very good aquifer

2. Eagle Valley Evaporite: no information
3. Fault Zone; no information
4. Complex of rocks; no information

Potential Yield

No information

The only registered wells near to the hatchery are in the river valley and are located in either river alluvium or the Maroon Fm., which appears about three quarters of a mile south of the fish hatchery. Information on these wells is included in this report.

Water Quality

The data base had no information from any well or spring close to the hatchery. Since the Leadville Limestone is probably inaccessible, (see recommendations below), the most probable source of additional water would be from the fault zone above the hatchery. This water would probably be very similar in chemical properties to the water currently in use. If the spring water from far up in the gorge was harnessed, it should be similar to the water at the Rifle Falls unit, since the geology is similar.

RECOMMENDATIONS

According to the existing geologic map of the area, there is a fault which crosses Mitchell Creek north of the site. Its location is probably very near to the last house up the gorge, since this family obtains its household water from a spring. This structure is probably the most likely source for obtaining additional water for the Glenwood facilities by means of a well. Also, the property owner has stated that several large volume springs occur further up along Mitchell Creek. If the rights to this water could be obtained, a spring capture system such as that used at Rifle Falls could be installed. Since the water would be gravity fed, the costs for using the water would be limited to a one time initial construction cost and the water rights.

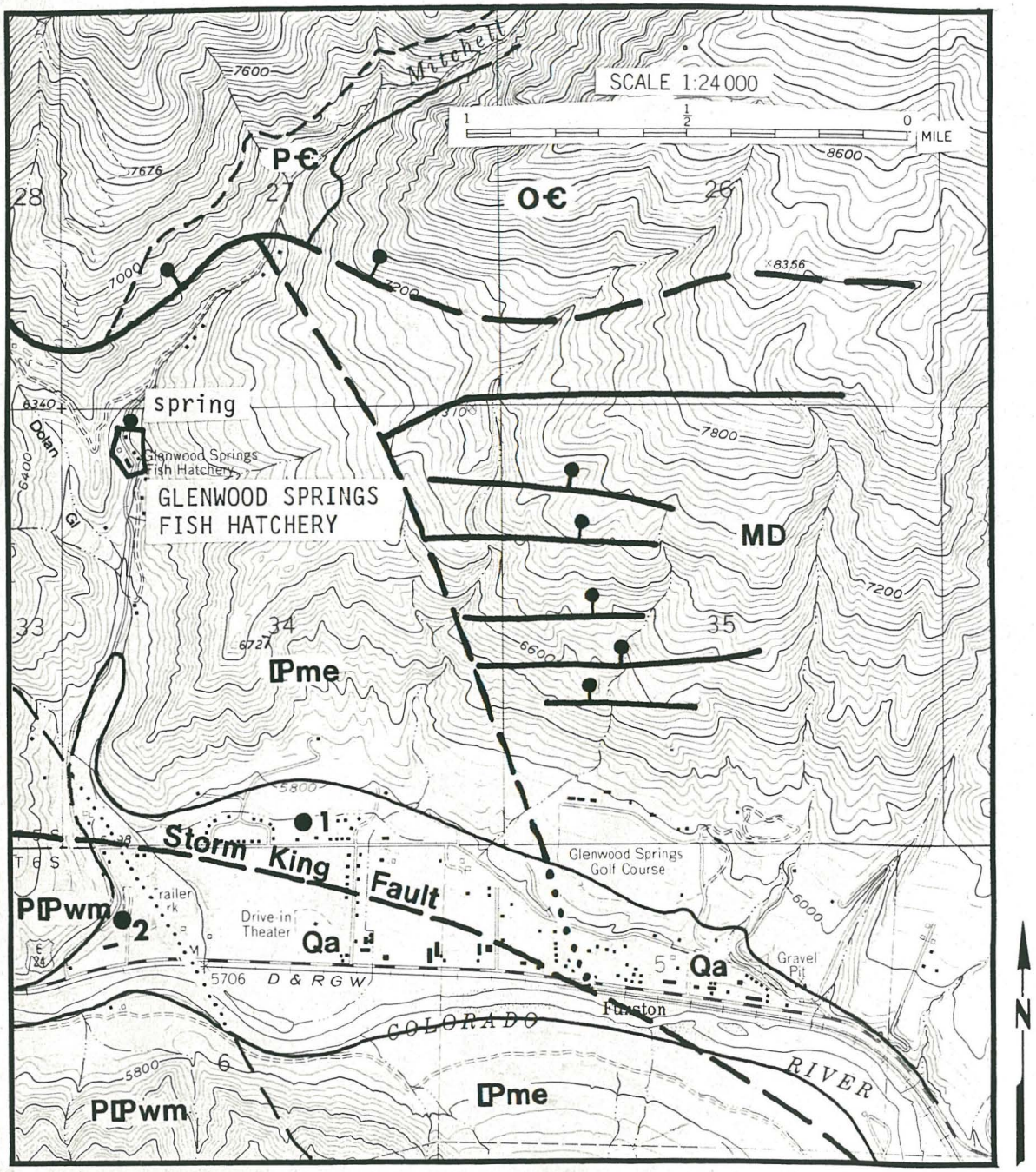
The Leadville Limestone, also a potential source of water, is probably 500-600 feet below the unit. The power cost of lifting the water such a distance would probably render this potential aquifer economically infeasible.

GENERAL GEOLOGY

The Glenwood Springs Fish Hatchery is located on Mitchell Creek northwest of Glenwood Springs. The hatchery sits on the Eagle Valley Evaporite which apparently interfingers with the Minturn and Maroon formations in this area. The Eagle Valley contains gypsum, anhydrite, siltstones, dolomite, and salt. Ground water found in this formation could be rich in calcium sulfate, sodium chloride, and magnesium, but these do not appear to be a problem in the present springs.

The site is surrounded by a number of faults. There is one just north of the hatchery. The fault zone could be a potential source of water since there is usually a fair amount of permeable material along the fault plane resulting from grinding action on the fault.

To the north of the fault there is a complex of sedimentary and metamorphic rocks. These also could prove a source of ground water along their contact planes.



EXPLANATION

Qa	Alluvium
PIPwm	Weber Sandstone and Maroon Fm.
IPmee	Minturn Fm. and Eagle Valley Evaporite
MD	Mississippian and and Devonian
O-€	Ordovician and Cambrian
P-€	Precambrian metamorphics

Figure 9. General geology and location of selected registered wells, Glenwood Springs Hatchery

Table 1

GLENWOOD SPRINGS FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	5-23-120560	89W	5S	34	SWSE		33	71	49-71	47	? Alluvium
2	5-23-016846F	89W	6S	6	NWNW		20	231	100-200	180	Maroon

DRILLERS LITHOLOGY
(As recorded in well records)

(1)
5-23-120560

(FT)	
0-6	Red clay
6-25	Soft sandy red clay
25-55	Red clay mixed with small gravel
55-71	River gravel, limestone fragments, river sand

(2)
5-23-016846F

(FT)	
0-15	Overburden
15-50	Red shale
50-80	Red sandstone
80-160	Red shale
160-190	Red stone
190-220	Red shale

REFERENCES

Bass, N., Wood, and Northrop, Stuart A., 1963; Geology of Glenwood Springs Quadrangle and vicinity northwestern Colorado. U.S. Geological Survey Bulletin 1142-J, p. 74.

Soule, J. M, and Stover, B. K., (in preparation); Surficial Geology, Geomorphology, and General Engineering Geology of parts of the Colorado River Valley, Roaring Fork River Valley, and adjacent areas, Garfield County, Colorado; Colorado Geological Survey publication.

Tweto, O., et al, 1978; Geologic map of the Leadville 1° X 2° quadrangle, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigation Series Map No. I-999.

U.S. Geological Survey, 1961, Glenwood Springs Quadrangle, Colorado - Garfield Co., 7.5 minute series, (topographic), scale 1:24,000.

MT. SHAVANO FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium and outwash gravels

Depth to Water

1. Alluvium; 4-30 ft

Potential Yields

1. Alluvium; 100^{+} gpm

Even though most registered wells are low-use and/or domestic in character, there are two large capacity wells within one-half mile of the site.

Water Quality

The existing water chemistry data base for the general area was quite good. Both the springs and wells typically have TDS values below 250 mg/l, indicating there should be no problems with water quality at this hatchery.

RECOMMENDATIONS

The springs to the north of this hatchery, located on the Bovee property, represent the most readily available source of additional water. A model for the development of this water was submitted to Mr. Clyde Smith during April of 1984. This report, written by Mr. Jeffrey Hynes of our office, discussed in detail how the Mt. Shavano unit could utilize this water. It is our opinion that this water represents the most pragmatic source for additional expansion purposes.

The alluvial material on the south side of the river might also serve as an additional source of water. Well No. 3, plotted on the map of this site, has a yield of 850 gpm. This indicates that water could be extracted by pumps if the Bovee project falls through.

GENERAL GEOLOGY*

The Mt. Shavano Fish Hatchery is located west of Salida in the Arkansas River Valley. The site rests directly on Quaternary sand and gravel terraces of glacial outwash associated with the Pleistocene valley glaciers in the Upper Arkansas Valley. At lower elevations adjacent to the Arkansas River there are terraces of flood plain deposits of post-glacial alluvium. Bedrock beneath the site is the Dry Union Formation which consists of a thick sequence of tan-to-brownish grey siltstones with interbedded friable sandstones and conglomerates. The total maximum thickness of the Dry Union in this area is greater than 5,000 feet, however, it thins away from the mountain front and has been modified by erosion and deposition by the Arkansas River. It was deposited as colluvial and alluvial fill into the Upper Arkansas Graben from the surrounding highlands during the late Miocene and Pliocene. A graben is a large fault-bounded block of rock that has slipped down relative to the rocks on either side. In the Arkansas Valley, the course of the river and the deposition of the alluvial and glacial outwash deposits has been controlled by the graben.

The springs along the west side of river are located on the steep bluff separating the youngest (Pinedale) terrace from the current floodplain. The lower Pinedale terrace surface lies approximately 10 meters above the river. At about 10 feet below the upper surface of this terrace there is a zone containing abundant very large boulders. These huge boulders were deposited by a massive flood caused by the rupture of a glacial dam upstream. The extremely coarse nature of this zone and the relative absence of fine-grained material cause a marked increase in the horizontal permeability of the sands and gravels in this zone. Where this boulder zone is exposed along the banks of the Arkansas River numerous springs are found.

The boulder zone was deposited on an irregular, undulating scour surface produced by the erosional force of the flood waters. The water tends to flow more readily in the lows or troughs in the boulder layer and consequently the number and volume of the springs increases markedly where these troughs are exposed in the bench slope.

The higher elevation of the boulder zone and perhaps even an absence of boulders in some areas accounts for the fact that some parts of the terrace edge are dry while others are very wet.

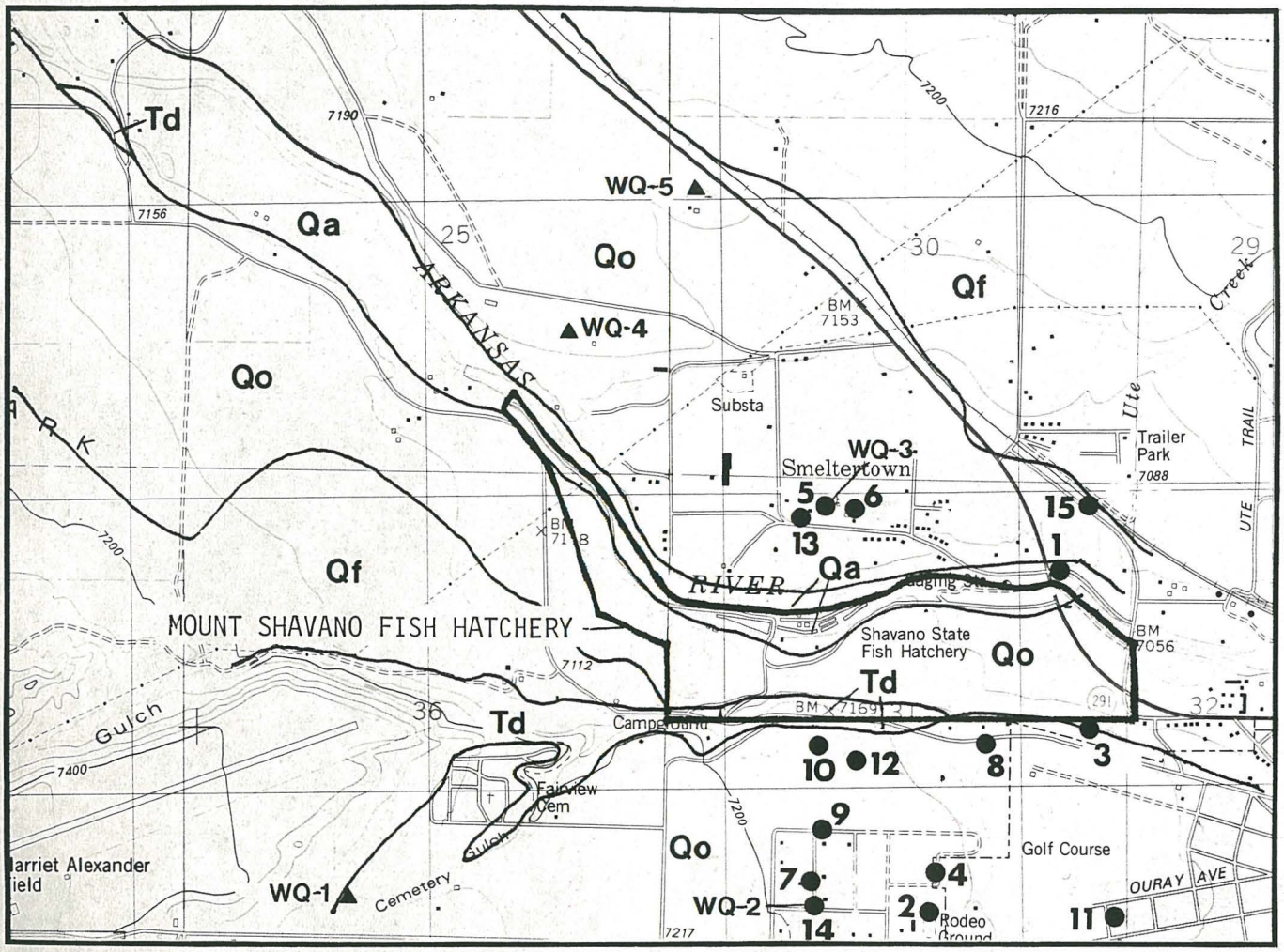
The large volume of water produced by the springs is due to the irrigation practices on the top of the terrace. Flood irrigation waters percolate down through the overlying sands and gravels in saturated flow until they reach the high permeability zone associated with the large boulders.

After the irrigation season the boulder layer acts as a blanket drain and dewaters the overlying sands and gravels. This causes a gradual diminution of the spring flows.

According to the land owner, John Bovee, the range of variation in flow rate from the peak irrigation season to minimum flows in February and March is roughly a factor of three or four to one (e.g., a decrease to about 25 percent of the maximum flow). For the larger spring network measured (the southern drainage) this would represent a minimum spring flow of approximately 0.5 cfs and a maximum of 2.0 cfs in addition to any surface drainage in the channel (measured at approximately 1 cfs in late March 1984).

Using the same ratio, the smaller spring network (northern drainage) should vary from a low of 0.25 cfs to a high of approximately 1.0 cfs.

*from 1984 Colorado Geological Survey report for DOW



EXPLANATION

Qa Alluvium

Qf Fan alluvium

Qo Outwash gravels

Td Dry Union Fm.

Figure 10. General geology and location of selected registered wells, water quality samples, Mt.Shavano Hatchery

Table 1

MT. SHAVANO FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	2-08-013485F	9E	50N	31	NENE		100	15	—	4	Alluvium
2	2-08-002065	9E	50N	31	SWSE		20	36	28-36	18	Alluvium
3	2-08-008544	9E	50N	31	NESE		850	130	80-130	32	Alluvium
4	2-08-008275	9E	50N	31	SWSE		15	60	53-58	25	Alluvium
5	2-08-008805	9E	50N	31	NENW		20	55	34-55	22	Alluvium
6	2-08-010966	9E	50N	31	NENW		20	60	50-60	30	Alluvium
7	2-08-046024	9E	50N	31	SESW		15	55	35-55	30	Alluvium
8	2-08-051215	9E	50N	31	NWSE		15	90	70-90	30	Alluvium
9	2-08-059726	9E	50N	31	NENW		15	47	27-47	27	Alluvium
10	2-08-062637	9E	50N	31	NESW		12	60	35-60	14	Alluvium
11	2-08-071398	9E	50N	31	SESE		15	62	42-62	36	Alluvium
12	2-08-072780	9E	50N	31	NESW		15	110	80-110	87	Alluvium
13	2-08-086494	9E	50N	31	NENW		5	43	—	24	Alluvium
14	2-08-103637	9E	50N	31	SESW		12	77	26-77	22	Alluvium
15	2-08-118940	9E	50N	31	NENE		15	52	40-52	30	Alluvium

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
2-08-013485F
(FT)
No Lithology recorded

(2)
2-08-002065
(FT)

0-26	Big granite boulders cemented
26-36	Water gravel & water
36-37	Sandy clay, hardpan

(3)
2-08-008544
(FT)

0-12	Topsoil
12-49	Fine sand & clay
49-75	Quick sand
75-130	Gravel

(4)
2-08-008275
(FT)

0-32	Big boulders in cemented gravel
32-40	Gray gravelly clay, small amount water
40-55	Brown coarse gravally clay
55-58	Soft gray clay

(5)
2-08-008805
(FT)

0-38	Boulders
38-55	Sand

(6)
2-08-010966
(FT)

0- 30	?
30-60	Sand

(7)
2-08-046024
(FT)

0-55	Glacial rock

(8)
2-08-051215
(FT)

0-50	Boulders
50-90	Sand, gravel, & clay

(9)
2-08-059726
(FT)

0-20	Heavy rock & sand
20-47	Fine sand

(10)
2-08-062637
(FT)

0-25	Cobbles, sand, gravel & clay
25-60	Sand, gravel & clay

(11)
2-08-071398
(FT)

0-41	Sand & some rock
41-62	Water sand & gravel

(12)
2-08-072780
(FT)

0-18	Overburden
18-45	Brown clay
45-80	Gray clay & gravel
80-110	Gravel & sand

DRILLERS LITHOLOGY
(as recorded in well records)

(13)
2-08-086494

(FT)	
0-33	?
33-43	Sand, gravel & water

(14)
2-08-103637

(FT)	
0-26	Rock & sand
26-34	Clay
34-60	Sand & gravel; water producing
60-77	Clay

(15)
2-08-118940

(FT)	
0-28	?
28-35	Clay & sand
35-52	Sand & gravel

REFERENCES

Boardman, S. J., 1976, "Geology of the Precambrian metamorphic rocks of the Salida area, Chaffee County, Colorado": The Mountain Geologist, v.13, no. 3, p. 89-100.

Hynes, J., 1984; Bovee Springs Project, conducted for D.O.W., C.G.S

Tweto, Ogden, et al., 1976, Preliminary geologic map of Montrose 1° X 2° Quadrangle, southwestern Colorado: U.S. Geological Survey, scale 1:250,000, U.S. Geological Survey Miscellaneous Field Studies Map no. MF-761.

U.S. Geological Survey, 1983, Salida West Quadrangle, Colorado - Chaffee Colorado, 7.5 minute series (topographic), scale 1:24,000.

PITKIN FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium
2. Minturn Fm./Belden Fm.
3. Fault Zone *

* See general Geology section for explanation of fault zone as a potential aquifer.

Depth to Water

1. Alluvium; 40 ft
2. Minturn Fm; 100 ft
3. Fault zone; very shallow

Potential Yield

1. Alluvium; 10 gpm
2. Minturn; 2-5 gpm
3. Fault Zone; ?

Water Quality

The available water analysis for the area around this unit is rather sparse, being limited to two analyses. Even with this limitation of data, the analyses represented in the appendix of this section clearly indicate the well water in this area to be of exceptional quality - TDS around 100 mg/l.

RECOMMENDATIONS

The best potential source of additional water at the Pitkin Fish Hatchery is a well or gallery in the fault zone that crosses the river valley from northwest to southeast just north of the hatchery (see geologic map).

It is our understanding that the hatchery is already using water from the fault zone in the form of a spring. A gallery at this location might capture additional water but could also dry up the shallow springs.

Because the fault cuts down Powderhouse Gulch and crosses Quartz Creek, there should be excellent recharge capacity and therefore potential for significant quantities of water in the zone. However, the water could be fairly cold.

In order to locate a well, it will first be necessary to carefully map the fault to determine as accurately as possible where it crosses the valley. Fault zones are not usually very wide although they can be very deep.

It should be noted that if a well is located into the fault, the spring may dry up.

GENERAL GEOLOGY

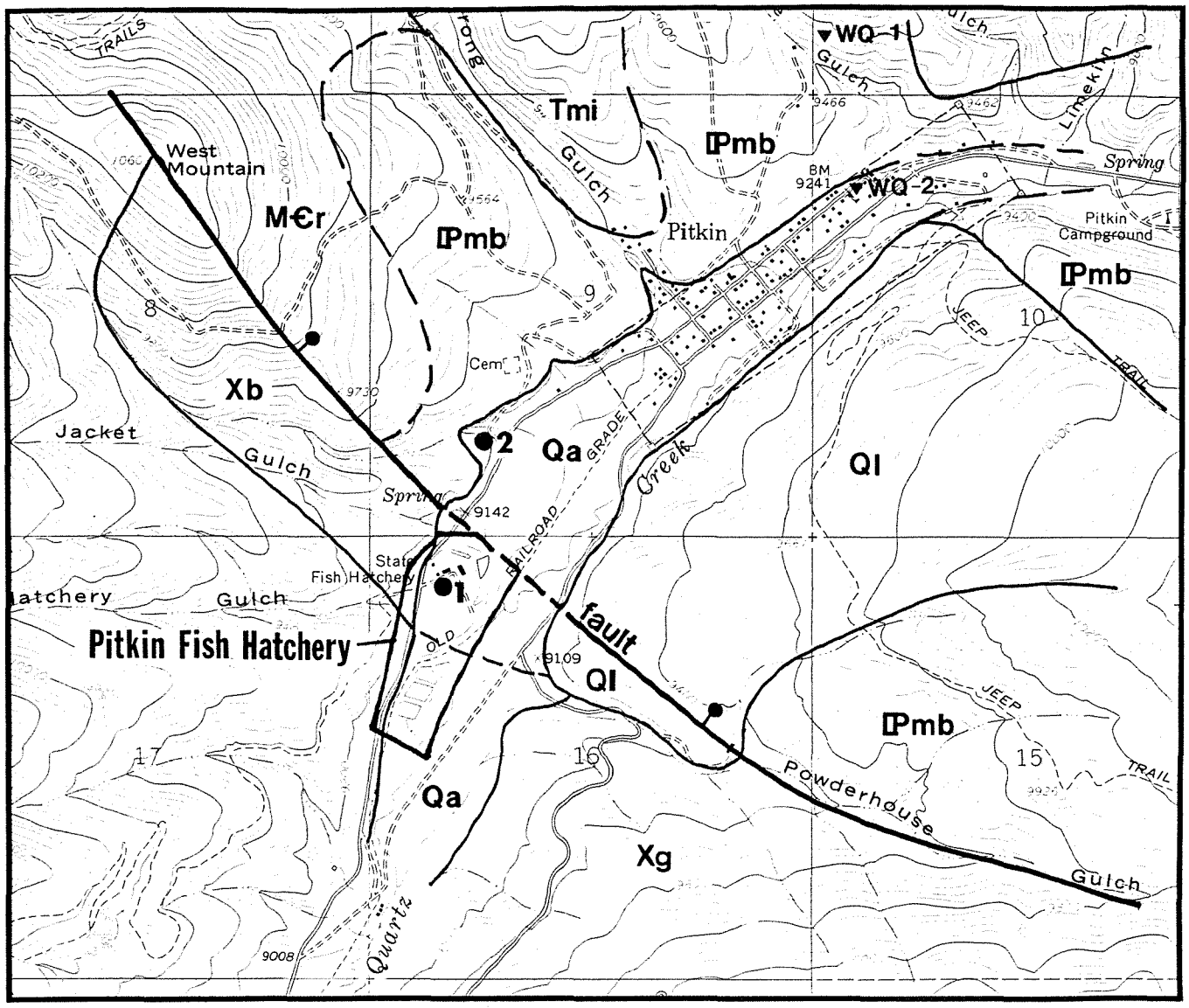
The geology in the area of the Pitkin Fish Hatchery is fairly complex. There are four formations in the area; 1) Precambrian Quartzite (Xq), 2) Precambrian biotite gneisses (Xb), 3) Pennsylvanian Minturn/Belden formations, 4) Quaternary alluvium.

It might be possible to drill into a fracture system in the quartzite or gneiss but fracture locations are difficult to predict.

The Minturn and Belden Fms., interfinger in this area and contain sandstone, shale, and limestone beds and are a possible source of water. However, the alluvium is the most dependable source of water.

The Montrose 1° X 2° Geology quadrangle shows a fault running down Powderhouse Gulch and through West Mountain. This fault has been drawn as accurately as possible on the accompanying map. The zone of fault gouge (finely ground material resulting from grinding movement on the fault) can be very permeable, and in this case the fault follows a mountain drainage, and crosses a river bed, both being places where it could collect significant amounts of water.

The spring issuing near the base of Red Jacket Gulch is probably in the fault zone.



EXPLANATION	
Qa	Alluvium
Ql	Landslide
Tmi	Intrusives (middle Tertiary)
IPmb	Minturn and Belden Fms.
MЄr	Mississippian, Devonian, Ordovician, and Cambrian
Xg	Granite
Xb	Biotite gneisses and Migmatite

Figure 11. General geology and location of selected registered wells and water quality samples, Pitkin

Table 1

PITKIN FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	4-26-044745	4E	50N	16	NWNW		8	60	4-42	12	? Alluvium
2	4-26-077452	4E	50N	8	SWSW		3.5	175	95-175	35	Minturn/Belden

DRILLERS LITHOLOGY

(As recorded in well records)

(1)
4-26-044745

(FT)	
0-3	Soil and gravel
3-5	Clay
5-42	Quick sand
42-45	Lime
45-60	Shells and clay

(2)
4-26-077452

(FT)	
0-22	Sand and gravel
22-47	Shale
47-52	Decomposed rock
52-90	Shale
90-140	Tan sandstone
140-175	White quartz, pink and grey decomposed granite

REFERENCES

Tweto, O., 1976; Preliminary geologic map of the Montrose 1° X 2° quadrangle, southwestern Colorado. USGS. Miscellaneous Field Studies Map no. MF-761.

U.S. Geological Survey, Pitkin Quadrangle, 1964, Colorado - Gunnison Co., 7.5 minute series, (topographic), scale 1:24,000.

POUDRE FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium
2. Metamorphic Rocks *

* The metamorphic rocks are not used as an aquifer in this area. However, such rocks do contain fracture systems which may supply water. Unfortunately, intersecting a system when drilling is mostly a matter of luck, and the supply may not be reliable.

Depth to Water

1. Alluvium; 6-40 feet
   (average 23 feet)

   The saturated thickness appears to be about 90 feet at the hatchery site

Potential Yields

1. Alluvium; 2-30 gpm
   (average 12 gpm)

Water Quality

No information

RECOMMENDATIONS

River alluvium appears to be the only source of water in this area. It is unlikely that water could be obtained by drilling into the metamorphic bedrock in hopes of locating a fracture system. However, it is possible that minor faults (as yet unmapped) or fracture systems exist in the valley sides or side drainages and could result in springs. A detailed investigation of the area combined with infrared photography would be necessary to determine if any springs were present. Although the amount of additional water from springs might not be great it would give the unit an additional source.

GENERAL GEOLOGY

The Poudre Fish Hatchery is situated on alluvium resting directly on bedrock of Precambrian metamorphic rocks. These felsic and hornblende gneisses may have been principally derived from volcanic rocks. Locally they contain interbedded biotite gneiss, amphibolite, and calc-silicate rock.

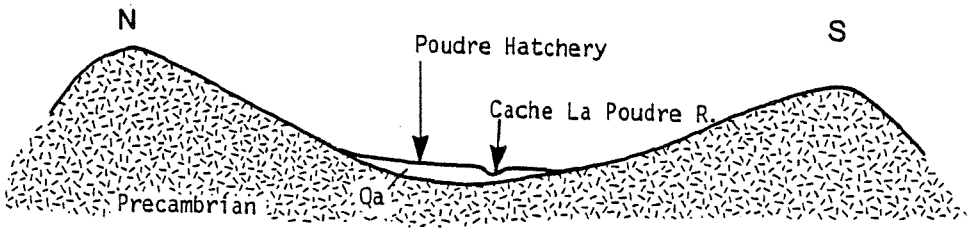


Figure 12. General geologic cross-section, Poudre Hatchery

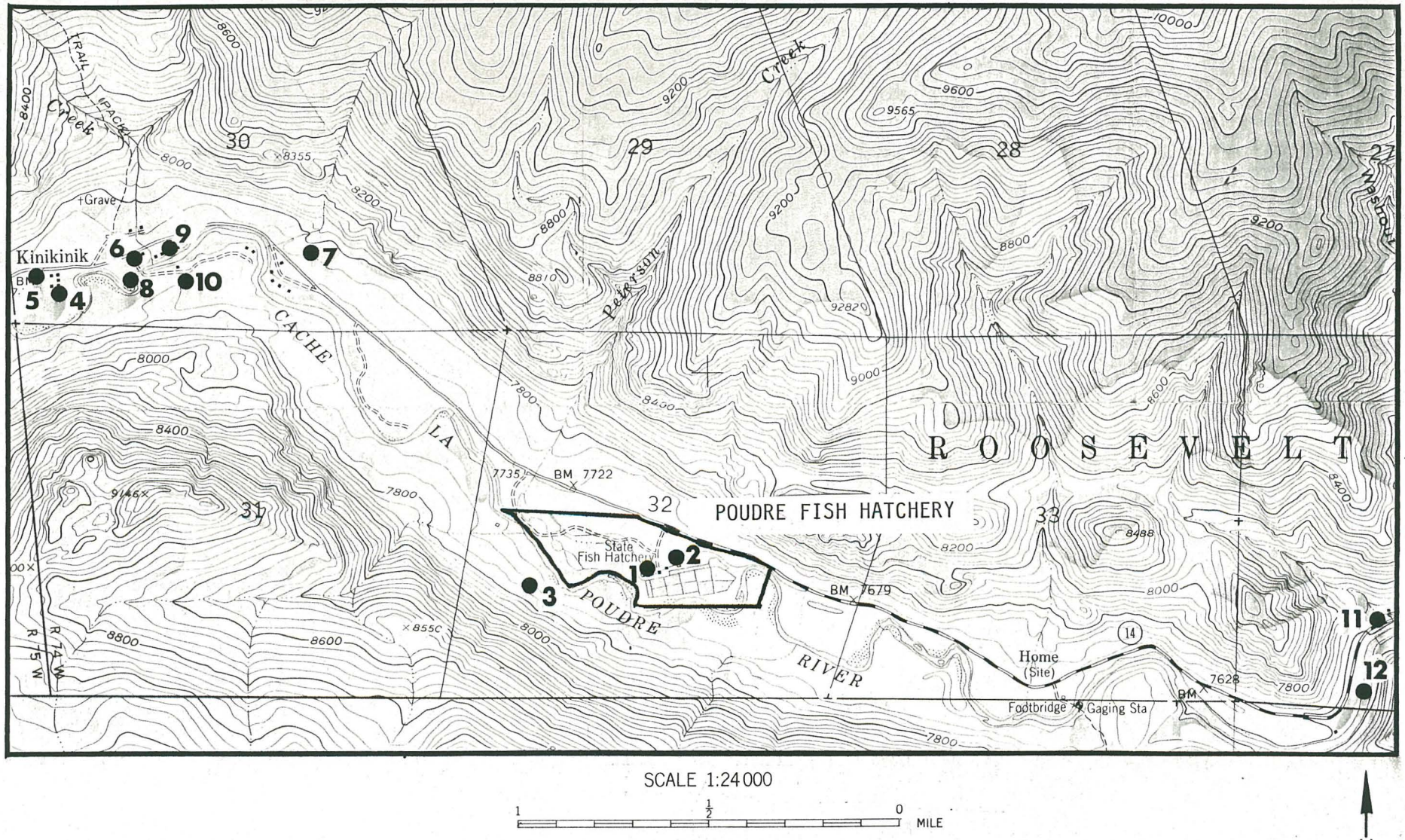


Figure 13. Location map of selected registered wells, Poudre Hatchery

Table 1

POUDRE FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	1-35-038985	74W	9N	32	NESW		30	114	54-114	25	Alluvium
2	1-35-060634	74W	9N	32	NWSE		30	112	-	-	Alluvium
3	1-35-063939	74W	9N	32	NWSW		8	53	38-53	35	Alluvium
4	1-35-057959	74W	9N	30	SWSW		6	43	26-43	20	Alluvium
5	1-35-058466	74W	9N	30	SWSW		10	56	51-56	25	Alluvium
6	1-35-063570	74W	9N	30	SESW		20	63	50-63	40	Alluvium
7	1-35-076570	74W	9N	30	SWSE		5	54	44-54	40	Alluvium
8	1-35-079781	74W	9N	30	SESW		10	30	22-30	6	Alluvium
9	1-35-054143	74W	9N	30	SESW		10	53	38-53	30	Alluvium
10	1-35-007735	74W	9N	30	SESW		2	10	4-10	6	Alluvium
11	1-35-079016	74W	9N	34	SESW		10	86	27-37	15	Alluvium
12	1-35-079177	74W	9N	34	SESW		10	55	25-40	10	Alluvium

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
1-35-038985

(FT)	
0-2	Topsoil
2-8	Large gravel and rocks
8-90	Small gravel and sand
90-105	Fine sand
105-114	Gray, silty clay

(2)
1-35-060634

(FT)	
No Lithology recorded	

(3)
1-35-063939

(FT)	
0-10	Topsoil and weathered granite
10-45	Boulders and gravel
45-53	Granite sluff

(4)
1-35-057959

(FT)	
0-5	Overburden
5-20	Boulders and sand
20-43	Sand and gravel

(5)
1-35-058466

(FT)	
0-5	Overburden
5-30	Boulders and gravel
30-35	Fine sand
35-56	Sand and coarse gravel

(6)
1-35-063570

(FT)	
0-10	Overburden
10-20	Gravel
20-30	Granite sluff
30-50	Sand and gravel

(7)
1-35-076570

(FT)	
0-3	Soil
3-44	Gray gravel
44-54	Sand and gravel, Brown

(8)
1-35-079781

(FT)	
0-2	Soil
2-11	Tan sand and medium gravel
11-27	Medium round gravel
27-30	Brown sand in medium gravel

(9)
1-35-054143

(FT)	
0-10	Overburden
10-40	Granite sluff
40-42	Heavy gravel
42-53	Granite sluff

(10)
1-35-007735

(FT)	
0-10.5	River Rock

(11)
1-35-079016

(FT)	
0-5	Topsoil
5-30	Sand and gravel
30-35	Boulders and granite
35-50	Brown granite
50-86	Gray granite with mica

(12)
1-35-079177

(FT)	
0-18	Gravel and sand
18-20	Boulders and gravel
20-40	Medium to fine gravel
40-50	Green-gray silicious
50-55	Tan and gray granite

REFERENCES

Braddock, W. A., and Cole, J. C., 1978; Preliminary geologic map of the Greeley 1° X 2° Quadrangle, Colorado and Wyoming, U.S. Geological Survey Open File Report 78-532.

U.S. Geological Survey, Kinikinik Quadrangle, 1962, Colorado - Larimer Co. 7.5 minute series, (topographic), scale 1:24,000.

RIFLE FALLS FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium/Tufa
2. Minturn Fm.
3. Fault zone
4. Springs

Depth of water

No Information

Potential yields

No Information

Water Quality

The computerized search of water quality information did not reveal any analyses for this location. However, since the Minturn Fm. interfingers with the Eagle Valley Evaporite in this area, the water from these formations could contain a high level of dissolved solids. This would be expressed as an excess of calcium, magnesium, chloride, and sulfate. Fortunately, the spring water in current use is free from these potential excesses, and is of good quality.

RECOMMENDATIONS

This hatchery is the most favorably located of all the units within the state. A suite of springs emerge up stream from the site, along the base of a lithologic contact. This water is already present in sufficient quantities to allow expansion of the hatchery. If, in the future, additional water is required beyond what is presently available, drilling the contact where the present springs emerge would be the most successful strategy. However, the geology at this location is far from simple. Because of this, geologic mapping of the area should precede any future drilling attempts.

GENERAL GEOLOGY

The Rifle Falls Fish Hatchery is situated on alluvium and tufa deposits resting directly on the Pennsylvanian Minturn Formation. The Minturn contains sandstones, shales, and limestones. The tufa is a chemical sedimentary rock composed of gravels and deposits of calcium carbonate deposited from solution by waters percolating through the limestones in the drainage basin. These waters probably surfaced as springs along the fault zone crossing the north edge of the hatchery.

In the area of the hatchery, the Minturn interfingers with the Eagle Valley Evaporite which contains gypsum, anhydrite, siltstone, dolomite, and salt. The minerals in this formation dissolve readily and would probably make any ground water from them unacceptably high in dissolved solids and salts.

On the north side of the fault are rocks of Mississippian and Devonian age, including the Leadville Limestone. It appears that springs are emerging at the lithologic contacts exposed in the valley sides. These springs apparently contain good quality water.

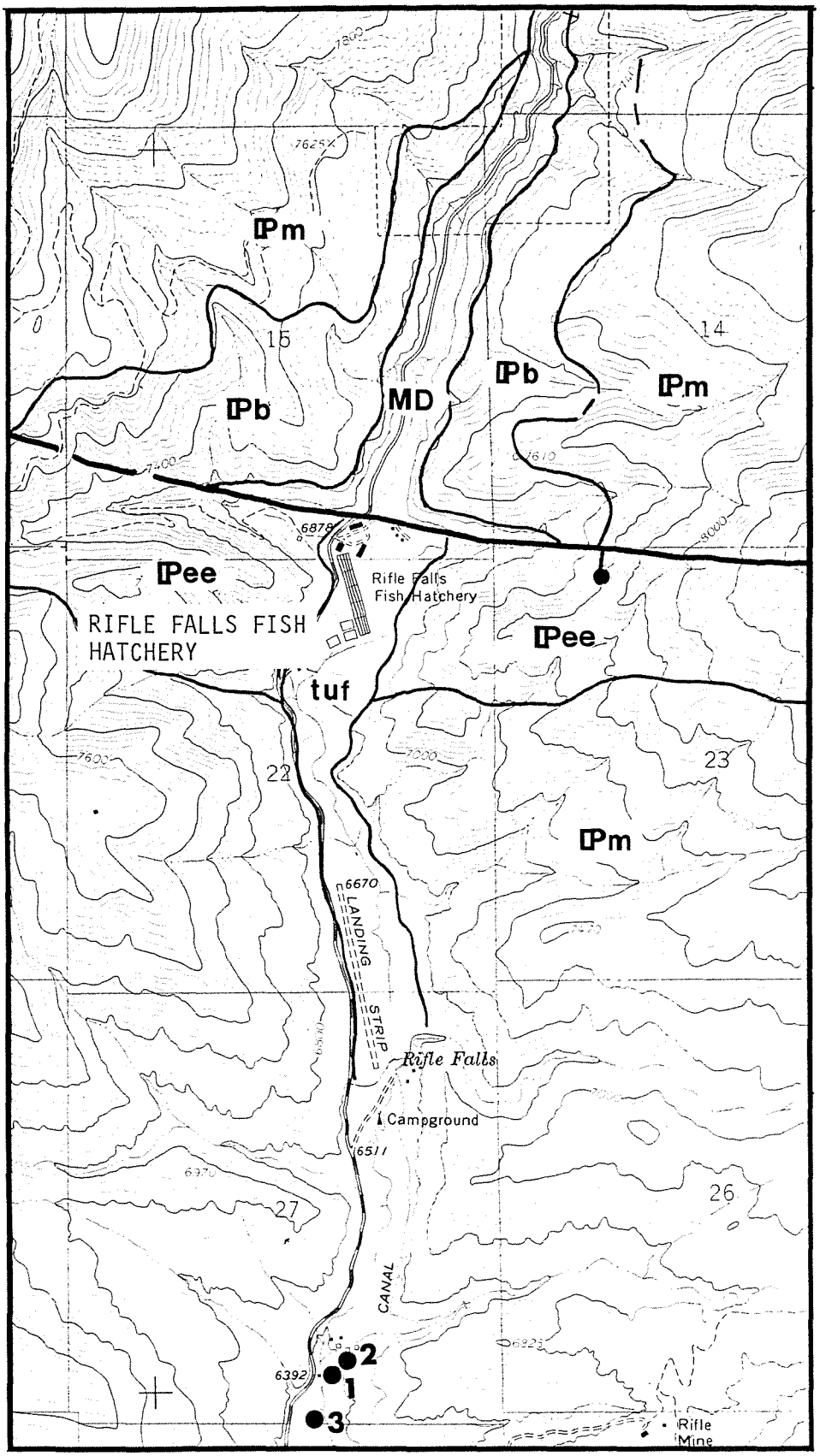


Figure 14, General geology and locations of selected registered wells, Rifle Falls Hatchery

REFERENCES

Tweto, O., et al, 1978; Geologic map of the Leadville 1° X 2° Quadrangle, northwestern Colorado: U.S. Geological Survey Miscellaneous Investigation Series Map No. I-999

Soule, J. M., and Stover, B. K., (in preparation); Surficial Geology, Geomorphology, and General Engineering Geology of parts of the Colorado River Valley, Roaring Fork River Valley, and adjacent areas, Garfield County, Colorado: Colorado Geological Survey Publication.

U.S. Geological Survey, Rifle Falls Quadrangle, 1966, Colorado - Garfield Co. 7.5 minute series, (topographic), scale 1:24,000.

ROARING JUDY FISH HATCHERY

SUMMARY OF FINDINGS

Potential Aquifers

1. Alluvium
2. Deep artesian (Entrada ?)

Depth to Water

1. Alluvium; 10-40 ft
2. Entrada; 670 ft

Potential Yields

1. Alluvium; 20-650 gpm
2. Entrada; 550 gpm

Water Quality

The water quality data for this location demonstrates that the Entrada Sandstone contains good quality water. Although elevated in iron and manganese, the total dissolved solids are quite low for water at this depth. This is consistent with water taken from the Entrada throughout the state, illustrating why this formation is one of Colorado's best aquifers.

RECOMMENDATIONS

The Roaring Judy Hatchery is located in a structurally complex area. There are at least two northwest to southeast trending faults crossing the northern part of the property and possibly a north to south trending fault on the east side of the valley. The result is a series of down-dropped blocks of sedimentary rocks underlaying the valley alluvium of the hatchery site.

It is our understanding that this hatchery has problems with both insufficient quantity of water and water that is too cold. It appears that water of sufficiently warm temperature is available in the Entrada Formation.

Well No. 2, drilled into the Entrada, is not currently being used because it was apparently completed with inappropriate casing. The records show this well produced 550 gpm.

Our first recommendation is that this well be recompleted in order to make it operational. This would be relatively inexpensive compared to the cost of drilling a new well.

If additional wells are desired, the two recommended areas are 1) a few hundred feet north of well No. 2, and 2) the area near the springs between the faults (see map).

The area south of the hatchery may be suitable for alluvial wells but not for drilling into the Entrada. Because of the westerly dip of the formations the eastern part of the valley floor is underlain by Precambrian metamorphics. The Entrada, which is eroded, appears only as a thin wedge across the valley floor (see cross-section A-A').

In the area of the springs the sedimentary rocks have dropped as a block down between the two northwest trending faults (see cross-section C-C'). In this area the Entrada probably maintains its full thickness and receives recharge both from water percolating down the fault zones and from water coming down through the alluvium and Morrison Fm. It is possible that if productive wells were located between the faults, the springs might dry up. Also, alluvial wells have been very productive in this area. Well No. 4 is recorded as producing 650 gpm.

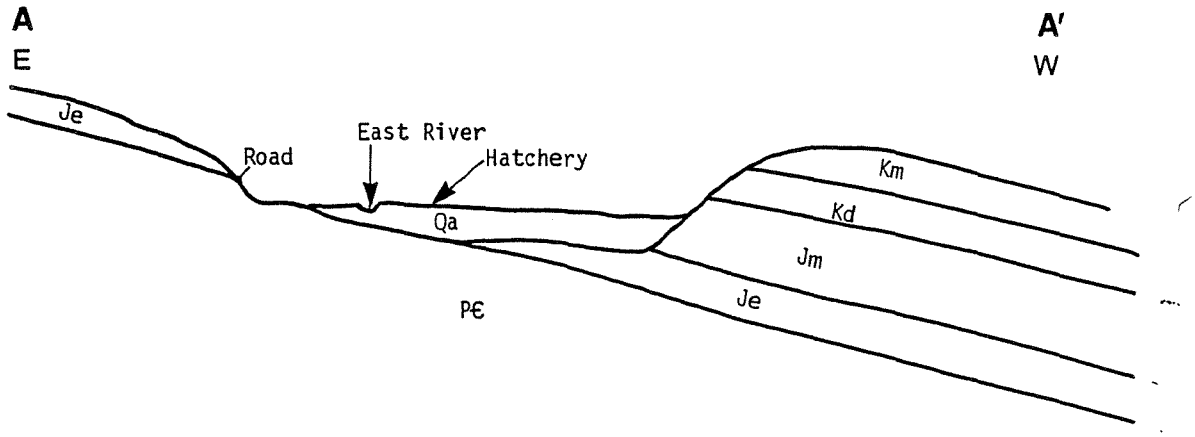
Cross-section B-B', which represents the west side of the valley, and was included in our earlier report to D.O.W., does not appear to be correct in the light of new information. A well drilled for D.O.W. (well No. 1) at the base of the hill encountered metamorphic rocks at about eighty feet. This would not agree with the cross-section and indicates that the geology in this area is even more complex than originally thought.

In our opinion, if well placement is considered in any areas other than the two recommended, detailed geologic mapping should be conducted.

Locating faults and determining their displacements at Roaring Judy would greatly aid understanding of the aquifers and ground water flow. Surface geophysical techniques could provide an inexpensive method of refining the geology of the site.

GENERAL GEOLOGY

The site at Roaring Judy is located on alluvial material of the East River valley. This material is about 60 feet thick under the site. Beneath this gravel and sand and on either side of the valley lies a thick sequence of largely undifferentiated sedimentary rocks - the Dakota Sandstone, Morrison and Junction Creek (Entrada) Formations. From a depth of 650 to 670 feet, these units have produced artesian water at a flow rate of 550 gpm. The specific producing unit may be the Junction Creek Formation. East of the site and across the river, a block of much older Precambrian gneiss is exposed, running in a northeasterly direction. This "basement" rock would probably yield very little water. Resting on top of the basement rocks lies the Junction Creek Sandstone (Entrada). This unit is at shallower depth on the east side of the river due to displacement along a fault. This fault bisects the hatchery property in a NW-SE trend.



EXPLANATION	
Qa	Alluvium
Km	Mancos Shale
Kd	Dakota Formation
Jm	Morrison Formation
Je	Entrada Formation
P€	Precambrian metamorphics

Figure 15. General geologic cross-section A-A', Roaring Judy Hatchery

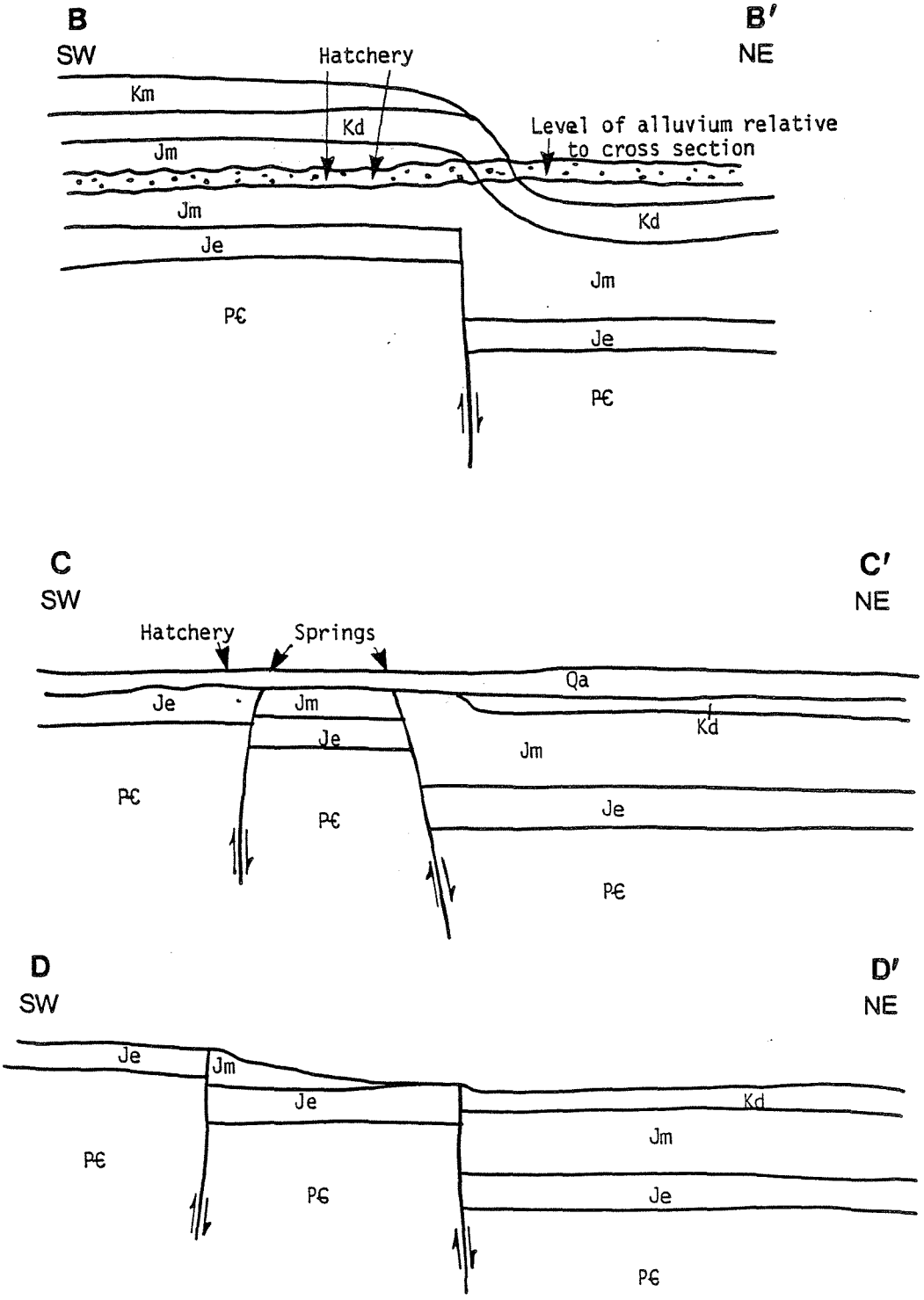


Figure 16. General geologic cross-sections B-B', C-C', and D-D', Roaring Judy Hatchery

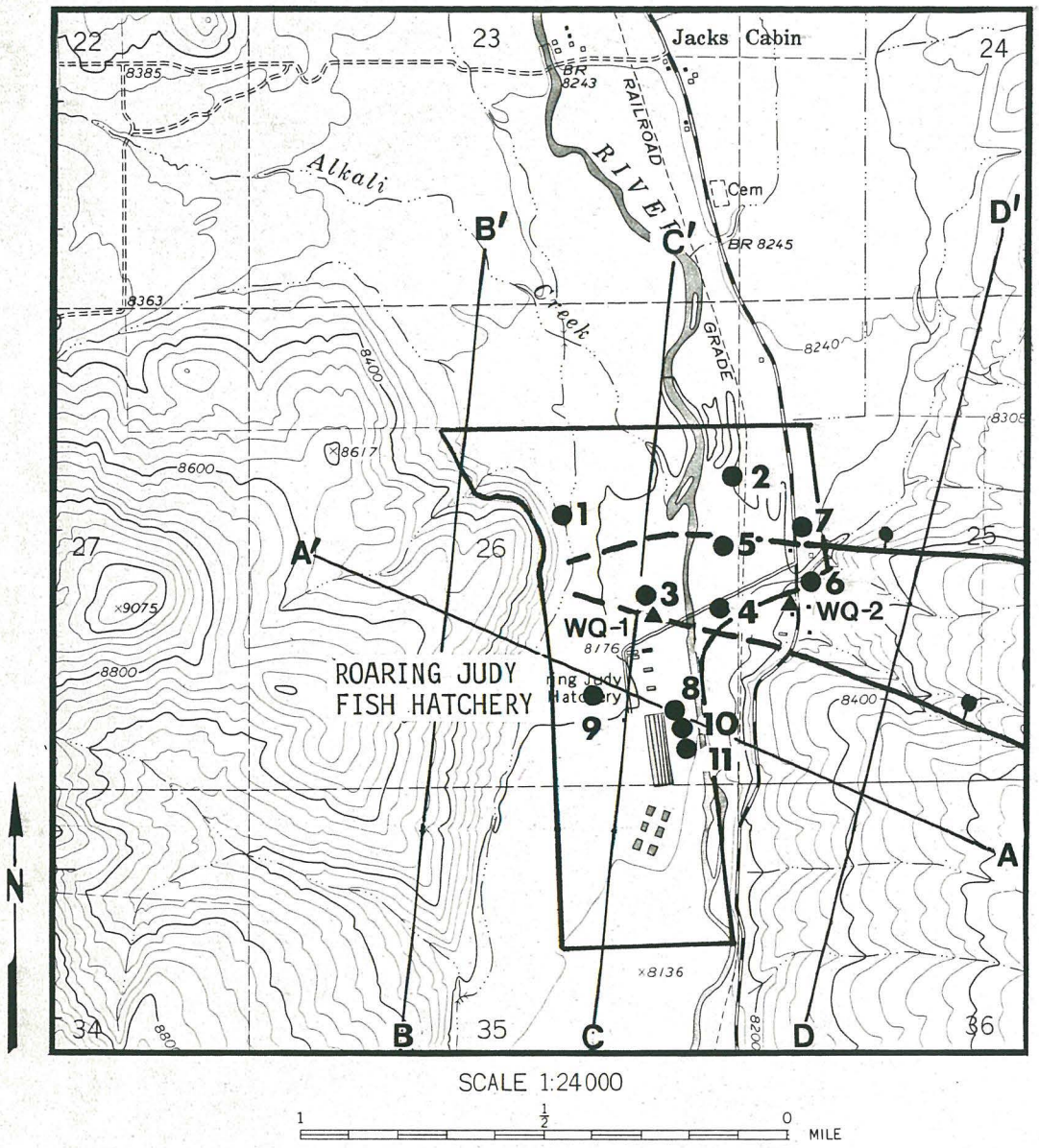


Figure 17. General geology, locations of selected registered wells, water quality samples, and cross-section lines, Roaring Judy Hatchery

Table 1

ROARING JUDY FISH HATCHERY

Information from selected registered wells

NO. ON MAP	WELL NO.	LOCATION Range	Township	Section	Qtr	Qtr	WELL YIELD (gpm)	WELL DEPTH (ft)	SLOTTED INTERVAL (ft)	STATIC WATER LEVEL (ft)	AQUIFER
1	4-26-013428F	85W	15S	26	SWNE		0	80	76-80	10	?
2	4-26-014280F	85W	15S	26	SENE		550	685	10-73/645-680	617 (?)	Entrada
3	4-26-022693F	85W	15S	26	NESE		325	6	22-53	050-60	Alluvium
4	4-26-022694F	85W	15S	26	NESE		650	30	10-30	11	Alluvium
5	4-26-022695F	85W	15S	26	NESE		555	55	15-55	5	Alluvium
6	4-26-014135	85W	15S	25	NESW		30	34	28-34	24	Alluvium
7	4-26-020246	85W	15S	25	SWNW		7	42	—	13	Alluvium
8	4-26-025496	85W	15S	26	SESE		25	60	45-60	40	Alluvium
9	4-26-027855	85W	15S	26	SWSE		20	60	50-60	24	Alluvium
10	4-26-027856	85W	15S	26	SESE		20	60	50-60	24	Alluvium
11	4-26-030717	85W	15S	26	SESE		30	42	32-42	11	Alluvium

DRILLERS LITHOLOGY
(as recorded in well records)

(1)
4-26-013428F

(FT)	
0-3	Soil
3-15	Clay
15-35	Sand & gravel
35-70	Shale, Blk w/shells
70-76	Lime, Blk
76-80	Granite

(2)
4-26-014280F

(FT)	
0-3	Soil & clay
3-10	Clay & Donies
10-75	Gravel & sand, Donies
75-78	Sand rock
78-85	Shale, Blk
85-105	Clay, yellow
105-250	Sh, Blk
250-285	Sh, White
285-295	Sand, light gray
295-306	Sh, sandy grey
306-320	Sh, Pink & Green
320-354	Sh, Green
354-374	Sh, & Shells, Pink & Green
374-381	Sh, Green
381-406	Sh, Gray & White
406-440	Lime shells w/Gray sh
440-443	Very hard shell
443-470	Gray & Green shale
470-490	Hard lime some chert
490-515	Sh, Gray & green w/shells
515-521	Lime, hard
521-590	Sh, Gray & Green
590-607	Hard shells w/ Gray Lime
607-625	Gray sandy lime
625-648	Sand, hard
648-670	Sand gray med. hard (artesian (H_2O)
670-673	Sand, dark gray very fine 50% lime
673-676	Sandy lime
676-685	Lime, porphyry

(3)
4-26-022693F

(FT)	
0-2	Soil
2-30	Boulders and clay
30-32	Sand
32-42	Rocks & clay
42-49	Rocks & clay
49-60	Clay

(4)
4-26-022694F

(FT)	
0-3	Soil
3-30	Large rocks & clay

(5)
4-26-022695F

(FT)	
0-4	Soil
4-36	Rock & clay
36-53	Rock & sand
53-55	———

(6)
4-26-014135

(FT)	
0-12	Soil & rocks
12-20	Sand, gravel & clay
20-34	Sand & gravel

(7)
4-26-020246

(FT)	
0-16	Soil w/ss Bldrs

(8)
4-26-025496

(FT)	
0-40	Rock & clay
40-60	Sand & gravel

(9)
4-26-027855

(FT)	
0-20	Clay & rock
20-60	Rock, sand & gravel

(10)
4-26-027856

(FT)	
0-25	Clay & Rock
25-60	Rock, sand & gravel

(11)
4-26-030717

(FT)	
0-3	Rock & soil
3-32	Clay & rock & sand
32-42	Sand & gravel

REFERENCES

Tweto, Ogden, et al., 1976, Preliminary geologic map of Montrose 1° X 2° Quadrangle, southwestern Colorado: U.S. Geological Survey, scale 1:250,000. U.S. Geological Survey Miscellaneous Field Studies Map No. MF-761.

U.S. Geological Survey, 1967, Almont Quadrangle, Colorado - Gunnison Co., 7.5 minute series (topographic), scale 1:24,000.

APPENDIX 1

(Water Quality Data)

Format for the station header information which appears on each page of the Storet data base information sheets.

```
                    Station number(s)
                    Latitude/Longitude precision code
                    Station Location
                    State/County Code State Name County Name
                    Major Basin Name Maj/Min/Sub Basin Code
                    Minor Basin Name
Station Type        Agency Code Hydrologic Unit Codes
        Sta.Depth   Sta.Stored Date Archive Class
River Mile Index
```

Aquifer Codes for Storet Data Base

COLORADO

CENOZOIC

CENOZOIC ERATHEM	100CNZC
CENOZOIC-MESOZOIC ERATHEMS	100CZMZ

QUATERNARY

QUATERNARY SYSTEM	110QRNR

HOLOCENE

ALLUVIUM,FLOOD PLAIN	111ALFP
ALLUVIUM,TERRACE	111AVMT
DUNE SAND	111DUNE
HOLOCENE SERIES	111HLCN
VALLEY-FILL DEPOSITS	111VLFL

PLEISTOCENE

GLACIAL DEPOSITS	112GLCL
PLEISTOCENE SERIES	112PLSC
SANTA FE FORMATION	112SNTF
TERRACE DEPOSITS	112TERC

TERTIARY

TERTIARY-CRETACEOUS SYSTEMS	120TRCC
TERTIARY SYSTEM	120TRTR

PLIOCENE

ALAMOSA FORMATION	121ALMS
DRY UNION FORMATION	121DRUN
NORTH PARK FORMATION	121NRPK
OGALLALA FORMATION	1210GLL
PLIOCENE-MIOCENE SERIES	121PCMC
PLIOCENE SERIES	121PLCN

MIOCENE

ARIKAREE FORMATION	122ARKR
BROWNS PARK FORMATION	122BRPK
MIOCENE SERIES	122MOCN

OLIGOCENE

BRULE FORMATION OF WHITE RIVER GROUP	123BRUL
CHADRON FORMATION OF WHITE RIVER GROUP	123CDRN
CASTLE ROCK CONGLOMERATE	123CRCK
OLIGOCENE SERIES	1230LGC
WHITE RIVER GROUP	123WRVR

EOCENE

CUCHARA FORMATION	124CCHR
DEVILS HOLE FORMATION	124DVLH
EOCENE-PALEOCENE SERIES	124ECPC
EOCENE SERIES	124EOCN
FARASITA CONGLOMERATE	124FRST
GREEN RIVER FORMATION	124GRRV
HUERFANO FORMATION	124HRFN
INTRUSIVE ROCKS	124IRSV
SAN JOSE AND NACIMIENTO FORMATIONS,UNDIFFERENTIATED (EOCENE-PALEOCENE)	124SJNM
SAN JOSE FORMATION	124SNJS
WASATCH FORMATION	124WSTC

PALEOCENE

ANIMAS FORMATION (PALEOCENE-UPPER CRETACEOUS)	125ANMS
DENVER FORMATION	125DNVR
DAWSON FORMATION	125DWSN
KIRTLAND SHALE	125KRLD
MIDDLE PARK FORMATION	125MDPK
NACIMIENTO FORMATION	125NCMN
OJO ALAMO SANDSTONE	125OJAM
PALEOCENE SERIES	125PLCN
POISON CANYON FORMATION	125PSNC
RATON FORMATION	125RTON

MESOZOIC

MESOZOIC ERATHEM	200MSZC
MESOZOIC-PALEOZOIC ERATHEMS	200MZPZ

CRETACEOUS

CRETACEOUS SYSTEM	210CRCS
DAKOTA GROUP	210DKOT

UPPER CRETACEOUS

A SANDSTONE MEMBER OF LARAMIE FORMATION	211A
ARAPAHOE CONGLOMERATE MEMBER OF LARAMIE FORMATION	211ARPH
BRIDGE CREEK LIMESTONE MEMBER OF GREENHORN LIMESTONE	211BGCK
BLUE HILL SHALE MEMBER OF CARLILE SHALE	211BLHL
B SANDSTONE MEMBER OF LARRIMIE FORMATION	211BLRM
BENTON SHALE	211BNTN
CODELL SANDSTONE MEMBER OF CARLILE SHALE	211CDLL
CLIFF HOUSE SANDSTONE OF MESAVERDE GROUP	211CLFH
UPPER CRETACEOUS SERIES	211CRCSU
CARLILE SHALE	211CRLL
FORT HAYS LIMESTONE MEMBER OF NIOBRARA FORMATION	211FRHS
FRUITLAND FORMATION	211FRLD
FAIRPORT CHALKY SHALE MEMBER OF CARLILE SHALE	211FRPR
FOX HILLS SANDSTONE	211FXHL
GREENHORN LIMESTONE	211GRNR
GRANEROS SHALE	211GRRS
HARTLAND SHALE MEMBER OF GREENHORN LIMESTONE	211HRLD

HYGIENE SANDSTONE MEMBER OF PIERRE SHALE..... 211HYGN
LINCOLN MEMBER OF GREENHORN LIMESTONE..... 211LNCL
LARAMIE FORMATION..... 211LRMI
LARIMER SANDSTONE MEMBER OF PIERRE SHALE..... 211LRMR
LEWIS SHALE..... 211LWIS
MCDERMOTT MEMBER OF ANIMAS FORMATION..... 211MCDM
MENEFEE FORMATION OF MESAVERDE GROUP..... 211MENF
MILLIKEN SANDSTONE MEMBER OF FOX HILLS SANDSTONE..... 211MLKN
MANCOS SHALE..... 211MNCS
MESAVERDE GROUP..... 211MVRD
NIOBRARA FORMATION..... 211NBRR
PICTURED CLIFFS SANDSTONE..... 211PCCF
PIERRE SHALE..... 211PIRR
POINT LOOKOUT SANDSTONE MEMBER OF MESAVERDE GROUP..... 211PNLK
RICHARD SANDSTONE MEMBER OF PIERRE SHALE..... 211RCRD
ROCKY RIDGE SANDSTONE MEMBER OF PIERRE SHALE..... 211RKRG
SMOKY HILL MARL MEMBER OF NIOBRARA FORMATION..... 211SMKH
TRINIDAD SANDSTONE..... 211TRDD
TRANSITION ZONE..... 211TRNS
TERRY SANDSTONE MEMBER OF PIERRE SHALE..... 211TRRY
VERMEJO FORMATION..... 211VRMJ

LOWER CRETACEOUS

BURRO CANYON FORMATION..... 217BRCN
LOWER CRETACEOUS SERIES..... 217CRCSL
CHEYENNE SANDSTONE MEMBER OF PURGATORIE FORMATION..... 217CYNN
KIOWA SHALE MEMBER OF PURGATORIE FORMATION..... 217KIOW
LYTLE FORMATION OF DAKOTA GROUP..... 217LYTL
MOWRY SHALE..... 217MWRY
PLAINVIEW SANDSTONE MEMBER OF SOUTH PLATTE FORMATION..... 217PLNV
PURGATORIE FORMATION..... 217PRGR
SOUTH PLATTE FORMATION OF DAKOTA GROUP..... 217STPL

JURASSIC

GLEN CANYON GROUP..... 220GLNC
JURASSIC-TRIASSIC SYSTEMS..... 220JCTC
JURASSIC SYSTEM..... 220JRSC
NAVAJO SANDSTONE OF GLEN CANYON GROUP..... 220NVJO

UPPER JURASSIC

BRUSHY BASIN SHALE MEMBER OF MORRISON FORMATION..... 221BRSB
CURTIS FORMATION OF SAN RAFAEL GROUP..... 221CRTS
ENTRADA SANDSTONE..... 221ENRD
JUNCTION CREEK SANDSTONE OF SAN RAFAEL GROUP..... 221JCCK
UPPER JURASSIC SERIES..... 221JRSCU
MOAB MEMBER OF ENTRADA SANDSTONE..... 221MOAB
MORRISON FORMATION..... 221MRSN
RECAPTURE SHALE MEMBER OF MORRISON FORMATION..... 221RCPR
RALSTON CREEK FORMATION..... 221RLCK
SLICK ROCK MEMBER OF ENTRADA SANDSTONE..... 221SKRK
SALT WASH SANDSTONE MEMBER OF MORRISON FORMATION..... 221SLWS
SUMMERVILLE FORMATION OF SAN RAFAEL GROUP..... 221SMVL
SAN RAFAEL GROUP..... 221SRFL

WESTWATER CANYON SANDSTONE MEMBER OF MORRISON FORMATION..... 221WSRC

MIDDLE JURASSIC

MIDDLE JURASSIC SERIES..... 224JRSCM

LOWER JURASSIC

LOWER JURASSIC SERIES..... 227JRSCL

TRIASSIC

LYKINS FORMATION..... 230LKNS
TRIASSIC-PERMIAN SYSTEMS..... 230TCPM
TRIASSIC SYSTEM..... 230TRSC

UPPER TRIASSIC

CHINLE FORMATION OF DOCKUM GROUP..... 231CHNL
DOCKUM GROUP..... 231DCKM
JELM FORMATION..... 231JELM
KAYENTA FORMATION OF GLEN CANYON GROUP..... 231KYNT
UPPER TRIASSIC SERIES..... 231TRSCU
WINGATE SANDSTONE OF GLEN CANYON GROUP..... 231WNGT

MIDDLE TRIASSIC

MIDDLE TRIASSIC SERIES..... 234TRSCM

LOWER TRIASSIC

LOWER TRIASSIC SERIES..... 237TRSCL

PALEOZOIC

PALEOZOIC ERATHEM..... 300PLZC

PERMIAN

LYONS FORMATION..... 310LYNS
PERMIAN-PENNSYLVANIAN SYSTEMS..... 310PMPV
PERMIAN SYSTEM..... 310PRMN
SANGRE DE CRISTO FORMATION..... 310SGRC
SATANKA SHALE..... 310STNK

UPPER PERMIAN

BIG BASIN FORMATION..... 311BGBS
UPPER PERMIAN SERIES..... 311PRMNU
TALOGA FORMATION OF CRAGIN..... 311TOLG

LOWER PERMIAN

FOUNTAIN FORMATION..... 317FNTN
INGLESIDE FORMATION..... 317IGLD
LOWER PERMIAN SERIES..... 317PRMNL

STORET RETRIEVAL DATE 85/05/09
403742105101201
40 37 42.0 105 10 12.0 2 Bellvue/Watson water quality sample 1
SB00806930ACC
08069 COLORADO LARIMER

112WRD 10190007 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			64/05/19	64/09/09	65/05/25	
	INITIAL TIME-DEPTH-BOTTOM						
00010	WATER	TEMP	CENT	13.3	15.6		
00011	WATER	TEMP	FAHN	56.0	60.0		
00095	CNDUCTVY	AT 25C	MICROMHO	679	673		
00400	PH		SU	7.80	8.00		
00410	T ALK	CACO3	MG/L	207	210	208	
00440	HCO3 ION	HCO3	MG/L	253	256		
00445	CO3 ION	CO3	MG/L	0	0		
00900	TOT HARD	CACO3	MG/L	352	345	349	
00902	NC HARD	CACO3	MG/L	145	135	141	
00915	CALCIUM	CA,DISS	MG/L	77.0	75.0		
00925	MGNSIUM	MG,DISS	MG/L	39.0	39.0		
00930	SODIUM	NA,DISS	MG/L	11.00	11.00		
00931	SODIUM	ADSBTION	RATIO	0.3	0.3	0.3	
00935	PTSSIUM	K,DISS	MG/L	1.90	0.80		
00940	CHLORIDE	TOTAL	MG/L	31	31		
00945	SULFATE	SO4-TOT	MG/L	74	66		
00950	FLUORIDE	F,DISS	MG/L	0.20	0.10	0.60	
00955	SILICA	DISOLVED	MG/L	10.0	11.0		
01020	BORON	B,DISS	UG/L	0	0	0	
70300	RESIDUE	DISS-180	C MG/L	465	454	439	
71851	NITRATE	DISS-NO3	MG/L	71.0	62.0	64.0	
71885	IRON	FE	UG/L	670.00	10.00	110.00	
72008	TOT DPTH	OF WELL	FT	44.0	44.0	44.0	

STORET RETRIEVAL DATE 85/05/09
 403657105082101 Bellvue/Watson water
40 36 57.0 105 08 21.0 2 quality sample 2
SB00806932DBD1
08069 COLORADO LARIMER
U

112WRD 10190007 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			61/01/05
	INITIAL TIME-DEPTH-BOTTOM			1200
00010	WATER	TEMP	CENT	9.0
00011	WATER	TEMP	FAHN	48.2
00410	T ALK	CACO3	MG/L	267
00440	HCO3 ION	HCO3	MG/L	326
00618	NO3-N	DISS	MG/L	0.05
00900	TOT HARD	CACO3	MG/L	357
00902	NC HARD	CACO3	MG/L	90
00915	CALCIUM	CA,DISS	MG/L	111.0
00925	MGNSIUM	MG,DISS	MG/L	19.0
00930	SODIUM	NA,DISS	MG/L	62.00
00931	SODIUM	ADSBTION	RATIO	1.4
00932	PERCENT	SODIUM	%	27
00935	PTSSIUM	K,DISS	MG/L	1.70
00940	CHLORIDE	TOTAL	MG/L	1
00945	SULFATE	SO4-TOT	MG/L	215
00950	FLUORIDE	F,DISS	MG/L	0.40
00955	SILICA	DISOLVED	MG/L	11.0
01020	BORON	B,DISS	UG/L	50
01046	IRON	FE,DISS	UG/L	30
70301	DISS SOL	SUM	MG/L	580
71851	NITRATE	DISS-NO3	MG/L	0.2
72008	TOT DPTH	OF WELL	FT	22.7
72019	DEPTH-FT	BL LAND	SURFACE	5.60
84000	GEOLOGIC	AGE	CODE	111A
84001	AQUIFER	NAME	CODE	LFP

STORET RETRIEVAL DATE 85/04/23
384358106102700
38 43 58.0 106 10 27.0 2
HORTENSE HOT WATER WELL
08015 COLORADO CHAFFEE

Chalk Cliff water quality
sample no. 1

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/07/01	
	INITIAL TIME-DEPTH-BOTTOM			1345	
00010	WATER	TEMP	CENT	82.0	
00011	WATER	TEMP	FAHN	179.6	
00095	CNDUCTVY	AT 25C	MICROMHO	420	
00410	T ALK	CACO3	MG/L	62	
00440	HCO3 ION	HCO3	MG/L	75	
00631	NO2&NO3	N-DISS	MG/L	0.0	
00660	ORTHOPO4	PO4	MG/L	0.03	
00671	PHOS-DIS	ORTHO	MG/L P	0.010	
00900	TOT HARD	CACO3	MG/L	20	
00902	NC HARD	CACO3	MG/L	0	
00915	CALCIUM	CA,DISS	MG/L	6.4	
00925	MGNSIUM	MG,DISS	MG/L	1.0	
00930	SODIUM	NA,DISS	MG/L	84.00	
00931	SODIUM	ADSBTION	RATIO	8.2	
00932	PERCENT	SODIUM	%	89	
00935	PTSSIUM	K,DISS	MG/L	2.80	
00940	CHLORIDE	TOTAL	MG/L	8	
00945	SULFATE	SO4-TOT	MG/L	92	
00950	FLUORIDE	F,DISS	MG/L	14.00	
00955	SILICA	DISOLVED	MG/L	72.0	
01000	ARSENIC	AS,DISS	UG/L	2	
01005	BARIUM	BA,DISS	UG/L	43	
01010	BERYLIUM	BE,DISS	UG/L	10.00	K
01015	BISMUTH	BI,DISS	UG/L	3	K
01020	BORON	B,DISS	UG/L	50	
01025	CADMIUM	CD,DISS	UG/L	4	K
01030	CHROMIUM	CR,DISS	UG/L	2	K
01035	COBALT	CO,DISS	UG/L	2	K
01040	COPPER	CU,DISS	UG/L	5	
01046	IRON	FE,DISS	UG/L	40	
01049	LEAD	PB,DISS	UG/L	3	
01056	MANGNESE	MN,DISS	UG/L	2.0	K
01060	MOLY	MO,DISS	UG/L	60	
01065	NICKEL	NI,DISS	UG/L	2	K
01075	SILVER	AG,DISS	UG/L	0.0	U
01080	STRONTUM	SR,DISS	UG/L	180	
01085	VANADIUM	V,DISS	UG/L	2	
01090	ZINC	ZN,DISS	UG/L	14	
01100	TIN	SN,DISS	UG/L	2	K
01106	ALUMINUM	AL,DISS	UG/L	130	
01120	GALLIUM	GA,DISS	UG/L	8	
01125	GERMANUM	GE,DISS	UG/L	3	K
01130	LITHIUM	LI,DISS	UG/L	180	
01145	SELENIUM	SE,DISS	UG/L	1	K
01150	TITANIUM	TI,DISS	UG/L	2	K

(SAMPLE CONTINUED ON NEXT PAGE)

STORET RETRIEVAL DATE 85/04/23
384358106102500
38 43 58.0 106 10 25.0 2
WRIGHT HOT WATER WELL WEST
08015 COLORADO CHAFFEE

Chalk Cliff water quality
sample no.2

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/07/01
	INITIAL TIME-DEPTH-BOTTOM			1300
00010	WATER	TEMP	CENT	72.0
00011	WATER	TEMP	FAHN	161.6
00095	CNDUCTVY	AT 25C	MICROMHO	370
00410	T ALK	CACO3	MG/L	59
00440	HCO3 ION	HCO3	MG/L	72
00631	NO2&NO3	N-DISS	MG/L	0.1
00660	ORTHOPO4	PO4	MG/L	27.00
00671	PHOS-DIS	ORTHO	MG/L P	8.800
00900	TOT HARD	CACO3	MG/L	16
00902	NC HARD	CACO3	MG/L	0
00915	CALCIUM	CA,DISS	MG/L	5.8
00925	MGNSIUM	MG,DISS	MG/L	0.3
00930	SODIUM	NA,DISS	MG/L	73.00
00931	SODIUM	ADSBTION	RATIO	8.0
00932	PERCENT	SODIUM	%	89
00935	PTSSIUM	K,DISS	MG/L	2.50
00940	CHLORIDE	TOTAL	MG/L	6
00945	SULFATE	SO4-TOT	MG/L	81
00950	FLUORIDE	F,DISS	MG/L	13.00
00955	SILICA	DISOLVED	MG/L	68.0
01000	ARSENIC	AS,DISS	UG/L	1
01020	BORON	B,DISS	UG/L	30
01025	CADMIUM	CD,DISS	UG/L	0 U
01046	IRON	FE,DISS	UG/L	20
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01090	ZINC	ZN,DISS	UG/L	20
01130	LITHIUM	LI,DISS	UG/L	100
01145	SELENIUM	SE,DISS	UG/L	1 K
70301	DISS SOL	SUM	MG/L	313
70303	DISS SOL	TONS PER	ACRE-FT	0.43
71890	MERCURY	HG,DISS	UG/L	0.5 K
84000	GEOLOGIC	AGE	CODE	1230
84001	AQUIFER	NAME	CODE	LGC

Chalk Cliff water quality
sample no. 3

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STORET RETRIEVAL DATE 85/04/23
 384358106094100
38 43 58.0 106 09 41.0  2
X-24
08001 COLORADO          ADAMS


112WRD              11020001              ON
        780228      DEPTH    0
/TYPA/AMBNT/WELL
INDEX
MILES
     INITIAL DATE                          75/07/01
     INITIAL TIME-DEPTH-BOTTOM
00010  WATER      TEMP       CENT          49.0
00011  WATER      TEMP       FAHN         120.2
00061  STREAM     FLOW,    INST-CFS          12
00095 CNDUCTVY  AT 25C    MICROMHO         310
00410  T ALK      CACO3      MG/L            60
00440 HCO3 ION    HCO3       MG/L            73
00631 NO2&NO3   N-DISS       MG/L           0.2
00660 ORTHOPO4    PO4        MG/L          0.12
00671 PHOS-DIS  ORTHO      MG/L P         0.040
00900 TOT HARD  CACO3        MG/L            32
00902 NC HARD   CACO3        MG/L             0
00915 CALCIUM   CA,DISS      MG/L          12.0
00925 MGNSIUM   MG,DISS      MG/L           0.5
00930  SODIUM   NA,DISS      MG/L         50.00
00931  SODIUM   ADSBTION     RATIO          3.8
00932  PERCENT   SODIUM      %               76
00935 PTSSIUM    K,DISS      MG/L          1.90
00940 CHLORIDE    TOTAL      MG/L             4
00945 SULFATE   SO4-TOT       MG/L            58
00950 FLUORIDE   F,DISS       MG/L          8.30
00955  SILICA   DISOLVED      MG/L          57.0
01000 ARSENIC   AS,DISS       UG/L             1
01020  BORON     B,DISS       UG/L            20 K
01025 CADMIUM    CD,DISS      UG/L             0 U
01046   IRON    FE,DISS       UG/L            10 K
01056 MANGNESE  MN,DISS       UG/L          10.0 K
01090   ZINC    ZN,DISS       UG/L             0 U
01130 LITHIUM   LI,DISS       UG/L            80
01145 SELENIUM  SE,DISS       UG/L             1 K
70301 DISS SOL    SUM         MG/L           229
70302 DISS SOL  TONS/DAY                    7.42
70303 DISS SOL  TONS PER  ACRE-FT           0.31
71890 MERCURY   HG,DISS       UG/L           0.5 K
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STORET RETRIEVAL DATE 85/04/23
384358106093600
38 43 58.0 106 09 39.0 2
SC01507819BCA2
08015 COLORADO CHAFFEE

Chalk Cliff water quality
sample no. 4

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			72/11/16	
	INITIAL TIME-DEPTH-BOTTOM			2359	
00010	WATER	TEMP	CENT	53.0	
00011	WATER	TEMP	FAHN	127.4	
00095	CNDUCTVY	AT 25C	MICROMHO	328	
00400	PH		SU	8.00	
00405	CO2		MG/L	1.2	
00410	T ALK	CACO3	MG/L	62	
00440	HCO3 ION	HCO3	MG/L	76	
00445	CO3 ION	CO3	MG/L	0	
00631	NO2&NO3	N-DISS	MG/L	0.1	
00660	ORTHOPO4	PO4	MG/L	0.09	
00671	PHOS-DIS	ORTHO	MG/L P	0.030	
00900	TOT HARD	CACO3	MG/L	32	
00902	NC HARD	CACO3	MG/L	0	
00915	CALCIUM	CA,DISS	MG/L	12.0	
00925	MGNSIUM	MG,DISS	MG/L	0.4	
00930	SODIUM	NA,DISS	MG/L	58.00	
00931	SODIUM	ADSBTION	RATIO	4.5	
00932	PERCENT	SODIUM	%	79	
00935	PTSSIUM	K,DISS	MG/L	2.20	
00940	CHLORIDE	TOTAL	MG/L	4	
00945	SULFATE	SO4-TOT	MG/L	68	
00950	FLUORIDE	F,DISS	MG/L	9.80	
00955	SILICA	DISOLVED	MG/L	61.0	
01020	BORON	B,DISS	UG/L	20	K
01040	COPPER	CU,DISS	UG/L	20	
01046	IRON	FE,DISS	UG/L	40	
01056	MANGNESE	MN,DISS	UG/L	10.0	K
01080	STRONTUM	SR,DISS	UG/L	210	
01090	ZINC	ZN,DISS	UG/L	0	U
01106	ALUMINUM	AL,DISS	UG/L	10	
01130	LITHIUM	LI,DISS	UG/L	90	
70301	DISS SOL	SUM	MG/L	254	
70303	DISS SOL	TONS PER	ACRE-FT	0.35	
71890	MERCURY	HG,DISS	UG/L	1.1	
84000	GEOLOGIC	AGE	CODE	120I	
84001	AQUIFER	NAME	CODE	RSV	

STORET RETRIEVAL DATE 85/04/23
384515106084000
38 45 15.0 106 08 40.0 2 Chalk Cliff water quality
X-26 sample no. 5
08001 COLORADO

112WRD
780228 DEPTH 0
/TYPA/AMBNT/WELL

	INITIAL DATE			73/09/26
	INITIAL TIME-DEPTH-BOTTOM			2100 0840
00003	VSAMPLOC	DEPTH	FEET	840
00010	WATER	TEMP	CENT	18.0
00011	WATER	TEMP	FAHN	64.4
00060	STREAM	FLOW	CFS	0
00095	CNDUCTVY	AT 25C	MICROMHO	202
00400	PH		SU	7.60
00405	CO2		MG/L	4.5
00410	T ALK	CACO3	MG/L	93
00440	HCO3 ION	HCO3	MG/L	113
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	1.1
00660	ORTHOPO4	PO4	MG/L	0.12
00666	PHOS-DIS		MG/L P	0.030
00671	PHOS-DIS	ORTHO	MG/L P	0.040
00900	TOT HARD	CACO3	MG/L	81
00902	NC HARD	CACO3	MG/L	0
00915	CALCIUM	CA,DISS	MG/L	27.0
00925	MGNSIUM	MG,DISS	MG/L	3.2
00930	SODIUM	NA,DISS	MG/L	9.70
00931	SODIUM	ADSBTION	RATIO	0.5
00932	PERCENT	SODIUM	%	20
00935	PTSSIUM	K,DISS	MG/L	1.30
00940	CHLORIDE	TOTAL	MG/L	1
00945	SULFATE	SO4-TOT	MG/L	9
00950	FLUORIDE	F,DISS	MG/L	0.20
00955	SILICA	DISOLVED	MG/L	15.0
01046	IRON	FE,DISS	UG/L	160
01056	MANGNESE	MN,DISS	UG/L	50.0
01106	ALUMINUM	AL,DISS	UG/L	40
70301	DISS SOL	SUM	MG/L	127
70302	DISS SOL	TONS/DAY		0.00
70303	DISS SOL	TONS PER	ACRE-FT	0.17

STORET RETRIEVAL DATE 85/04/23
 384444106073800
38 44 44.0 106 07 38.0 2
HATCHERY COLD WELL
08015 COLORADO CHAFFEE

Chalk Cliff water quality
sample no. 6

112WRD 11020001 ON
 780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			76/07/29
	INITIAL TIME-DEPTH-BOTTOM			1730
00010	WATER	TEMP	CENT	10.0
00011	WATER	TEMP	FAHN	50.0
00095	CNDUCTVY	AT 25C	MICROMHO	310
00400	PH		SU	7.50
07000	H-3	TOTAL	PC/L	920.0

STORET RETRIEVAL DATE 85/04/23
392350107111400
39 23 50.0 107 11 14.0 2
SC00708835DCB CONTINENTAL COAL
08045 COLORADO GARFIELD

Crystal River water quality
sample no. 1

112WRD 14010004 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/04/25
	INITIAL TIME-DEPTH-BOTTOM			1300
00010	WATER	TEMP	CENT	18.0
00011	WATER	TEMP	FAHN	64.4
00095	CNDUCTVY	AT 25C	MICROMHO	1900
00400	PH		SU	6.80
00405	CO2		MG/L	72.0
00410	T ALK	CACO3	MG/L	232
00440	HCO3 ION	HCO3	MG/L	283
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.0
00660	ORTHOPO4	PO4	MG/L	0.09
00671	PHOS-DIS	ORTHO	MG/L P	0.030
00900	TOT HARD	CACO3	MG/L	1100
00902	NC HARD	CACO3	MG/L	910
00915	CALCIUM	CA,DISS	MG/L	390.0
00925	MGNSIUM	MG,DISS	MG/L	42.0
00930	SODIUM	NA,DISS	MG/L	6.20
00931	SODIUM	ADSBTION	RATIO	0.1
00932	PERCENT	SODIUM	%	1
00935	PTSSIUM	K,DISS	MG/L	2.50
00940	CHLORIDE	TOTAL	MG/L	3
00945	SULFATE	SO4-TOT	MG/L	870
00950	FLUORIDE	F,DISS	MG/L	0.30
00955	SILICA	DISOLVED	MG/L	8.6
01000	ARSENIC	AS,DISS	UG/L	1 K
01046	IRON	FE,DISS	UG/L	2000
01056	MANGNESE	MN,DISS	UG/L	100.0
01145	SELENIUM	SE,DISS	UG/L	1 K
70301	DISS SOL	SUM	MG/L	1460
70303	DISS SOL	TONS PER	ACRE-FT	1.99
84000	GEOLOGIC	AGE	CODE	111V
84001	AQUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
392348107131601
39 23 48.0 107 13 16.0 2
SC00708833DDD FENDER
08045 COLORADO GARFIELD

Crystal River water quality
sample no. 2

112WRD 14010004 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/04/18
	INITIAL TIME-DEPTH-BOTTOM			1200
00010	WATER	TEMP	CENT	33.0
00011	WATER	TEMP	FAHN	91.4
00095	CNDUCTVY	AT 25C	MICROMHO	900
00400	PH		SU	7.15
00405	CO2		MG/L	30.0
00410	T ALK	CACO3	MG/L	217
00440	HCO3 ION	HCO3	MG/L	265
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.6
00660	ORTHOPO4	PO4	MG/L	0.03
00671	PHOS-DIS	ORTHO	MG/L P	0.010
00900	TOT HARD	CACO3	MG/L	530
00902	NC HARD	CACO3	MG/L	310
00915	CALCIUM	CA,DISS	MG/L	170.0
00925	MGNSIUM	MG,DISS	MG/L	26.0
00930	SODIUM	NA,DISS	MG/L	16.00
00931	SODIUM	ADSBTION	RATIO	0.3
00932	PERCENT	SODIUM	%	6
00935	PTSSIUM	K,DISS	MG/L	1.60
00940	CHLORIDE	TOTAL	MG/L	5
00945	SULFATE	SO4-TOT	MG/L	320
00950	FLUORIDE	F,DISS	MG/L	0.10
00955	SILICA	DISOLVED	MG/L	12.0
01000	ARSENIC	AS,DISS	UG/L	1 K
01046	IRON	FE,DISS	UG/L	50
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01145	SELENIUM	SE,DISS	UG/L	1 K
70301	DISS SOL	SUM	MG/L	684
70303	DISS SOL	TONS PER	ACRE-FT	0.93
84000	GEOLOGIC	AGE	CODE	111V
84001	AQUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
 392303107120101
39 23 03.0 107 12 01.0 2
SC00808803DBA HATTIE COOPER
08045 COLORADO GARFIELD

Crystal River water quality
sample no. 3

112WRD 14010004 ON
 780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/04/18
	INITIAL TIME-DEPTH-BOTTOM			0800
00010	WATER	TEMP	CENT	30.0
00011	WATER	TEMP	FAHN	86.0
00095	CNDUCTVY	AT 25C	MICROMHO	610
00400	PH		SU	7.20
00405	CO2		MG/L	35.0
00410	T ALK	CACO3	MG/L	281
00440	HCO3 ION	HCO3	MG/L	342
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	1.0
00660	ORTHOPO4	PO4	MG/L	0.09
00671	PHOS-DIS	ORTHO	MG/L P	0.030
00900	TOT HARD	CACO3	MG/L	410
00902	NC HARD	CACO3	MG/L	130
00915	CALCIUM	CA,DISS	MG/L	100.0
00925	MGNSIUM	MG,DISS	MG/L	38.0
00930	SODIUM	NA,DISS	MG/L	34.00
00931	SODIUM	ADSBTION	RATIO	0.7
00932	PERCENT	SODIUM	%	15
00935	PTSSIUM	K,DISS	MG/L	1.90
00940	CHLORIDE	TOTAL	MG/L	3
00945	SULFATE	SO4-TOT	MG/L	180
00950	FLUORIDE	F,DISS	MG/L	0.20
00955	SILICA	DISOLVED	MG/L	25.0
01000	ARSENIC	AS,DISS	UG/L	1 K
01046	IRON	FE,DISS	UG/L	250
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01145	SELENIUM	SE,DISS	UG/L	1
70301	DISS SOL	SUM	MG/L	556
70303	DISS SOL	TONS PER	ACRE-FT	0.76
84000	GEOLOGIC	AGE	CODE	111V
84001	AQUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
392240107121000
39 22 40.0 107 12 10.0 2 Crystal River water quality
SC00808810AAC GAME & FISH DEPT sample no. 4
08045 COLORADO GARFIELD

112WRD 14010004 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/02/24	
	INITIAL TIME-DEPTH-BOTTOM			1430	
00010	WATER	TEMP	CENT	9.5	
00011	WATER	TEMP	FAHN	49.1	
00095	CNDUCTVY	AT 25C	MICROMHO	720	
00400	PH		SU	7.10	
00405	CO2		MG/L	30.0	
00410	T ALK	CACO3	MG/L	195	
00440	HCO3 ION	HCO3	MG/L	238	
00445	CO3 ION	CO3	MG/L	0	
00631	NO2&NO3	N-DISS	MG/L	0.5	
00660	ORTHOPO4	PO4	MG/L	0.00	
00671	PHOS-DIS	ORTHO	MG/L P	0.010	K
00900	TOT HARD	CACO3	MG/L	340	
00902	NC HARD	CACO3	MG/L	150	
00915	CALCIUM	CA,DISS	MG/L	110.0	
00925	MGNSIUM	MG,DISS	MG/L	16.0	
00930	SODIUM	NA,DISS	MG/L	12.00	
00931	SODIUM	ADSBTION	RATIO	0.3	
00932	PERCENT	SODIUM	%	7	
00935	PTSSIUM	K,DISS	MG/L	2.30	
00940	CHLORIDE	TOTAL	MG/L	6	
00945	SULFATE	SO4-TOT	MG/L	140	
00950	FLUORIDE	F,DISS	MG/L	0.10	
00955	SILICA	DISOLVED	MG/L	14.0	
01000	ARSENIC	AS,DISS	UG/L	1	K
01046	IRON	FE,DISS	UG/L	40	
01056	MANGNESE	MN,DISS	UG/L	10.0	K
01145	SELENIUM	SE,DISS	UG/L	1	K
70301	DISS SOL	SUM	MG/L	420	
70303	DISS SOL	TONS PER	ACRE-FT	0.57	
84000	GEOLOGIC	AGE	CODE	111V	
84001	AQUIFER	NAME	CODE	LFL	

STORET RETRIEVAL DATE 85/04/23
383210106021100
38 32 10.0 106 02 11.0 2
NA05000835DCC Mt. Shavano water quality
08015 COLORADO CHAFFEE sample no. 1

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			73/04/27
	INITIAL TIME-DEPTH-BOTTOM			
00010	WATER	TEMP	CENT	9.5
00011	WATER	TEMP	FAHN	49.1
00095	CNDUCTVY	AT 25C	MICROMHO	349
00400	PH		SU	7.80
00405	CO2		MG/L	5.0
00410	T ALK	CACO3	MG/L	162
00440	HCO3 ION	HCO3	MG/L	197
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.8
00660	ORTHOPO4	PO4	MG/L	0.03
00671	PHOS-DIS	ORTHO	MG/L P	0.010
00900	TOT HARD	CACO3	MG/L	170
00902	NC HARD	CACO3	MG/L	11
00915	CALCIUM	CA,DISS	MG/L	46.0
00925	MGNSIUM	MG,DISS	MG/L	14.0
00930	SODIUM	NA,DISS	MG/L	12.00
00931	SODIUM	ADSBTION	RATIO	0.4
00932	PERCENT	SODIUM	%	13
00935	PTSSIUM	K,DISS	MG/L	2.60
00940	CHLORIDE	TOTAL	MG/L	4
00945	SULFATE	SO4-TOT	MG/L	18
00950	FLUORIDE	F,DISS	MG/L	0.80
00955	SILICA	DISOLVED	MG/L	20.0
01005	BARIUM	BA,DISS	UG/L	100 K
01046	IRON	FE,DISS	UG/L	30
01049	LEAD	PB,DISS	UG/L	2
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01080	STRONTUM	SR,DISS	UG/L	440
01090	ZINC	ZN,DISS	UG/L	40
01106	ALUMINUM	AL,DISS	UG/L	10
01130	LITHIUM	LI,DISS	UG/L	10 K
70301	DISS SOL	SUM	MG/L	219
70303	DISS SOL	TONS PER	ACRE-FT	0.30
84000	GEOLOGIC	AGE	CODE	121D
84001	AQUIFER	NAME	CODE	RUN

STORET RETRIEVAL DATE 85/04/23
383209106010500
38 32 09.0 106 01 05.0 2 Mt. Shavano water quality
NA05000931CDC sample no. 2
08015 COLORADO CHAFFEE

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/10/17
	INITIAL TIME-DEPTH-BOTTOM			1400
00010	WATER	TEMP	CENT	11.5
00011	WATER	TEMP	FAHN	52.7
00095	CNDUCTVY	AT 25C	MICROMHO	460
00400	PH		SU	7.80
00405	CO2		MG/L	6.7
00410	T ALK	CACO3	MG/L	218
00440	HCO3 ION	HCO3	MG/L	266
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.8
00660	ORTHOPO4	PO4	MG/L	0.03
00671	PHOS-DIS	ORTHO	MG/L P	0.010
00900	TOT HARD	CACO3	MG/L	180
00902	NC HARD	CACO3	MG/L	0
00915	CALCIUM	CA,DISS	MG/L	49.0
00925	MGNSIUM	MG,DISS	MG/L	15.0
00930	SODIUM	NA,DISS	MG/L	20.00
00931	SODIUM	ADSBTION	RATIO	0.6
00932	PERCENT	SODIUM	%	19
00935	PTSSIUM	K,DISS	MG/L	3.40
00940	CHLORIDE	TOTAL	MG/L	3
00945	SULFATE	SO4-TOT	MG/L	16
00950	FLUORIDE	F,DISS	MG/L	0.80
00955	SILICA	DISOLVED	MG/L	16.0
01046	IRON	FE,DISS	UG/L	10 K
01056	MANGNESE	MN,DISS	UG/L	10.0 K
70301	DISS SOL	SUM	MG/L	258
70303	DISS SOL	TONS PER	ACRE-FT	0.35
84000	GEOLOGIC	AGE	CODE	111V
84001	AGUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
383254106010200
38 32 54.0 106 01 02.0 2 Mt. Shavano water quality
NA05000931BAB sample no. 3
08015 COLORADO CHAFFEE

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			73/04/27
	INITIAL TIME-DEPTH-BOTTOM			0038
00003	VSAMPLOC	DEPTH	FEET	38
00010	WATER	TEMP	CENT	15.0
00011	WATER	TEMP	FAHN	59.0
00095	CNDUCTVY	AT 25C	MICROMHO	436
00400	PH		SU	7.70
00405	CO2		MG/L	7.9
00410	T ALK	CACO3	MG/L	203
00440	HCO3 ION	HCO3	MG/L	247
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.6
00660	ORTHOPO4	PO4	MG/L	0.12
00671	PHOS-DIS	ORTHO	MG/L P	0.040
00900	TOT HARD	CACO3	MG/L	220
00902	NC HARD	CACO3	MG/L	14
00915	CALCIUM	CA,DISS	MG/L	72.0
00925	MGNSIUM	MG,DISS	MG/L	8.9
00930	SODIUM	NA,DISS	MG/L	8.70
00931	SODIUM	ADSBTION	RATIO	0.3
00932	PERCENT	SODIUM	%	8
00935	PTSSIUM	K,DISS	MG/L	2.40
00940	CHLORIDE	TOTAL	MG/L	4
00945	SULFATE	SO4-TOT	MG/L	27
00950	FLUORIDE	F,DISS	MG/L	0.50
00955	SILICA	DISOLVED	MG/L	15.0
01005	BARIUM	BA,DISS	UG/L	100 K
01040	COPPER	CU,DISS	UG/L	20 K
01046	IRON	FE,DISS	UG/L	50
01049	LEAD	PB,DISS	UG/L	3
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01080	STRONTUM	SR,DISS	UG/L	370
01090	ZINC	ZN,DISS	UG/L	30
01106	ALUMINUM	AL,DISS	UG/L	10
70301	DISS SOL	SUM	MG/L	263
70303	DISS SOL	TONS PER	ACRE-FT	0.36
84000	GEOLOGIC	AGE	CODE	111V
84001	AQUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
383311106013700
38 33 11.0 106 01 37.0 2
NA05000825DD8
08015 COLORADO CHAFFEE

Mt. Shavano water quality sample no. 4

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			73/04/27
	INITIAL TIME-DEPTH-BOTTOM			2359
00010	WATER	TEMP	CENT	14.5
00011	WATER	TEMP	FAHN	58.1
00095	CNDUCTVY	AT 25C	MICROMHO	340
00400	PH		SU	8.00
00405	CO2		MG/L	3.1
00410	T ALK	CACO3	MG/L	158
00440	HCO3 ION	HCO3	MG/L	193
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.1
00660	ORTHOPO4	PO4	MG/L	0.03
00671	PHOS-DIS	ORTHO	MG/L P	0.010
00900	TOT HARD	CACO3	MG/L	170
00902	NC HARD	CACO3	MG/L	15
00915	CALCIUM	CA,DISS	MG/L	58.0
00925	MGNSIUM	MG,DISS	MG/L	6.8
00930	SODIUM	NA,DISS	MG/L	5.10
00931	SODIUM	ADSBTION	RATIO	0.2
00932	PERCENT	SODIUM	%	6
00935	PTSSIUM	K,DISS	MG/L	2.10
00940	CHLORIDE	TOTAL	MG/L	3
00945	SULFATE	SO4-TOT	MG/L	21
00950	FLUORIDE	F,DISS	MG/L	0.60
00955	SILICA	DISOLVED	MG/L	11.0
01005	BARIUM	BA,DISS	UG/L	100 K
01040	COPPER	CU,DISS	UG/L	20 K
01046	IRON	FE,DISS	UG/L	50
01049	LEAD	PB,DISS	UG/L	2
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01080	STRONTUM	SR,DISS	UG/L	280
01085	VANADIUM	V,DISS	UG/L	2
01090	ZINC	ZN,DISS	UG/L	20 K
01106	ALUMINUM	AL,DISS	UG/L	10
70301	DISS SOL	SUM	MG/L	203
70303	DISS SOL	TONS PER	ACRE-FT	0.28
84000	GEOLOGIC	AGE	CODE	112G
84001	AQUIFER	NAME	CODE	LCL

STORET RETRIEVAL DATE 85/04/23
383328106012200
38 33 28.0 106 01 22.0 2 Mt. Shavano water quality
NA05000930BCC sample no. 5
08015 COLORADO CHAFFEE

112WRD 11020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			75/10/16	
	INITIAL TIME-DEPTH-BOTTOM			1545 0051	
00003	VSAMPLOC	DEPTH	FEET	51	
00010	WATER	TEMP	CENT	11.5	
00011	WATER	TEMP	FAHN	52.7	
00095	CNDUCTVY	AT 25C	MICROMHO	400	
00400	PH		SU	7.60	
00405	CO2		MG/L	8.6	
00410	T ALK	CACO3	MG/L	176	
00440	HCO3 ION	HCO3	MG/L	214	
00445	CO3 ION	CO3	MG/L	0	
00631	NO2&NO3	N-DISS	MG/L	0.8	
00660	ORTHOPO4	PO4	MG/L	0.00	
00671	PHOS-DIS	ORTHO	MG/L P	0.010	K
00900	TOT HARD	CACO3	MG/L	180	
00902	NC HARD	CACO3	MG/L	6	
00915	CALCIUM	CA,DISS	MG/L	58.0	
00925	MGNSIUM	MG,DISS	MG/L	8.8	
00930	SODIUM	NA,DISS	MG/L	9.20	
00931	SODIUM	ADSBTION	RATIO	0.3	
00932	PERCENT	SODIUM	%	10	
00935	PTSSIUM	K,DISS	MG/L	2.00	
00940	CHLORIDE	TOTAL	MG/L	1	
00945	SULFATE	SO4-TOT	MG/L	21	
00950	FLUORIDE	F,DISS	MG/L	0.50	
00955	SILICA	DISOLVED	MG/L	17.0	
01046	IRON	FE,DISS	UG/L	10	K
01056	MANGNESE	MN,DISS	UG/L	10.0	K
70301	DISS SOL	SUM	MG/L	227	
70303	DISS SOL	TONS PER	ACRE-FT	0.31	
84000	GEOLOGIC	AGE	CODE	121D	
84001	AQUIFER	NAME	CODE	RUN	

STORET RETRIEVAL DATE 85/04/23
383657106305601
38 36 57.0 106 30 56.0 2
NA05000404DDD
08051 COLORADO GUNNISON
U

Pitkin water quality
sample 1

112WRD 14020003 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			74/06/08	
	INITIAL TIME-DEPTH-BOTTOM			0900 0012	
00003	VSAMPLOC	DEPTH	FEET	12	
00010	WATER	TEMP	CENT	7.0	
00011	WATER	TEMP	FAHN	44.6	
00095	CNDUCTVY	AT 25C	MICROMHO	142	
00400	PH		SU	7.50	
00405	CO2		MG/L	4.1	
00410	T ALK	CACO3	MG/L	67	
00440	HCO3 ION	HCO3	MG/L	82	
00445	CO3 ION	CO3	MG/L	0	
00631	NO2&NO3	N-DISS	MG/L	0.1	
00660	ORTHOPO4	PO4	MG/L	0.03	
00671	PHOS-DIS	ORTHO	MG/L P	0.010	
00900	TOT HARD	CACO3	MG/L	68	
00902	NC HARD	CACO3	MG/L	0	
00915	CALCIUM	CA,DISS	MG/L	22.0	
00925	MGNSIUM	MG,DISS	MG/L	3.1	
00930	SODIUM	NA,DISS	MG/L	3.60	
00931	SODIUM	ADSBTION	RATIO	0.2	
00932	PERCENT	SODIUM	%	10	
00935	PTSSIUM	K,DISS	MG/L	0.20	
00940	CHLORIDE	TOTAL	MG/L	1	
00945	SULFATE	SO4-TOT	MG/L	5	
00950	FLUORIDE	F,DISS	MG/L	0.10	
00955	SILICA	DISOLVED	MG/L	12.0	
01002	ARSENIC	AS,TOT	UG/L	1	K
01020	BORON	B,DISS	UG/L	20	K
01046	IRON	FE,DISS	UG/L	20	
01056	MANGNESE	MN,DISS	UG/L	30.0	
01147	SELENIUM	SE,TOT	UG/L	1	K
70301	DISS SOL	SUM	MG/L	88	
70303	DISS SOL	TONS PER	ACRE-FT	0.12	
84000	GEOLOGIC	AGE	CODE	341D	
84001	AQUIFER	NAME	CODE	VNNU	

STORET RETRIEVAL DATE 85/04/23 Pitkin water quality
383642106304601 sample 2
38 36 42.0 106 30 46.0 2
NA05000410BBD
08051 COLORADO GUNNISON

112WRD 14020003 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			74/06/08
	INITIAL TIME-DEPTH-BOTTOM			0800 0032
00003	VSAMPLOC	DEPTH	FEET	32
00010	WATER	TEMP	CENT	5.5
00011	WATER	TEMP	FAHN	41.9
00095	CNDUCTVY	AT 25C	MICROMHO	209
00400	PH		SU	7.50
00405	CO2		MG/L	6.0
00410	T ALK	CACO3	MG/L	98
00440	HCO3 ION	HCO3	MG/L	119
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.0
00660	ORTHOPO4	PO4	MG/L	0.06
00671	PHOS-DIS	ORTHO	MG/L P	0.020
00900	TOT HARD	CACO3	MG/L	100
00902	NC HARD	CACO3	MG/L	6
00915	CALCIUM	CA,DISS	MG/L	33.0
00925	MGNSIUM	MG,DISS	MG/L	5.2
00930	SODIUM	NA,DISS	MG/L	3.40
00931	SODIUM	ADSRTION	RATIO	0.1
00932	PERCENT	SODIUM	%	7
00935	PTSSIUM	K,DISS	MG/L	0.70
00940	CHLORIDE	TOTAL	MG/L	2
00945	SULFATE	SO4-TOT	MG/L	9
00950	FLUORIDE	F,DISS	MG/L	0.10
00955	SILICA	DISOLVED	MG/L	6.0
01002	ARSENIC	AS,TOT	UG/L	1
01020	BORON	B,DISS	UG/L	9
01046	IRON	FE,DISS	UG/L	10 K
01056	MANGNESE	MN,DISS	UG/L	20.0
01147	SELENIUM	SE,TOT	UG/L	2
70301	DISS SOL	SUM	MG/L	118
70303	DISS SOL	TONS PER	ACRE-FT	0.16
84000	GEOLOGIC	AGE	CODE	111V
84001	AQUIFER	NAME	CODE	LFL

STORET RETRIEVAL DATE 85/04/23
384255106510801
38 42 55.0 106 51 08.0 2 Roaring Judy water quality sample no. 1
SC01508526DAC
08051 COLORADO GUNNISON

112WRD 14020001 ON
811031 DEPTH 0
/TYPA/AMBNT/WELL

	INITIAL DATE			76/10/28
	INITIAL TIME-DEPTH-BOTTOM			1000 0041
00003	VSAMPLOC	DEPTH	FEET	41
00010	WATER	TEMP	CENT	11.0
00011	WATER	TEMP	FAHN	51.8
00095	CNDUCTVY	AT 25C	MICROMHO	380
00400	PH		SU	7.30
00405	CO2		MG/L	18.0
00410	T ALK	CACO3	MG/L	185
00440	HCO3 ION	HCO3	MG/L	226
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.1
00660	ORTHOPO4	PO4	MG/L	0.03
00671	PHOS-DIS	ORTHO	MG/L P	0.010
00900	TOT HARD	CACO3	MG/L	200
00902	NC HARD	CACO3	MG/L	17
00915	CALCIUM	CA,DISS	MG/L	63.0
00925	MGNSIUM	MG,DISS	MG/L	11.0
00930	SODIUM	NA,DISS	MG/L	5.00
00931	SODIUM	ADSBTION	RATIO	0.2
00932	PERCENT	SODIUM	%	5
00935	PTSSIUM	K,DISS	MG/L	1.40
00940	CHLORIDE	TOTAL	MG/L	1
00945	SULFATE	SO4-TOT	MG/L	31
00950	FLUORIDE	F,DISS	MG/L	0.10
00955	SILICA	DISOLVED	MG/L	9.4
01000	ARSENIC	AS,DISS	UG/L	1 K
01046	IRON	FE,DISS	UG/L	40
01056	MANGNESE	MN,DISS	UG/L	10.0 K
01145	SELENIUM	SE,DISS	UG/L	1 K
70301	DISS SOL	SUM	MG/L	234
70303	DISS SOL	TONS PER	ACRE-FT	0.32
72008	TOT DPTH	OF WELL	FT	41.0
72019	DEPTH-FT	BL LAND	SURFACE	14.00
84000	GEOLOGIC	AGE	CODE	111A
84001	AQUIFER	NAME	CODE	VMT

STORET RETRIEVAL DATE 85/04/23
384258106504601
38 42 58.0 106 50 46.0 2
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Roaring Judy water quality
sample no. 2

112WRD 14020001 ON
780228 DEPTH 0
/TYPA/AMBNT/WELL
INDEX
MILES

	INITIAL DATE			74/06/07
	INITIAL TIME-DEPTH-BOTTOM			1200 0042
00003	VSAMPLOC	DEPTH	FEET	42
00010	WATER	TEMP	CENT	16.0
00011	WATER	TEMP	FAHN	60.8
00095	CNDUCTVY	AT 25C	MICROMHO	402
00400	PH		SU	7.70
00405	CO2		MG/L	7.4
00410	T ALK	CACO3	MG/L	190
00440	HCO3 ION	HCO3	MG/L	232
00445	CO3 ION	CO3	MG/L	0
00631	NO2&NO3	N-DISS	MG/L	0.4
00660	ORTHOPO4	PO4	MG/L	0.06
00671	PHOS-DIS	ORTHO	MG/L P	0.020
00900	TOT HARD	CACO3	MG/L	190
00902	NC HARD	CACO3	MG/L	0
00915	CALCIUM	CA,DISS	MG/L	53.0
00925	MGNSIUM	MG,DISS	MG/L	13.0
00930	SODIUM	NA,DISS	MG/L	12.00
00931	SODIUM	ADSRTION	RATIO	0.4
00932	PERCENT	SODIUM	%	12
00935	PTSSIUM	K,DISS	MG/L	2.30
00940	CHLORIDE	TOTAL	MG/L	5
00945	SULFATE	SO4-TOT	MG/L	15
00950	FLUORIDE	F,DISS	MG/L	0.40
00955	SILICA	DISOLVED	MG/L	12.0
01002	ARSENIC	AS,TOT	UG/L	1 K
01020	BORON	B,DISS	UG/L	20 K
01046	IRON	FE,DISS	UG/L	10 K
01056	MANGNESE	MN,DISS	UG/L	90.0
01147	SELENIUM	SE,TOT	UG/L	3
70301	DISS SOL	SUM	MG/L	229
70303	DISS SOL	TONS PER	ACRE-FT	0.31
84000	GEOLOGIC	AGE	CODE	111A
84001	AQUIFER	NAME	CODE	VMI