

Report of Investigation
Utah Geological and Mineral Survey

No. 162

GEOLOGIC INVESTIGATION TO LOCATE A
CULINARY WATER WELL FOR GUNNISON CITY,
SANPETE COUNTY, UTAH

by
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Site Investigations Section
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INTRODUCTION

In response to a request from Mr. Lester Hill, Mayor of Gunnison City, an investigation was conducted to locate possible sites for a new culinary water well. The city's present water system consists of two springs and one well. Peacock Spring, which flows at approximately 800 gpm, has a high sulfur content, producing a strong odor, and Little Nine Mile Spring is not in use at this time. A well, drilled in 1978, produces approximately 240 gpm but the water contains about two percent salt which exceeds the State of Utah Public Drinking Water Standards. Therefore, there is a need for a high quality culinary water source with special consideration given to identifying well sites that are in reasonably close proximity to the present water system's existing transmission facilities.

SCOPE OF WORK

The purpose of this investigation was to gather all pertinent geologic, hydrologic and topographic information on the area to assist in the identification of potential water well sites. To accomplish that objective, the following scope of work was undertaken:

1. A review of all applicable published and available unpublished geologic and hydrologic literature including reports, maps, well logs and other data pertaining to the study area.
2. A day spent in the field examining potential well sites, as well as a conversation with Mr. Tristan DeMille, of Horrocks Engineers, concerning any limitations imposed by Gunnison City pertaining to the extent, etc. of the study area.

3. Telephone conversation with Mr. Carl H. Carpenter, co-author of U. S. Geological Survey Water-Supply Paper 1787, covering the ground water possibilities in the areas being studied.
4. Preparation of this report and accompanying figures.

SETTING

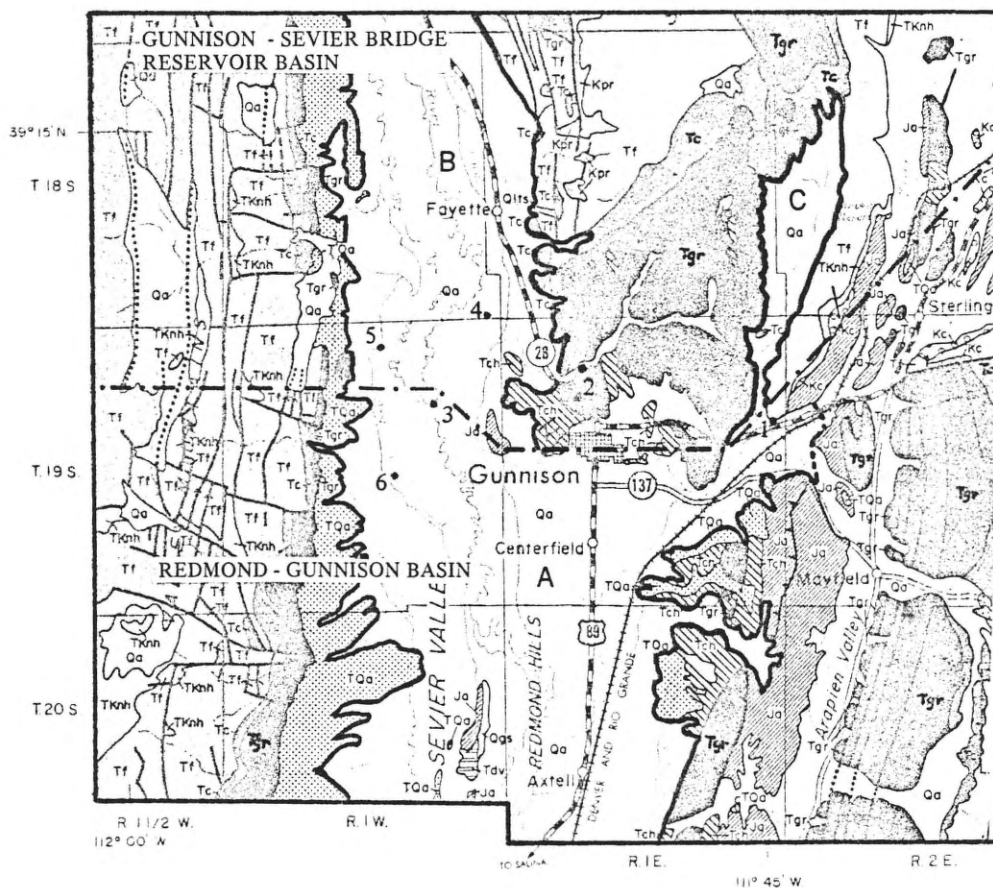
The study area involves two basins within the central Sevier Valley: the Redmond-Gunnison Basin which is 6 miles wide and extends south from Gunnison approximately 9.5 miles to just north of Redmond, and the Gunnison-Sevier Bridge Reservoir Basin which is 18 miles long and 3 miles wide extending from 3 miles northwest of Gunnison to Yuba Dam (sec. 1, T. 17 S., R. 2 W.). Within this basin, Antelope Valley, located east-northeast of Gunnison, was also given careful consideration (Figure 1).

The climate in the study area ranges from semiarid on the valley floor to humid on the mountains and plateaus bordering the valley. Average annual precipitation ranges from less than 10 inches on the valley floor at an elevation of 5020 feet, to 30 inches or more at the higher altitudes, approximately 6500 feet.

GEOLOGY

The consolidated rock formations exposed in the mountains and plateaus surrounding the central Sevier Valley include many of the units found in southern Utah from the Coconino Sandstone of Permian age (250 million years before present) to the Sevier River Formation of Pliocene or Pleistocene age (13 million years before present). In the study area, however, the oldest rocks exposed are the Arapien Formation of Jurassic Age (181 million years before present). Formations older than the Arapien have little or no effect on the ground-water potential in the basins.

The generalized geologic section in Table 1 names and briefly describes the formations shown on Figure 1, tells where they are exposed, and gives an estimate of their water-yielding potential. In general, most of the consolidated formations lie too deep beneath the valley fill for present ground-water development (Young



Scale 1" = 4 miles

Figure 1:
General Location and Geologic Map, Study Area
for proposed culinary water well for Gunnison
City, Sanpete County, Utah, (after Stokes and
others, 1970)

EXPLANATION

QUATERNARY		Unconsolidated alluvium Sand, gravel, borrow material and alluvial fans Qls - Lake terrace sands Qgs - Gravel surfaces
		Glaciated ground and moraines, includes bare rock and moraines of all types.
		Landslide deposits and other masses displaced chiefly by gravity.
		Tertiary and Quaternary deposits (undifferentiated).
CENOZOIC		Moroni Formation Detritus of volcanic rocks, boulders of quartzite, sandstone, chert and metaconglomerate welded tuff.
		Dipping Vat Formation Light-gray to white tuffaceous sandstone.
		Crazy Hollow Formation Red and orange sandstone, siltstone and shale, white and pepper-and-salt sandstone.
		Golden Ranch Formation Tawny limestone, sandstone, shale, siltstone and conglomerate.
		Green River Formation Interbedded shale, calcitic dolomite and oolite.
		Colton Formation Light greenish-gray, medium-grained calcareous sandstone and white thin-bedded limestone.
		Flagstaff Limestone Yellow, gray and red limestone, gray shale, gray sandstone, oil shale, conglomerate.
		North Horn Formation Nonmarine fossiliferous sandstones, and conglomerates, shales, limestones, flood-plain and channel deposits. Coal.
		Price River Formation Coarse-grained gray to buff conglomerates locally red; gray shale beds.
		Castlegate Formation Massive conglomeratic pink or white sandstone, siltstone, shales. Lagoonal deposits of coal. Littoral marine bar sandstones.
MESOZOIC		Arapien Formation Drab calcareous shale with red patches and intercalated limestone, gypsum and salt.
		JURASSIC

SYMBOLS

	Contact
	Fault - dashed where approximately located, dotted where concealed
	Thrust fault - saw-teeth on side of upper plate
	Basin Boundary
	Study Area
	Boring Location

TABLE 1.—Generalized geologic section in the central Sevier Valley

Sys-tem	Series	Geologic unit	Description and location	Thickness (feet)	Water supply
Quaternary	Pleistocene and Recent	Alluvium	Poorly to well-sorted clay, silt, sand, gravel, and boulders. Includes alluvial-fan material. Found on the valley floor in stream courses and in depressions on the plateaus.	0-800+	Poor to excellent. Yields large quantities of water to wells where clean sand or gravel is penetrated. Artesian conditions exist where near-surface clays confine water in underlying permeable deposits.
		Landslide deposits	Unsorted slide material derived from steep slopes. Found principally along the Sevier fault.	0-400+	Poor because of lack of sorting, but infiltration of surface water may be induced because of hummocky surfaces.
		Terrace gravel	Partly sorted sand and gravel deposits along present and former stream courses. Exist in Marysvale area, between Joseph and Monroe, and in Redmond Hills.	0-50	Generally well drained, but some of the larger bodies yield water to shallow wells and to springs.
	Pliocene or Pleistocene	Sevier River Formation	Fanglomerate deposit consisting of silt, sand, gravel, cobbles, and boulders derived from adjacent highlands by torrential runoff; very poorly sorted. Includes Axtell Formation of Spieker (1949, p. 38). Exposed along flanks of Sevier Valley and in basins on the plateaus.	0-800	Poor to moderate. Because of low permeability, functions as confining medium where it is underlain by permeable formations. A few wells derive small amounts of water from this formation.
Tertiary	Eocene	Green River Formation	Massive to thin-bedded white to yellowish-gray limestone and green to grayish-green shale. Exposed from Richfield north in Pavant Range, in Valley Mountains, and in Wasatch and Gunnison Plateaus.	400-1,200	May yield water where joints or solution cavities are developed in the limestone member.
		Colton Formation	Evenly bedded brownish-red shale and sandstone. Exposed from Salina north in Valley Mountains and in Wasatch and Gunnison Plateaus.	0-1,600	Permeability relatively low.
Cretaceous	Paleocene and Eocene(?)	Flagstaff Limestone	White to red massive to thin-bedded limestone, siltstone, and sandstone. Exposed from Richfield north in both sides of valley.	100-1,500	Wells are not known to penetrate this formation, although it yields about 1,900 gallons per minute to Fayette Spring, (D-18-1) 19dab, from a solution cavity.
	Paleocene and Upper Cretaceous	North Horn Formation	Yellow-brown sandstone with minor gray and red shale and some conglomerate. Exposed in fault block east of Gunnison.	500-2,800	Yields water to wells adjacent to the project area where formation is fractured by faulting.
	Upper Cretaceous	Price River Formation	Buff sandstone to red boulder conglomerate. Exposed in Gunnison Plateau.	800-2,000	Wells are not known to penetrate this formation.
		Indianaola Group	Sandstone and coal-bearing shale. Exposed in fault block east of Gunnison.	7,000-15,000	Wells are not known to penetrate this group.
Jurassic	Upper Jurassic	Morrison(?) Formation	Red coarse sandstone and conglomerate. Exposed in fault block east of Gunnison.	1,800±	Wells are not known to penetrate this formation.
		Arapien Shale	Red and gray shale and red and gray fine-grained sandstone containing interbedded salt and gypsum. Exposed in east side of valley north of Glenwood, in Redmond Hills, in hills west of Gunnison, and in small outcrops southwest of Marysvale.	10,000±	Permeability low. This formation prevents ground water movement from the Wasatch and Fishlake Plateaus to the valley fill. It contributes large amounts of chloride and sulfate to water in the fill along the east side of the valley from Glenwood to Gunnison and in the vicinity of the Redmond Hills.

(after Young & Carpenter, 1965)

and Carpenter, 1965).

STRUCTURAL FEATURES

The major structural features in the study area are the Sanpete-Sevier Anticline which is approximately 4 miles east of Gunnison, the Gunnison Plateau Syncline, a quarter of a mile east of Gunnison and extending north for several miles, and the Redmond Hills Anticline, approximately 2 miles west and extending south from Gunnison (Plate 1).

The hills and plateaus surrounding the valley floor are cut by numerous normal faults, many of which are part of the larger north-trending fault zones. Other faults trend approximately east-west across the major structural zones (Figure 1).

Thrust faulting is less common than normal faulting in the area, but a series of thrusts east of Redmond which involve the Arapien, Flagstaff, Colton, Green River, and Crazy Hollow Formations are present (Figure 1).

HYDROLOGY

Ground water is available under either water-table or artesian conditions almost everywhere in the alluvium of the Redmond-Gunnison and Gunnison-Sevier Bridge Reservoir Basins (Figure 1).

Study Area A/Redmond-Gunnison Basin

About 150,000 acre-feet of ground water is in storage in the sand and gravel deposits of the Redmond-Gunnison Basin (Young and Carpenter, 1965). The most permeable of these deposits underlie the artesian area at depths of from about 20 to 180 feet below land surface.

The potential development of ground water is not recommended in most parts of the Redmond-Gunnison Basin. Ground water in the gravel and sand beds underlying most of the basin is slightly to moderately saline because the Arapien Shale, which contains salt and gypsum deposits, underlies most of the valley at depths of less than 200 feet. Better results could be obtained in the north-western portion of the basin west of the Sevier River in secs. 11, 14, and 23,

T. 19 S., R. 1 W. (Figure 2) where the valley fill reaches a thickness of more than 300 feet, but because the area that might be developed is comparatively small, pumping large quantities of water may induce the inflow of slightly to moderately saline ground water into the aquifer from adjacent areas. The amount of water that could be developed annually would probably be less than 1,000 acre-feet (Young and Carpenter, 1965).

Study Area B/Gunnison-Sevier Bridge Reservoir Basin

Ground water is available in large quantities under artesian conditions in the alluvium in the center of the valley floor and lesser amounts under water-table conditions in the alluvium and in the Sevier River Formation at the sides of the valley floor. The confining material in the artesian area is a silty clay which ranges in thickness from about 20 to 80 feet. About 300,000 acre-feet of ground water is stored in the sand and gravel deposits in the basin and the best aquifers are the beds of sand and gravel between depths of 40 and 425 feet below ground surface (Young and Carpenter, 1965).

There are records for more than 200 flowing wells, each 2 to 3 inches in diameter and 20 to 80 feet deep, in the center of the valley. These wells discharge about 3,900 acre-feet of water annually. Springs discharge annually about 12,000 acre-feet of water from the alluvium where there are leaks in the confining silty clay. Fayette Spring, sec. 19, T. 18 S., R. 1 E., is the only large bedrock spring in the Gunnison-Sevier Bridge Reservoir Basin. The source of the spring is precipitation on the Gunnison Plateau, which is trapped in solution cavities in the Flagstaff Limestone. The spring discharges about 1,900 gpm or about 3,000 acre-feet annually (Young and Carpenter, 1965).

About 15,000 acre-feet of water could be pumped annually from gravel and sand artesian aquifers in the valley fill in the Gunnison-Sevier Bridge Reservoir basin without greatly affecting the flow in the Sevier River (Young and Carpenter, 1965). Because the river is separated from the aquifer by about 20 to 80 feet of silty clay, pumping from wells would not directly effect the stream flow. The

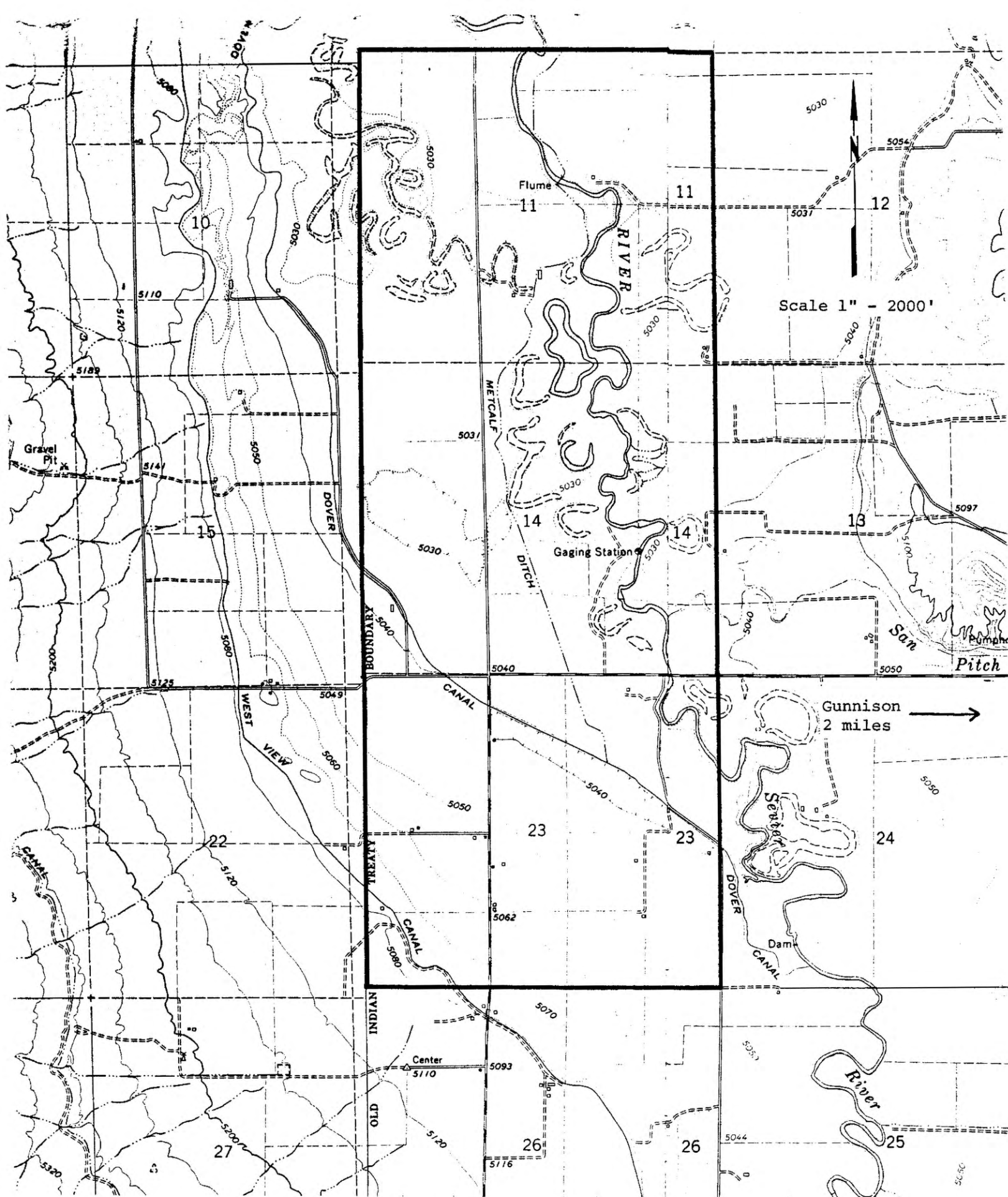


Figure 2: Map showing area of possible acceptable culinary water in Redmond-Gunnison Basin.

pumping, however, probably would decrease the side inflow into the stream from sloughs, springs, drains, and flowing wells. The flow from Fayette Spring would not be effected by pumping from aquifers in valley fill (Young and Carpenter, 1965).

Study Area C/Antelope Valley

Antelope Valley is located within the Gunnison-Sevier Bridge Reservoir Basin. The valley is approximately 7 miles long and averages three-quarters of a mile in width. No previous study has been carried out in the area and the closest boring is located at the mouth of the valley (boring #1, Figure 1). Therefore, no information is known concerning the depth of valley fill, the depth to water, or the chemical quality of the water.

POTENTIAL DEVELOPMENT

Study Area A/Redmond-Gunnison Basin

As stated earlier, development of ground water is not recommended in most parts of this basin due to high salinity in the water caused by salt and gypsum lenses found in the Arapien Shale. Borings #3 and #6 (Figure 1), which are located in the most favorable area of the Redmond-Gunnison Basin (Figure 2), indicate brackish water above at least the 280 foot level (Appendix).

Study Area B/Gunnison-Sevier Bridge Reservoir Basin

The possibilities for finding fresh ground water within the Gunnison-Sevier Bridge Reservoir Basin are much better. The best gravel and sand aquifer can be found between 40 and 425 feet below the surface, but the deeper the well, the better the water quality (Young and Carpenter, 1965). Boring #4 (Figure 1) produced acceptable water from 246 feet. This was an artesian well with a head of +5.6 feet and a flow of 60 gpm. Boring #5 (Figure 1) produced water from 110 and 156 feet with a low chloride count of 190 parts per million (PPM). Boring #2 (Figure 1), located just north of Gunnison was drilled to a depth of 1775 feet in bedrock and produced water with traces of oil and gas and unacceptable amounts of lead and iron. Therefore, this vicinity should be avoided (Appendix).

The best quality water will be found in the center of the valley and as far north as possible. However, the limitations that have been imposed by Gunnison City and Horrocks Engineering due to economic feasibility in terms of distance from Gunnison and from an existing power source, limit the selection area. Under these limitations, the best location for a culinary water well within individual study area B would be in sections 35 or 36, T. 18 S., R. 1 W., or sections 1 and 2, T. 19 S., R. 1 W. (Figure 3). The well should be to a depth of at least 300 feet. Although acceptable ground water can be found in the study area, the volume of water is questionable. Of the artesian wells found in this area, the average flow is 28 gpm with a high of 60 gpm. The pumped wells in the area, which are 2 to 3 inches in diameter and 20 to 80 feet deep, produce an average of 12 gpm with a high of 20 gpm. Therefore, there is no definite data that would indicate the volume of water than can be obtained from a large diameter production well in this basin.

Study Area C/Antelope Valley

Although no data has been generated in Antelope Valley concerning depth of valley fill, depth to water, or water quality, this area could be an excellent location for a high quality culinary water well. The Arapien Shale, which is the formation that creates the brackish ground-water conditions found in the basins, is located east and southeast of Antelope Valley and is separated from the valley fill by the San Pitch Mountains. Therefore, the ground water in Antelope Valley is separated from the Arapien Formation by the Flagstaff Limestone, the North Horn Formation, the Castlegate Formation, and possibly the Morrison Formation. This is a total bedrock thickness of from 1800 to 2200 feet. Boring #1 (Figure 1) is located at the mouth of Antelope Valley and is producing water with a two percent salt content (Appendix). The White Hills, which are composed predominantly of Arapien Shale, are located just over a half mile south-southeast of the well, and there are no other formations separating the valley alluvium from the shale. Therefore, to ensure water

quality, any new well should be placed further north into the valley. The best location for a new culinary water well, which would benefit most from the protective sequence of bedrock and still be near an existing power line, would be in the center of section 30, T. 18 S., R. 2 E. Other possible locations would be the SE $\frac{1}{4}$ sec. 19, T. 18 S., R. 2 E., and the NE $\frac{1}{4}$ sec. 36, T. 18 S., R. 1 E. (Figure 4). These three locations are in the widest portion of the valley and may possibly have the thickest sequence of valley fill to act as an aquifer.

CONCLUSIONS AND RECOMMENDATIONS

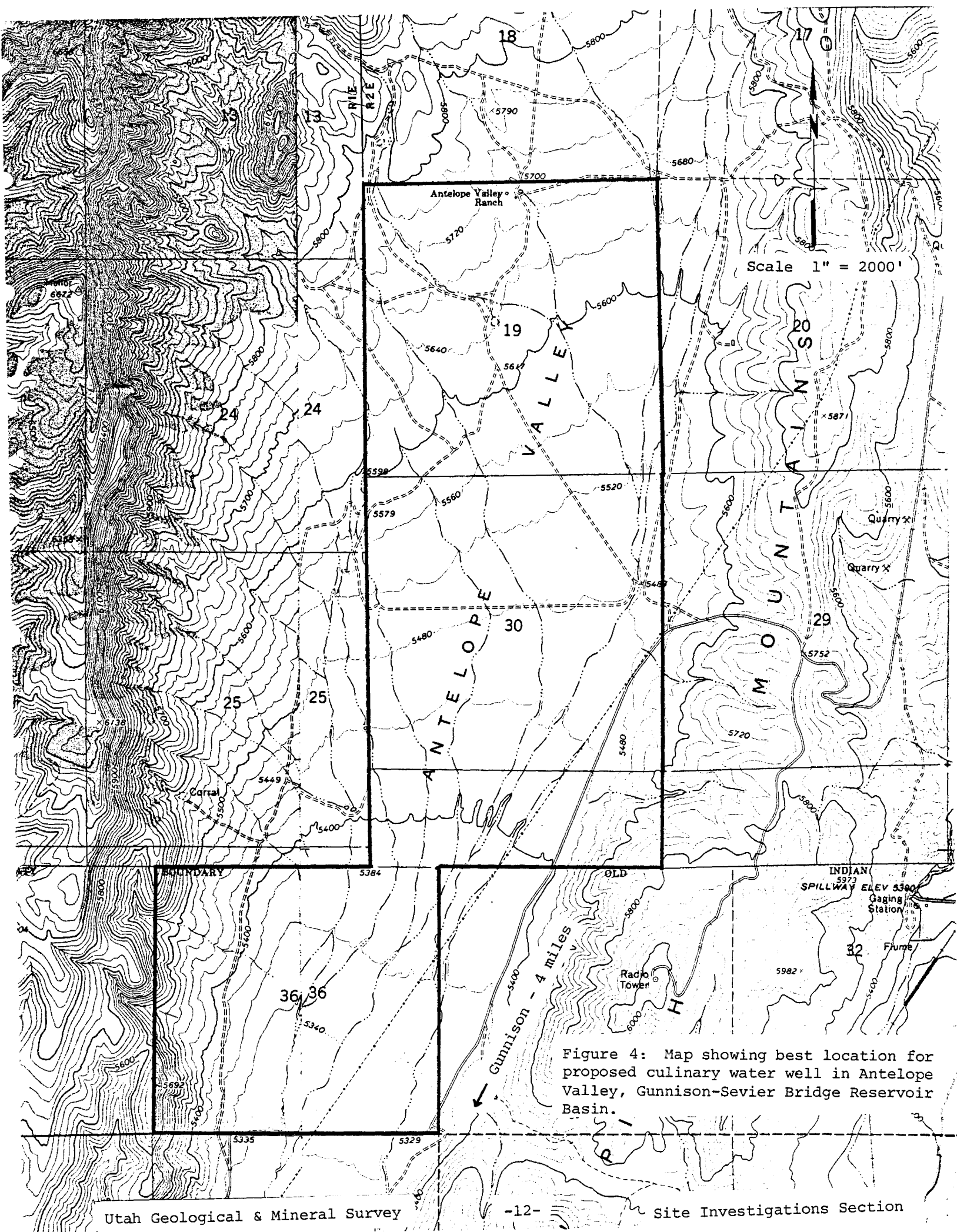
Based upon the results of the investigation, the following conclusions and recommendations for the three individual study areas are provided:

Study Area A

1. Ground water is available under either water-table or artesian conditions almost everywhere in the alluvium of the Redmond-Gunnison basin.
2. About 150,000 acre-feet of ground water is in storage in the sand and gravel deposits within the basin.
3. The development of a culinary water well is not recommended in this basin because the ground water has a slight to moderate salinity due to the Arapien Shale underlying the valley fill at less than 200 feet.

Study Area B

1. Ground water is available in large quantities under artesian conditions in the alluvium in the center of the valley floor, and in lesser amounts under water-table conditions in the alluvium at the sides of the valley floor.
2. About 300,000 acre-feet of ground water is stored in the sand and gravel deposits in the basin and approximately 15,000 acre-feet of water could be pumped annually from these aquifers in the valley fill without greatly effecting the flow of the Sevier River.



3. The flow from Fayette Spring would not be affected by pumping from aquifers in the valley fill.
4. A properly designed well, located in sections 35 or 36, T. 18 S., R. 1 W., or sections 1 and 2, T. 19 S., R. 1 W., between 300 and 500 feet deep, could reasonably be expected to produce high quality culinary water.
5. In a recent telephone conversation with Mr. Carl H. Carpenter, co-author of U. S. Geological Survey Water-Supply Paper 1787, he contended that although there is abundant water located in the deeper valley alluvium, no data has been generated that would indicate the volume of water that can be pumped from a large diameter production well, and he felt that the volume produced may be smaller than required.
6. The drilling of a pilot hole prior to commencing work on the production well is strongly recommended. A small diameter preliminary boring could be used to confirm the presence of high quality ground water at the site.

Study Area C

1. No data is available on depth to water, depth of valley fill or water quality in this area.
2. This valley should provide the greatest degree of protection from the influence of the Arapien Formation.
3. A properly designed well located in the center of section 30, T. 18 S., R. 2 E.; the SE $\frac{1}{4}$ sec. 19, T. 18 S., R. 2 E.; or the NE $\frac{1}{4}$ sec. 36, T. 18 S., R. 1 E., could reasonably be expected to produce high quality culinary water.
4. The drilling of a small diameter exploratory boring, to confirm the presence of water and allow testing for water quality and temperature, is strongly recommended.

SELECTED REFERENCES

- Bjorklund, L. J., and Robinson, C. B., Jr., 1968, Ground-Water Resources of the Sevier River Basin Between Yuba Dam and Leamington Canyon, Utah, U. S. Geological Survey Water-Supply Paper No. 1848.
- Carpenter, C. H., and Young, R. A., 1963, Ground-Water Data Central Sevier Valley, Parts of Sanpete, Sevier, and Piute Counties, Utah, U. S. Geological Survey; Water Rights.
- Gilliland, W. N., 1963, Sanpete-Sevier Valley Anticline of Central Utah, G.S.A. Bulletin, v. 74, p. 115-124.
- Hardy, C. T., 1952, Eastern Sevier Valley, Sevier and Sanpete Counties, Utah, Utah Geological and Mineral Survey Bulletin 43.
- Pratt, A. R., and Callaghan, E., 1970, Land and Mineral Resources of Sanpete County, Utah, Utah Geological and Mineral Survey and College of Mines, University of Utah.
- Robinson, G. B., Jr., 1971, Ground-Water Hydrology of the San Pitch River Drainage Basin, Sanpete County, Utah, U. S. Geological Survey Water-Supply Paper No. 1896.
- Spieker, E. M., 1949, The Transition Between the Colorado Plateaus and the Great Basin in Central Utah, Guidebook to the Geology of Utah No. 4, Utah Geological Society.
- Young, R. A., 1960, Ground Water Areas and Well Logs Central Sevier Valley, Utah, U. S. Geological Survey, Water Rights.
- Young, R. A. and Carpenter, C. H., 1965, Ground-Water Conditions and Storage in the Central Sevier Valley, Utah, U. S. Geological Survey Water-Supply Paper No. 1787.

APPENDIX

Selected Boring Logs

APPENDIX

Selected Boring Logs

Redmond-Gunnison and Gunnison-Sevier Bridge Reservoir Basins

- * indicates stratum of water-bearing materials
- ** indicates stratum from which best production may be expected
- # indicates stratum that produces highly mineralized water (probably unsuitable for irrigation).

Boring No. 1 (T. 19 S., R. 1 E., NW $\frac{1}{4}$ sec. 13)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
Clay	10	10
Clay	10	20
Clay & gravel	10	30
# Gravel	10	40
# Sand & gravel	10	50
# Clay & gravel	10	60
# Sand & gravel	5	65
* Bedrock - brown	95	160
Bedrock - yellow grey	10	170
Bedrock - yellow	10	180
Bedrock - brown	10	190
Bedrock - tan	10	200
Bedrock - yellow	10	210
Bedrock - tan	10	220
Bedrock - brown	10	230
Water bearing material @ 135 feet; water contains 2% salt		

Boring No. 2 (T. 19 S., R. 1 E., NE $\frac{1}{4}$ sec. 8)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
* Blue clay & shale (Green River Formation)	330	330
Red clay with sand lenses	70	400
Sandy with limestone lenses	230	630
Blue clay and shale (possibly Colton Formation)	40	670
** Flagstaff Limestone	130	800
Blue clay with red lenses	106	906
Clay & white sand	24	930
Grey sand with chert nodules	55	985
Grey hard lime	53	1038
Red sandy shale	7	1045
Hard quartz, varied color	5	1050
Sandy shale, red	15	1065
Coarse quartz gravel	5	1070
Reddish grey sand	12	1082
# Yellowish clay	38	1120
# Reddish clay & shale	108	1288

APPENDIX (cont.)

Boring No. 2 (cont.)

# Hard conglomerate	375	1600
# Sticky red shale	125	1775

Water bearing material @ 65 and 300 feet; containing traces of oil and gas as well as unacceptable amounts of iron and lead.

Boring No. 3 (T. 19 S., R. 1 W., NE¼ sec. 11)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
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Pleistocene and Recent deposits
(undifferentiated):

Soil, black, sandy	2	2
Clay, brick-red to gray and black clay; gastropods	28	30
Gravel, fine	3	33
Clay, gray	4	37
# Gravel, fine to coarse	23	60
Clay, grey	3	63
# Gravel, coarse	13	76
Clay, tan, gray, black, sandy	9	85
# Sand and gravel	29	114
Clay, tan	6	120
# Sand and gravel	48	168
Clay, tan to grey	30	198
# Gravel, fine to coarse	7	205
Clay, tan to grey	20	225
# Gravel, fine to coarse, and sand	37	262
Clay, tan to grey	20	282
* Gravel, fine to coarse	18	300
Clay, tan	24	324

Sevier River (?) formation:

* Gravel, fine to coarse, and sand; with thin layers clay & limestone	154	478
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Water bearing material @ 172 feet; water brackish above 180 feet.

Boring No. 4 (T. 18 S., R. 1 W., SE¼ sec. 36)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
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Pleistocene and Recent deposits
(undifferentiated):

Silt and sand, brown	7	7
Clay, red and black, very plastic	15	22
Clay, grey-green, silty	1	23
Clay, dark-brown, silty	4	27
Clay, grey, plastic	7	34
* Gravel, coarse	26	60
Clay, grey	9	69
Sand, fine, and gravel	8	77
Clay, tan to grey; very hard drilling	13	90
** Gravel, fine to coarse	75	165

APPENDIX (cont.)

Boring No. 4 (cont.)

Clay, blue-grey to dark-brown	50	215
** Gravel, coarse	33	248
Clay, tan, clean	24	272
* Sand, coarse, and fine gravel	4	276
Clay, grey	40	316
* Gravel, fine to coarse	28	344
Clay, light-tan to dark-brown, clean	28	372
** Gravel, coarse	40	412
Clay, red-brown to grey	13	425
* Gravel	40	465
Clay, white and blue, hard; gravel lens at 469	35	500

Water bearing material @ 246 feet; water acceptable for irrigation purposes.

Boring No. 5 (T. 19 S., R. 1 W., NW $\frac{1}{4}$ sec. 3)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
Pleistocene and Recent deposits (undifferentiated):		
Boulders in hardpan	22	22
Boulders in loose dirt	36	58
Clay, sandy	10	68
Sand	4	72
Clay, sandy	20	92
* Sand, water bearing	18	110
Sand, coarse	34	144
Sand, fine	3	147
Sand, coarse	8	155
Clay	$\frac{1}{2}$	155 $\frac{1}{2}$
** Sand and gravel, water-bearing	$\frac{1}{2}$	156

Possible fresh water @ 156 feet.

Boring No. 6 (T. 19 S., R. 1 W., NE $\frac{1}{4}$ sec. 22)

Stratigraphic Unit	Thickness (feet)	Depth (feet)
Pleistocene and Recent deposits (undifferentiated):		
No record	6	6
Clay, white, hard	15	21
Sand and clay layers	13	34
Clay	21	55
Quicksand	31	86
Sand	35	121
Clay	4	125
Rock	8	133
Sand layers	9	142
# Gravel, water-bearing	1	143

Water saline.

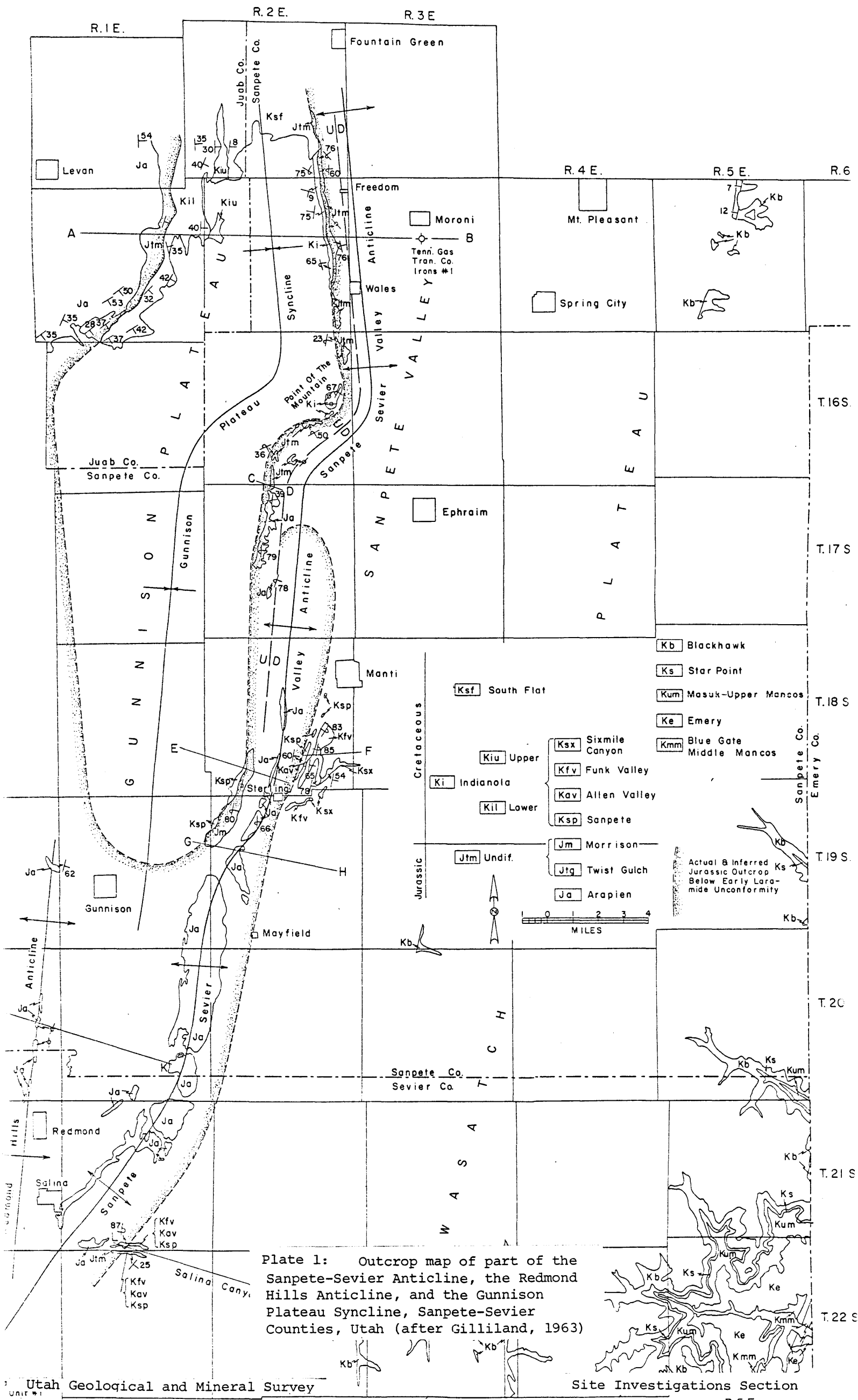


Plate 1: Outcrop map of part of the Sanpete-Sevier Anticline, the Redmond Hills Anticline, and the Gunnison Plateau Syncline, Sanpete-Sevier Counties, Utah (after Gilliland, 1963)