GROUND WATER INVESTIGATION OF THE MOUNTAIN HOME PLATEAU, IDAHO

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INTRODUCTION

Purpose and Objectives

On May 7, 1981, a 128 square mile area northwest of Mountain Home was designated as the Cinder Cone Butte Critical Ground Water Area (C.G.W.A). This declaration was the response by the Director of the Idaho Department of Water Resources (IDWR) to declining ground water levels and a possibly over-appropriated system.

This study was initiated on May 19, 1981 to review the hydrogeology of a larger area including and surrounding the Cinder Cone Butte C.G.W.A. and to develop a water budget for the combined areas. The results of the study will be used to modify the boundaries of the C.G.W.A., if warranted, and develop recommendations for management of the region's ground water resource.

The objectives of the study are:

1) Determine the recharge for the study area,
2) Determine the aquifer(s) and ground water movement for the study area,
3) Determine the net withdrawal from existing development and the potential net withdrawal from the study area by water right permits and applications for ground water development projects,

4) Propose changes in the C.G.W.A. boundaries, if warranted, and

5) Recommend management provisions such as well spacing, casing requirements.

Description of the Study Area

Located in southwestern Idaho (Figure 1), much of the study area is part of a generally broad, flat plateau which slopes gently towards the southwest. The plateau is broken by volcanic structures --- crater rings, cinder cones, and shield volcanoes. The northern boundary of the study area is formed by the Danskin Mountains while the southern boundary is the rim of the Snake River Canyon (Figure 2). Local ground water conditions within the canyon along the river are not addressed by this study. The eastern boundary of the study area was selected to include essentially all of the plateau east of Mountain Home which could be considered to have a source of recharge similar to areas to the west. The boundary is a topographic divide running generally north-south approximately one mile east of Reverse. The northwestern boundary was similarly chosen to include areas where the ground water recharge is considered to be a common source (Figure 2). Tributaries of Indian Creek which flow westward to the Boise River were excluded.

The study area varies in elevation from 6694 feet at Danskin Peak to about 2330 feet near the Snake River. All streams draining the plateau are ephemeral, flowing south toward the Snake River. The larger streams draining the

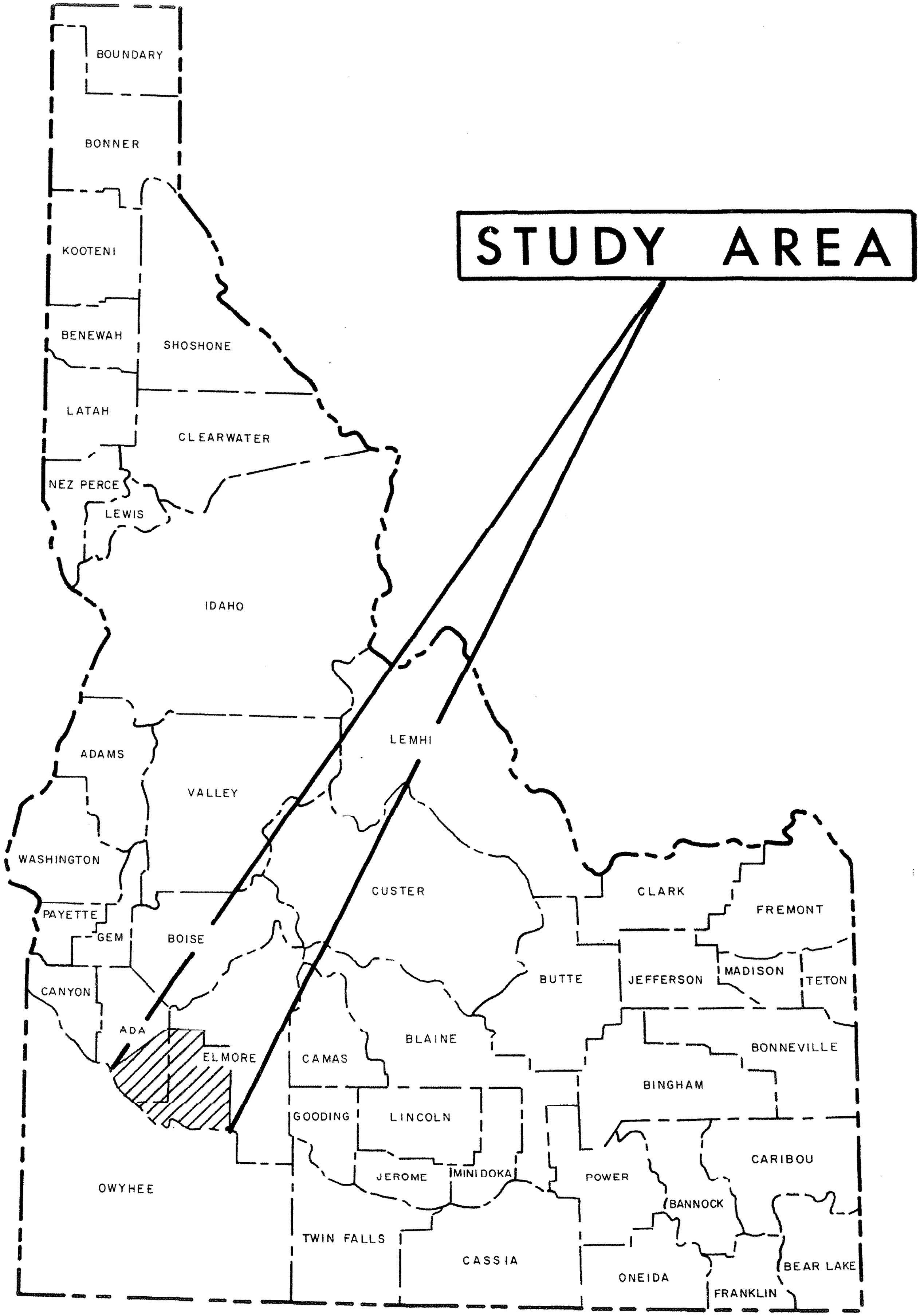


Figure 1. Study Area Location

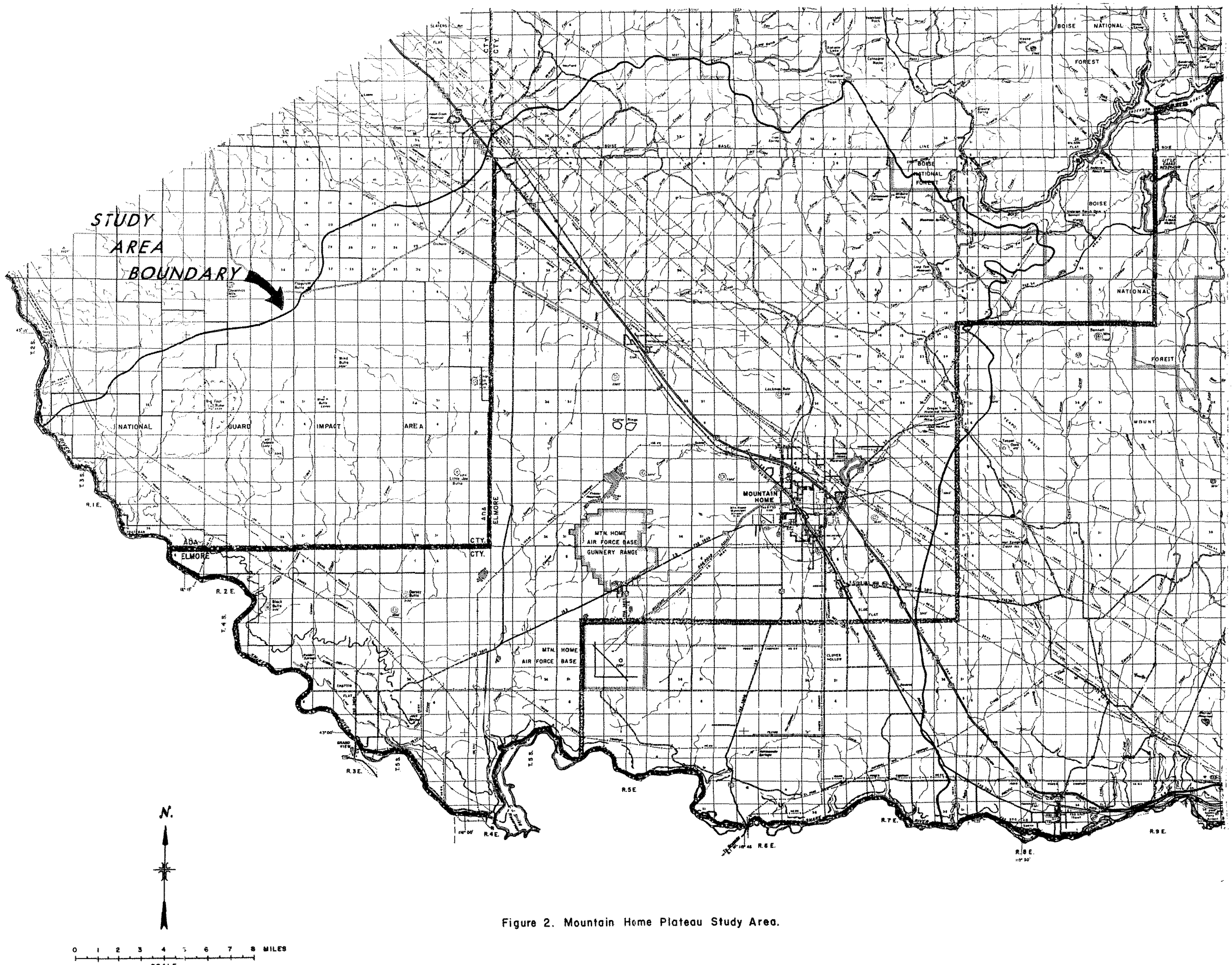


Figure 2. Mountain Home Plateau Study Area.

Danskin Mountains are fed by springs in the Tertiary volcanics and Cretaceous granites. Characterized by hot, dry summers and cold winters, the climate of the plateau is semi-arid. Average annual precipitation ranges from nine inches on the plateau to about 23 inches in the mountains.

Previous Studies

Two studies were made by Ralston and Chapman (1968 and 1970) before the majority of ground water development took place. Those studies found that recharge to the ground water system in the eastern portion of the Mountain Home Plateau is limited due to low amounts of precipitation, relatively impermeable material in the area of most precipitation, and high evapotranspiration rates. The authors further state: "The lack of evidence of recharge and discharge in the area indicates a very limited resource."

By 1977, development of the ground water resource had caused water levels to decline in areas south and west of Mountain Home (Young, 1977). The conclusion was drawn that additional large scale ground water development would probably result in economically prohibitive pumping lifts or excessive uses of energy to lift the water. No estimate was made of the volume of recharge to the ground water system.

HYDROGEOLOGY

Geology

The major geologic units in the Mountain Home Plateau are: 1) alluvium and younger terrace gravels, 2) Snake River Group, 3) Idaho Group, 4) Idavada Volcanics, and 5) Idaho Batholith. A description of each geologic unit and its water bearing characteristic is listed in Table 1 (Young, 1977). The areal extent of the geologic units and the location of the hydrogeologic cross sections are shown in Figure 3.

The cross sections, based on well logs, show that the basalts are considerably thicker in the northern section of the study area (Figures 4A-4D). The basalts of the Bruneau Formation thin rapidly to the east (cross section A) and to the south (cross sections B, C, & D). Two parallel northwest trending faults cut through the area (Bond, 1978). An apparent third fault, trending east from Cinder Cone Butte, bisects one of the northwest faults near Cleft. Several volcanic structures are present on the plateau including Crater Rings, Cinder Cone Butte, and Lockman Butte.

A deeper ground water system may exist below the Glenns Ferry Formation. Gravity data indicate that there may be 10,000 feet of material above the basement complex (Hill, 1963). If a system exists, artesian pressure may be great enough to allow development (pumping) for irrigation. Maximum

TABLE 1. Description and Water-Bearing Characteristics of Geologic Units in the Mountain Home Plateau Area (Young, 1977)

Period	Epoch	Geologic Unit	Description	Water-Bearing Characteristics
Quaternary	Holocene	Alluvium	Unconsolidated clay, silt, sand, and gravel occurring beneath flood plains of Boise and Snake Rivers. Crops out in narrow belts along major tributaries and in a broad belt near Mountain Home. Thickness probably does not exceed 70 ft.	Hydraulic conductivity generally high: however, because of thinness and irregularity of beds, yields to wells are generally small to moderate. Most important along Boise River flood plain where well yields of 2,500 gal/min are reported.
	Holocene and Pleistocene	Basalt of Snake River Group	Vesicular olivine basalt, light to dark gray, irregular to columnar jointing. Crops out on much of Mountain Home plateau and in Boise Valley. Intercalated in places with older terrace gravels. Thickness of flows probably does not exceed 550 ft.	Hydraulic conductivity variable. Where saturated, reported well yields range from 20 to 3,100 gal/min; however, the basalt is above water table in most of study area.
	Pleistocene	Older Terrace Gravel	Unconsolidated clay, sand, and fine to coarse gravel. Occurs only in western part of study area where thickness does not exceed 150 ft.	Hydraulic conductivity generally high. Reported well yields range from 20 to 2,700 gal/min.
Quaternary and Tertiary	Pleistocene and Pliocene	Idaho Group; undifferentiated	Poorly to well-stratified fluvial and lake deposits of unconsolidated to consolidated silt, sand, and gravel, with layers of ash and intercalated basaltic lava flows. Thickness unknown.	Hydraulic conductivity generally high. Reported well yields range from 15 to 3,000 gal/min.
Quaternary	Pleistocene	Bruneau Formation of Idaho Group	Includes fan deposits consisting largely of coarse sands derived from decayed granitic rocks. Thickness of fan deposits does not exceed 300 ft. Also includes vesicular olivine basalt, dark gray to black, weathers to reddish-gray-brown. Thickness of basaltic flows is about 800 ft. in study area. Unit also includes detrital material, dominated by massive lake beds of white-weathering fine silt, clay, diatomite, and minor amounts of sand.	Fan deposits are generally above water table. Basalt composes principal aquifer in Mountain Home area. Reported well yields from basalt range from 10 to 3,500 gal/min. Detrital material generally has low hydraulic conductivity.
Quaternary and Tertiary	Pleistocene and Pliocene	Glenns Ferry Formation of Idaho Group	Poorly consolidated detrital material and minor flows of olivine basalt. Includes lake and stream deposits consisting of massive silt layers, cemented sand beds, thin beds of dark clay, olive silt, and granitic sand and fine pebble gravel. Maximum thickness is about 2,000 ft.	Hydraulic conductivity generally low. Reported well yields range from 3 to 350 gal/min.
Tertiary	Miocene	Idavada Volcanics	Silicic latite; chiefly thick layers of devitrified welded tuff, but includes some vitric tuff and lava flows. Maximum thickness is about 2,000 ft.	Hydraulic conductivity variable.
Cretaceous		Idaho Batholith	Quartz monzonite and granodiorite, light to medium gray.	Hydraulic conductivity low. Yields to wells small.

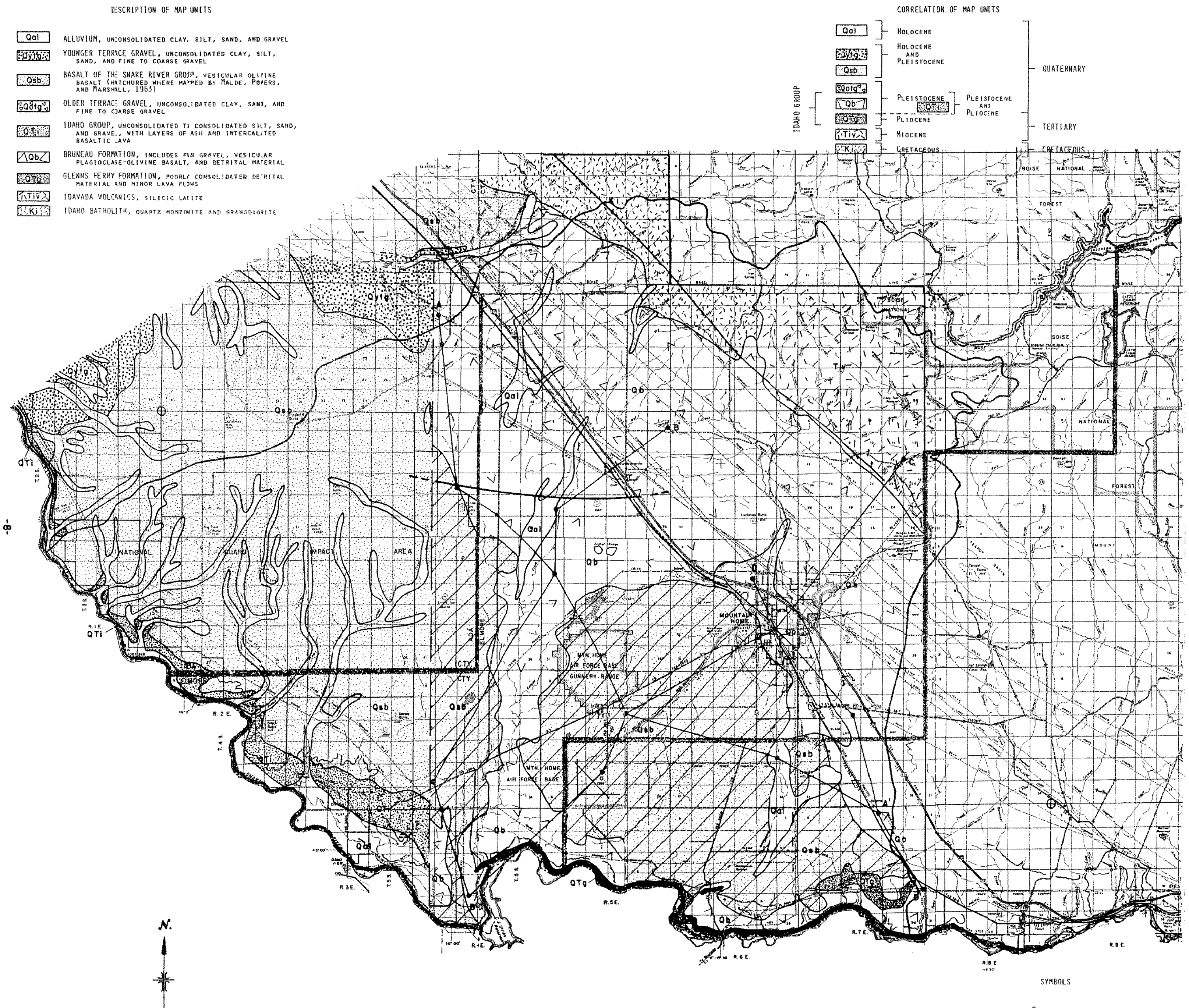


Figure 3. Major Geologic Units and Locations of Cross Sections on Mountain Home Plateau. (Adapted From Young, 1977)

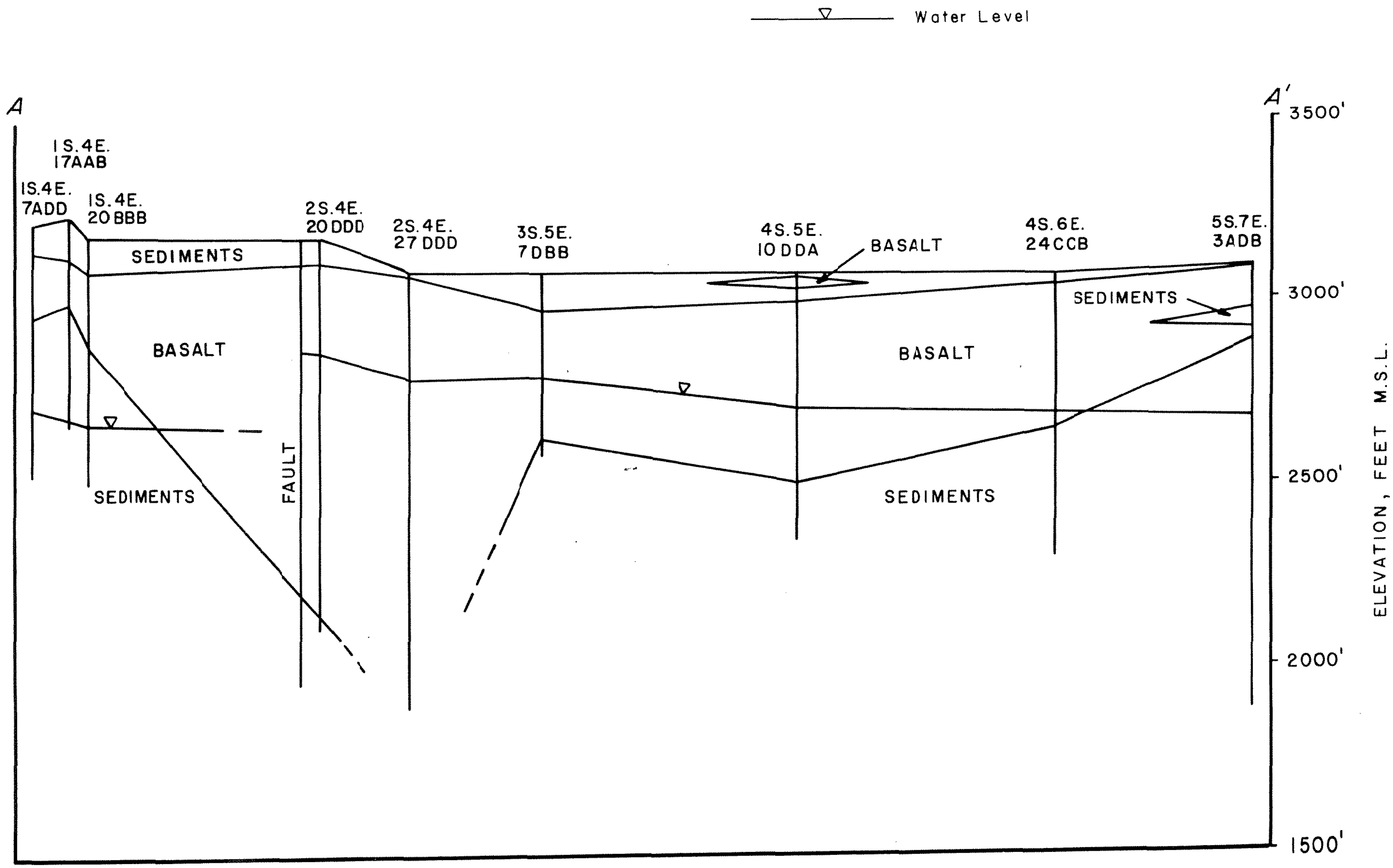


Figure 4A. Cross Section A

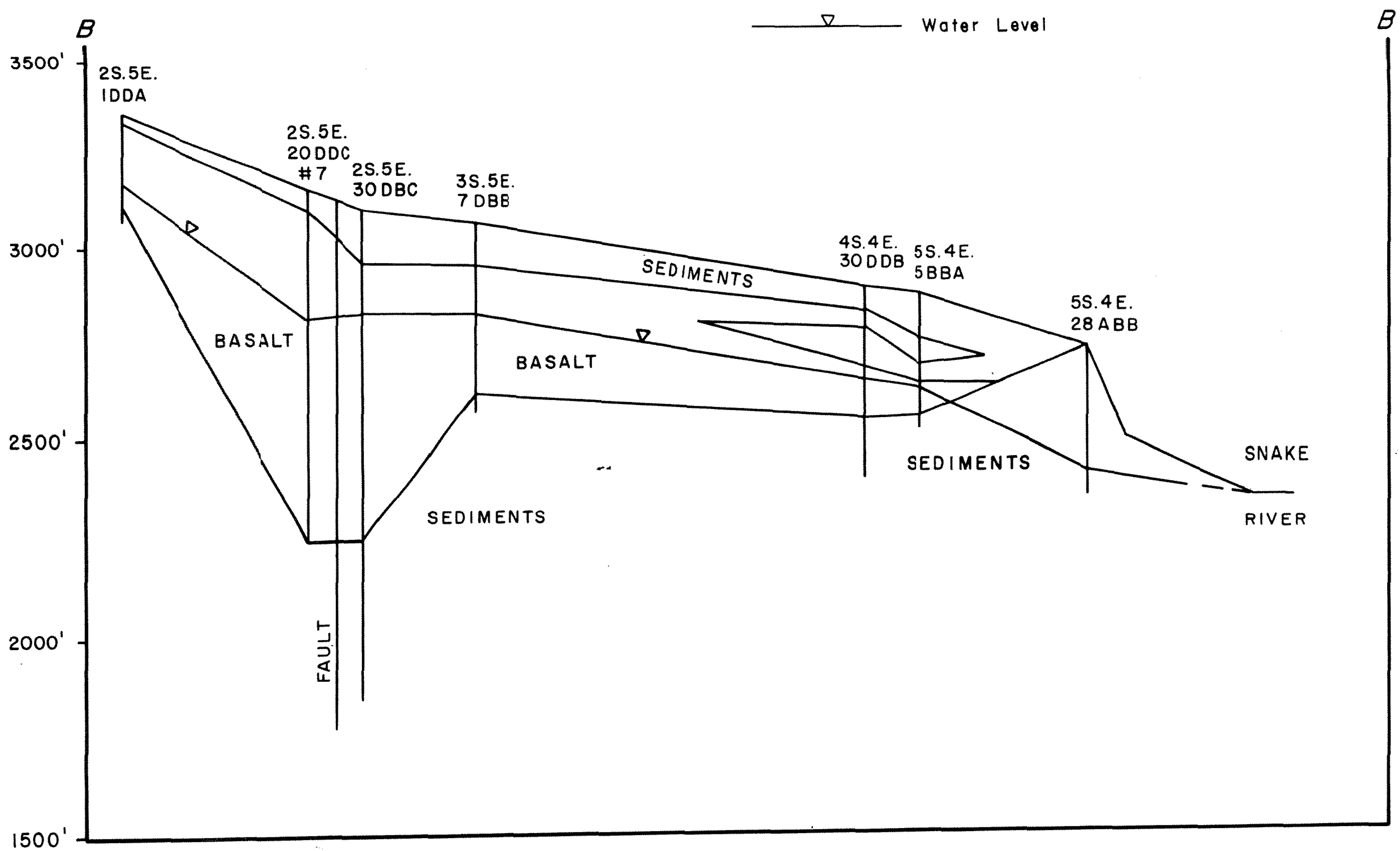


Figure 4B. Cross Section B

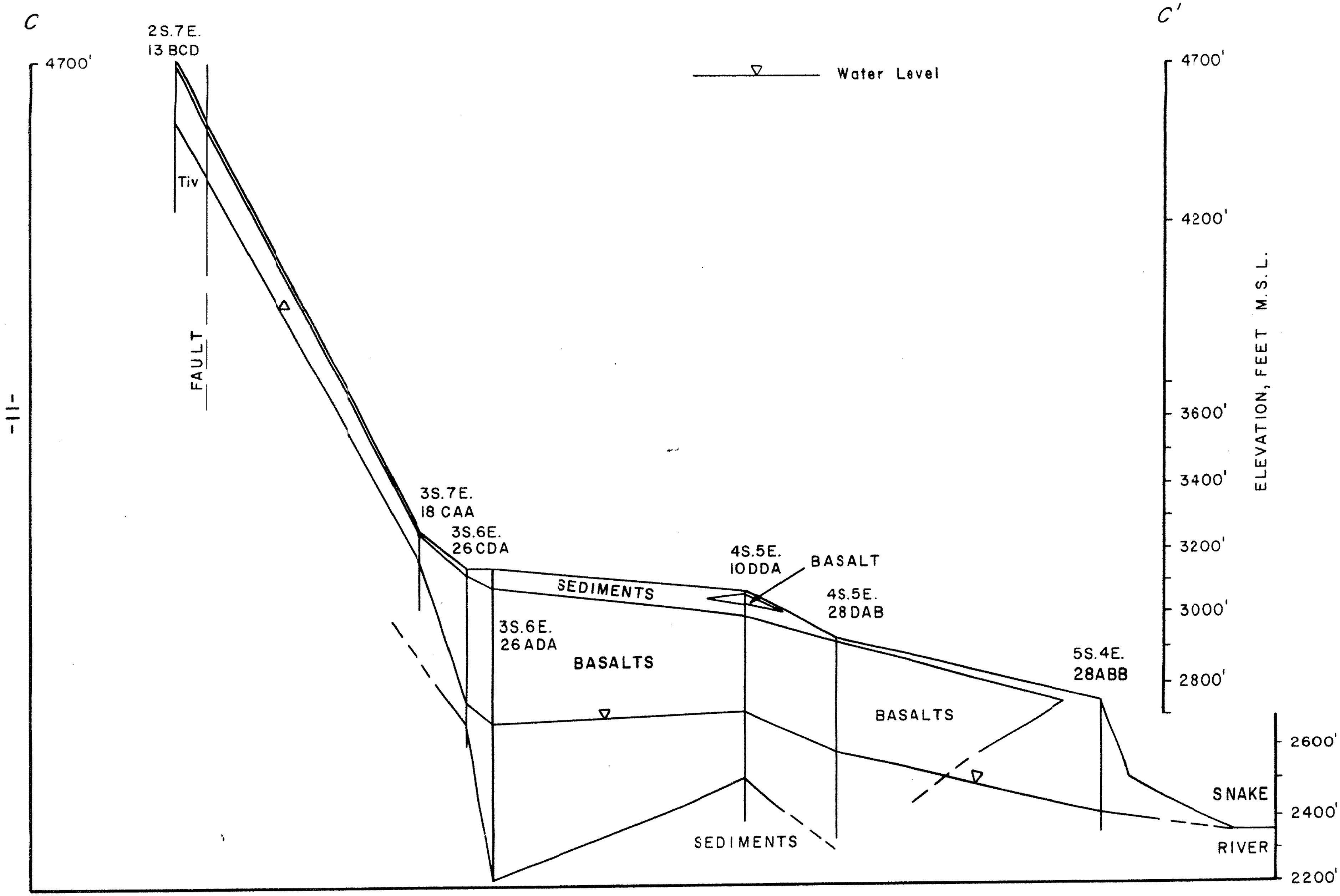


Figure 4C. Cross Section C

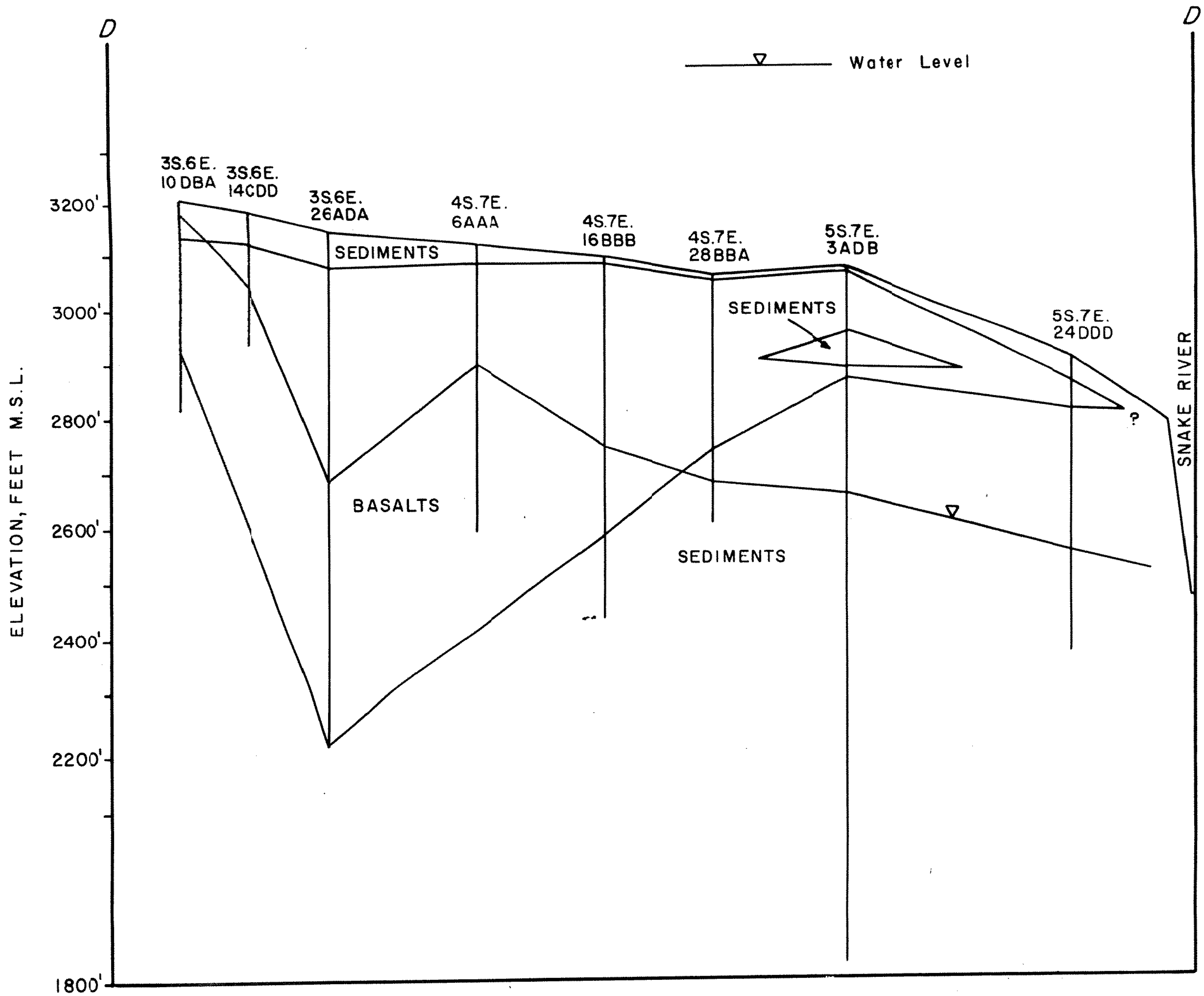


Figure 4D. Cross Section D

thickness of the Glenns Ferry Formation is 2,000 feet with 300 to 1100 feet of basalt above it.

Aquifer Description

In addition to the possible aquifer below the Glenns Ferry Formation, there are two main aquifers in the Mountain Home study area: 1) a shallow, perched system beneath Mountain Home and 2) a deeper, regional system. The perched system underlies approximately 38,000 acres as mapped by Young (1977) (Figure 5). For the most part, ground water in the perched system is in the clay, silt, sand, and gravel layers of the Quaternary Alluvium. Basalts of the Snake River Group and basalts and fan deposits of the Bruneau Formation beneath the alluvium also contain ground water from the perched system. Depth to water in the shallow system can be less than 10 feet but varies considerably along the limits of the perched system as the water moves vertically down to the regional system.

Recharge to the perched system occurs from both Rattlesnake and Canyon Creeks as well as seepage from Mountain Home Reservoir and the canals and laterals that distribute the water. It has been estimated by the Mountain Home Irrigation District that it takes a diversion to the reservoir of approximately 28 cfs to maintain the reservoir at full stage with no releases (Charles Cook, personal communication).

Natural discharge from the perched system occurs mainly as downward percolation to the regional system and as spring flow at Rattlesnake Spring near the Snake River Canyon rim.

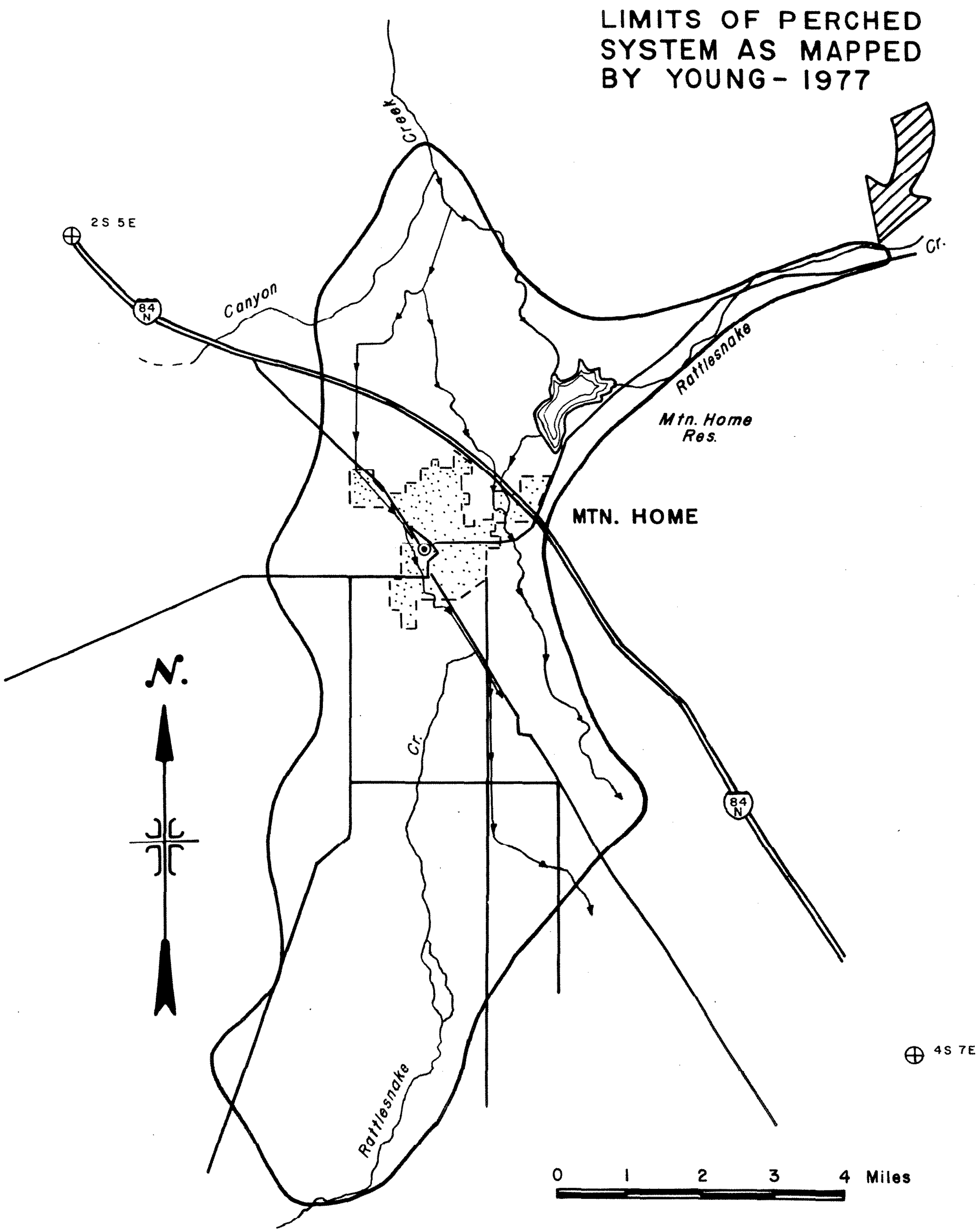


Figure 5. Location of Perched Aquifer

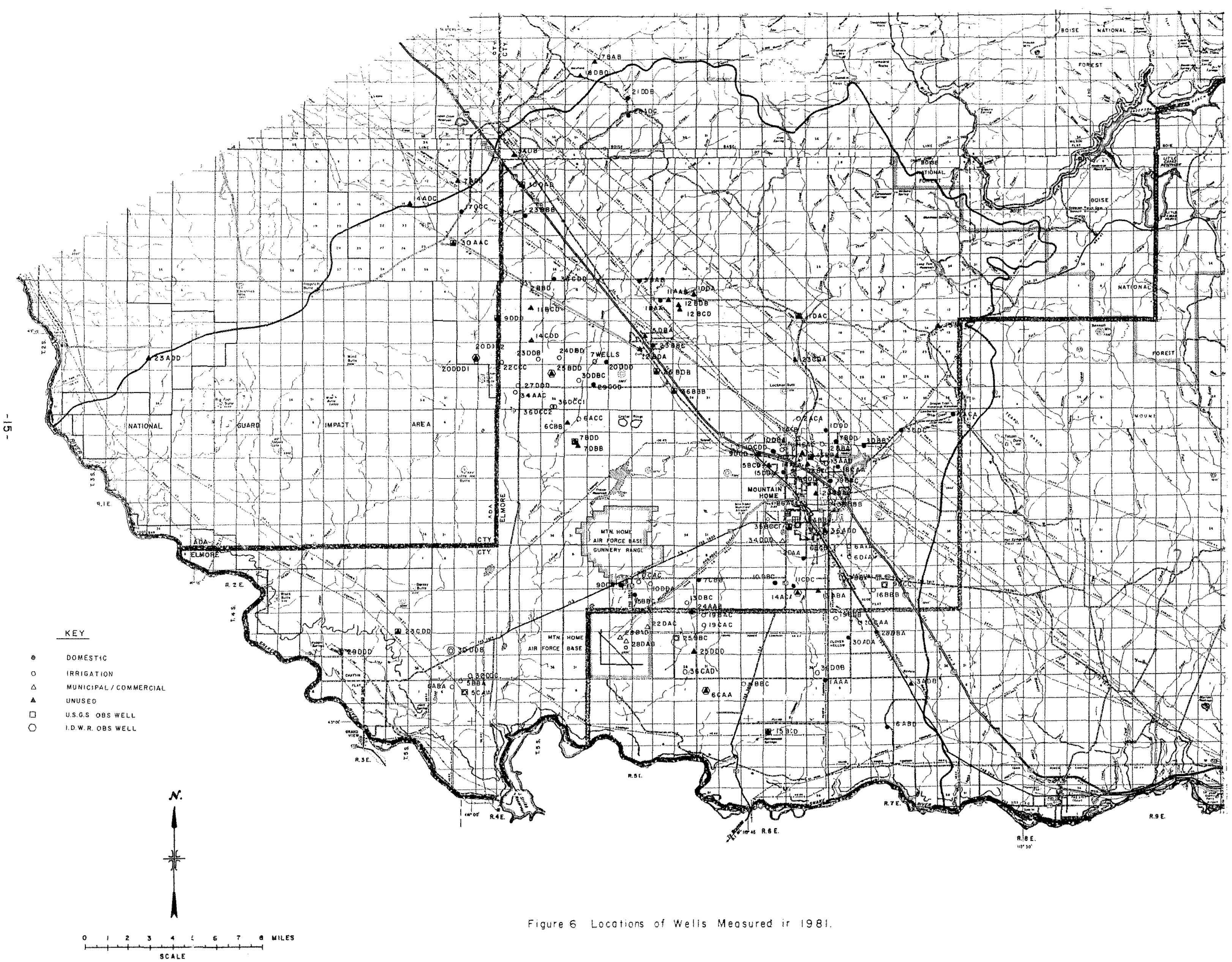


Figure 6 Locations of Wells Measured in 1981.

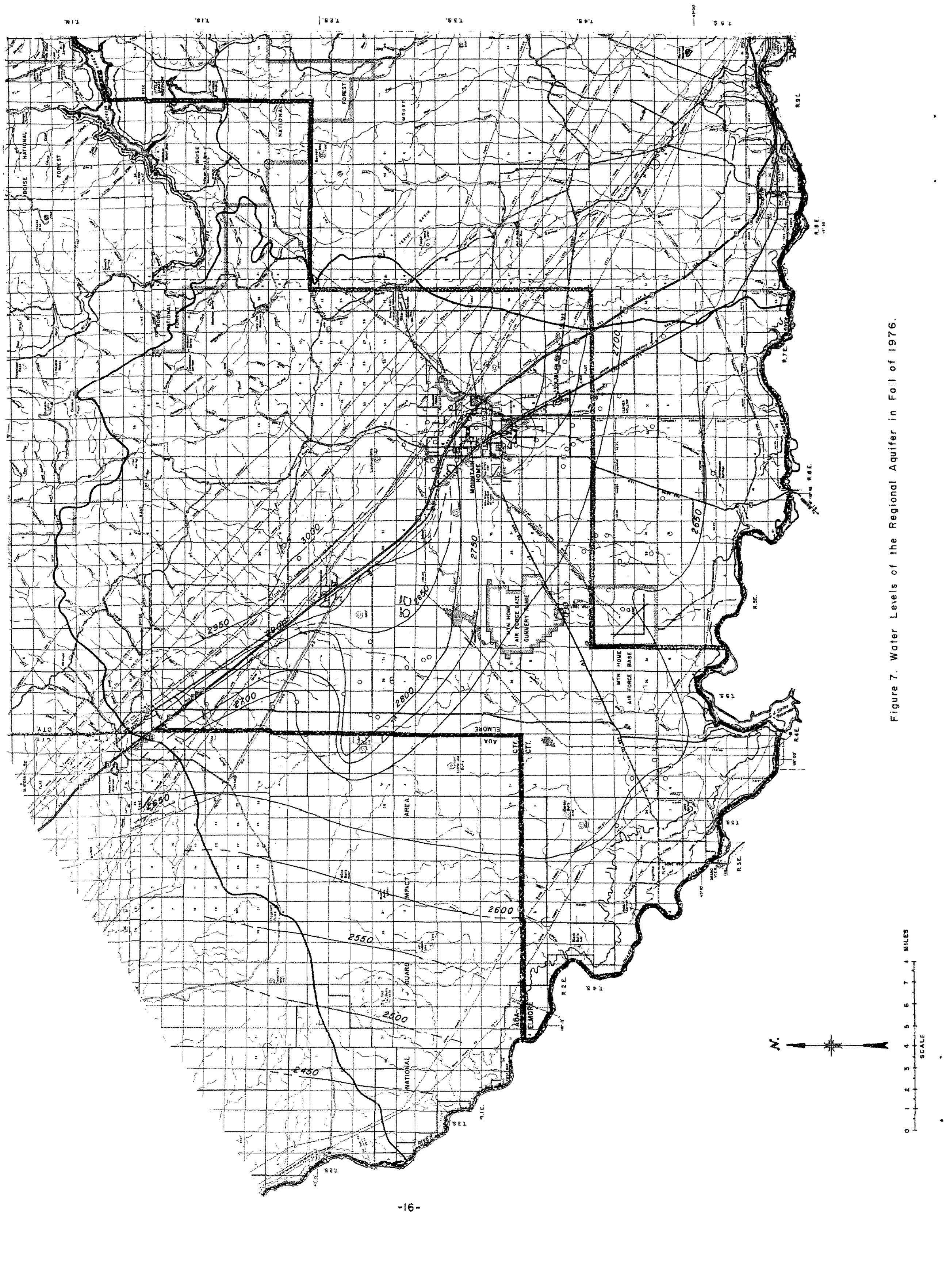
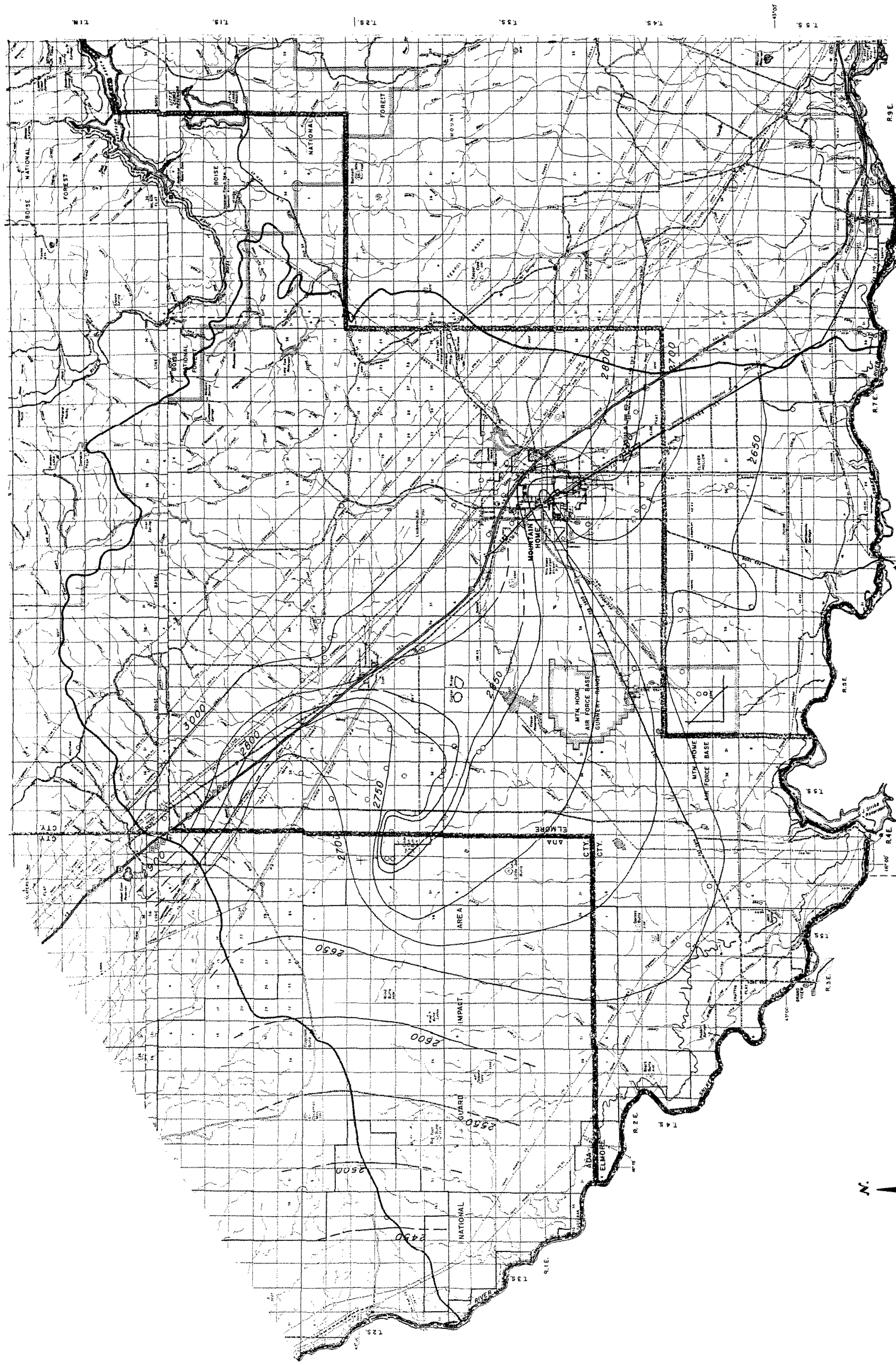


Figure 7. Water Levels of the Regional Aquifer in Fal of 1976.



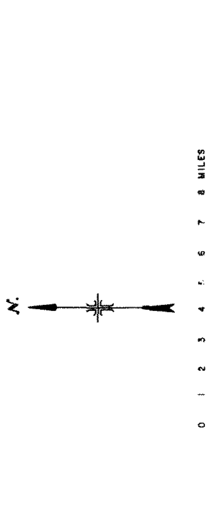


Figure 8. Water Levels of the Regional Aquifer in Fall of 1981.

The amount of flow from the spring is not known. There has been some development of the perched system as a domestic supply and for small irrigation uses (less than 40 acres).

The deeper, regional aquifer supplies ground water to the large irrigation wells and municipal wells for Mountain Home and the Air Force base. The major rock types are basalts of the Bruneau Formation, Idaho Group and poorly consolidated detrital material and minor basalt flows of the Glenns Ferry Formation, Idaho Group. Well yields from the basalts (Bruneau Formation) range from 10 to 3500 gpm. The range of the well yields for the Glenns Ferry Formation is three to 350 gpm. The Bruneau Formation thins rapidly towards the east where the Glenns Ferry Formation becomes the major source of ground water.

Recharge to the regional system occurs as downward percolation of precipitation that falls on the mountains, losses from intermittent stream flows, and from downward percolation from the perched system. Some of the precipitation falling on areas having little soil cover probably also reaches the aquifer.

Discharge from the regional system occurs as spring flow, underflow to the Snake River, and pumpage. Young (1977) estimated that 3000 acre-ft/yr are discharged through four springs in the Snake River Canyon; one of the springs is west of the study area. Pumpage for irrigation is the largest discharge from the regional aquifer system.

Data Collection

Ground water level data collected by the U.S. Geological Survey for the 1976-77 study, in addition to the observation well data, were supplemented by a mass measurement in the fall of 1981. The locations of wells measured in 1981 are shown in Figure 6. In addition to the mass measurement, several wells were measured periodically to help determine the amount and location of recharge.

A staff gage was installed on Canyon Creek above the bridge on Foothill Road (T.2S. R.6E. Sec. 11). Measurements of Canyon Creek at the old U.S. Highway 30 bridge were made to determine channel loss between Foothill Road and the highway.

Direction of Ground Water Flow

Contour maps of the regional ground water system for the fall of 1976 and 1981 are shown in Figures 7 and 8. The direction of ground water flow is perpendicular to the contour lines. In general, the direction of flow is towards the southwest with a southern component in the southeast and a western component in the northwest. Low permeability along the apparent east-west trending fault through Cleft limits the flow toward the north. The ground water elevation is 70 to 165 feet higher on the south side of the fault. Due to a greater number of wells in the Cinder Cone Butte area now than in 1976, the effects of the fault are more readily visible.

The direction of flow in the perched ground water system is towards the southwest (Figures 9 and 10). Note the change

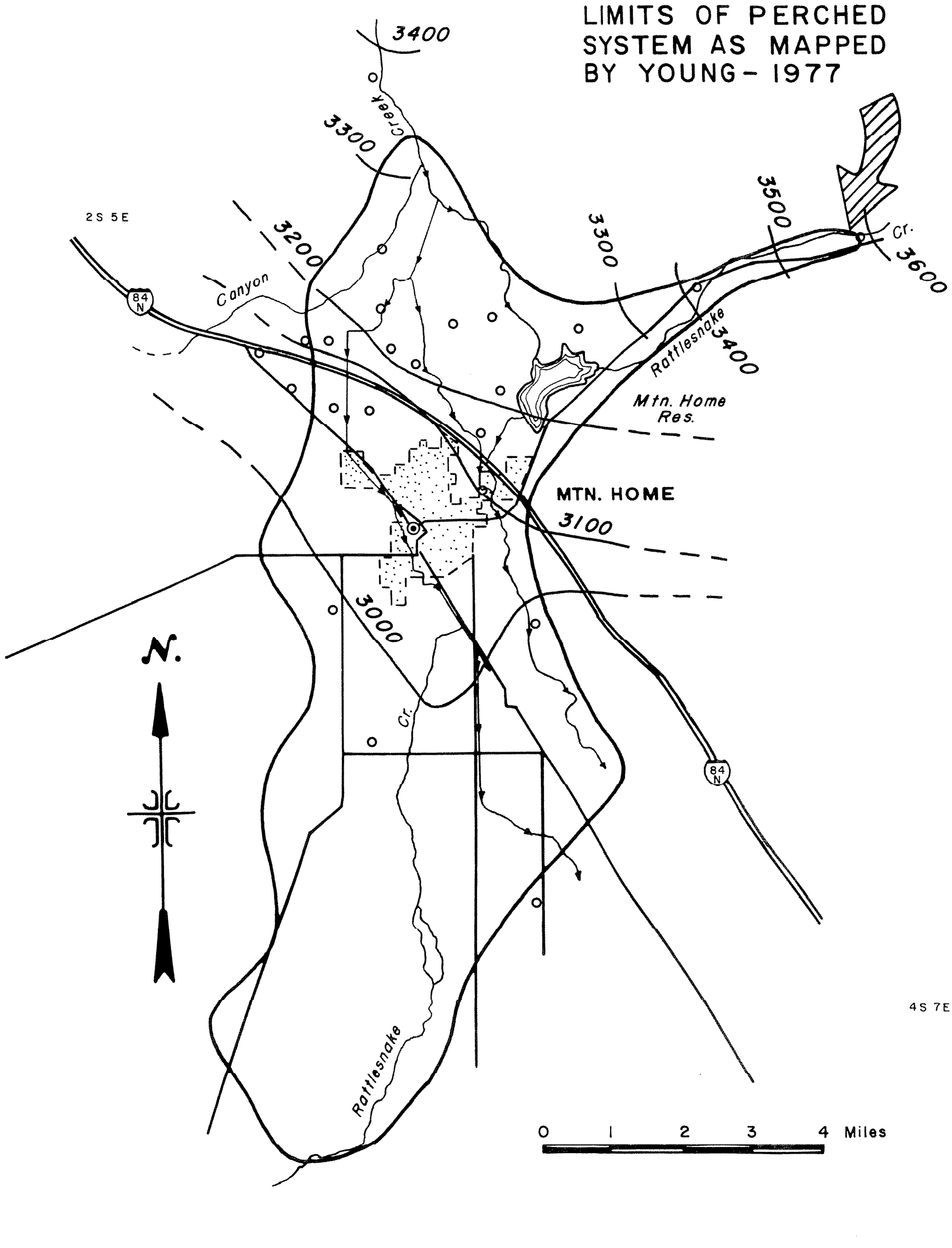


Figure 9. Water Levels of the Perched Aquifer, 1976.

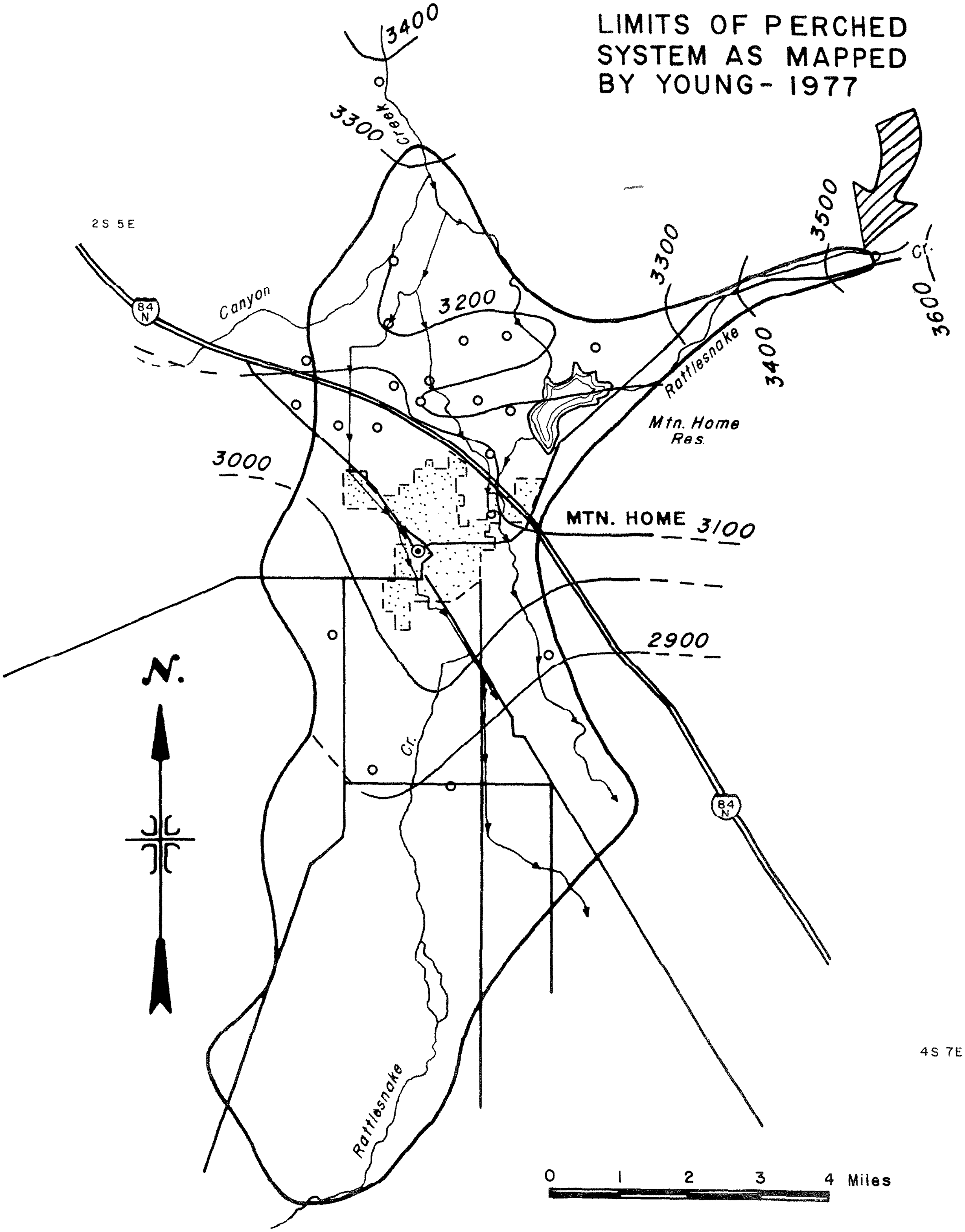


Figure 10. Water Levels of the Perched Aquifer, 1981.

in the 3200 foot contour between 1976 and 1981. This change is in response to development of the perched system as a domestic supply of water.

Water Level Fluctuations

In general, a ground water system can be considered in equilibrium when discharge from, recharge to, and the volume in storage remain constant. When development occurs, the equilibrium is changed. The direction of the change depends on the type of development; if surface water irrigation is started, more water is made available for recharge and water levels rise. But if pumpage from the ground water system occurs, water is taken from storage and water levels will decline. Natural discharge from the system may increase in response to recharge and may decrease with pumpage. When development reaches the new level, the system will reach a new equilibrium or steady state condition. Water level fluctuations provide an indication of how the ground water system is reacting to changes in recharge, discharge, and pumping.

There are 15 observation wells of the USGS - IDWR network in the study area. Two other observation wells have been discontinued. Twelve wells have long term records (1967 to present) while records for the five remaining wells began in 1976. Depth to water ranges from less than three feet (perched system) to over 487 feet (regional system). Locations of these wells are shown in Figure 6 and the hydrographs are plotted in Figures 11 through 17.

Four of the wells do not show signs of decline. Two (T.1S. R.4E, Sec. 10DAD1 and T.4S. R.3E. Sec. 29DD1) are stable (Figures 12 and 15). One (Figure 11) has risen from 488 feet in 1967 to 482 feet in 1981 (T.1S. R.4E. Sec. 30AAC1), while the fourth (Figure 13) took several years to recover from test pumping in 1973 (T.2S. R.6E. Sec. 11DAC1).

Declines in the remaining observation wells have varied from less than one foot to over 35 feet. The ground water level in well T.2S. R.4E. Sec. 9DDD2 rose seven feet from 1960 through 1977 (Figure 11). The upward trend then reversed and the water level has declined to the 1960 level over the last five years. Well T.2S. R.5E. Sec. 26BDB1, located northwest of Mountain Home, has declined one-half foot since 1976 (Figure 12). An upward trend in well T.2S. R.5E. Sec. 36 BBB1 reversed during the winter of 1977 and declined almost two feet by September 1981 (Figure 12). The hydrograph of domestic well T.3S. R.5E. Sec. 7BDD1 shows a steady decline from July through January (Figure 13). The water level rises only slightly, if at all, during the spring. This indicates little or no recharge to the ground water system in this area. Well T.3S. R.6E. Sec. 13BBA1 is in the perched system north of Mountain Home and has declined over 30 feet since 1976 (Figure 14). The water level declines from March through September in response to pumpage in the area, and recovery in the well occurs during the winter. A shallow well used as a domestic source of water in the late 1960's shows a similar trend to the previous well (T.3S. R.6E.

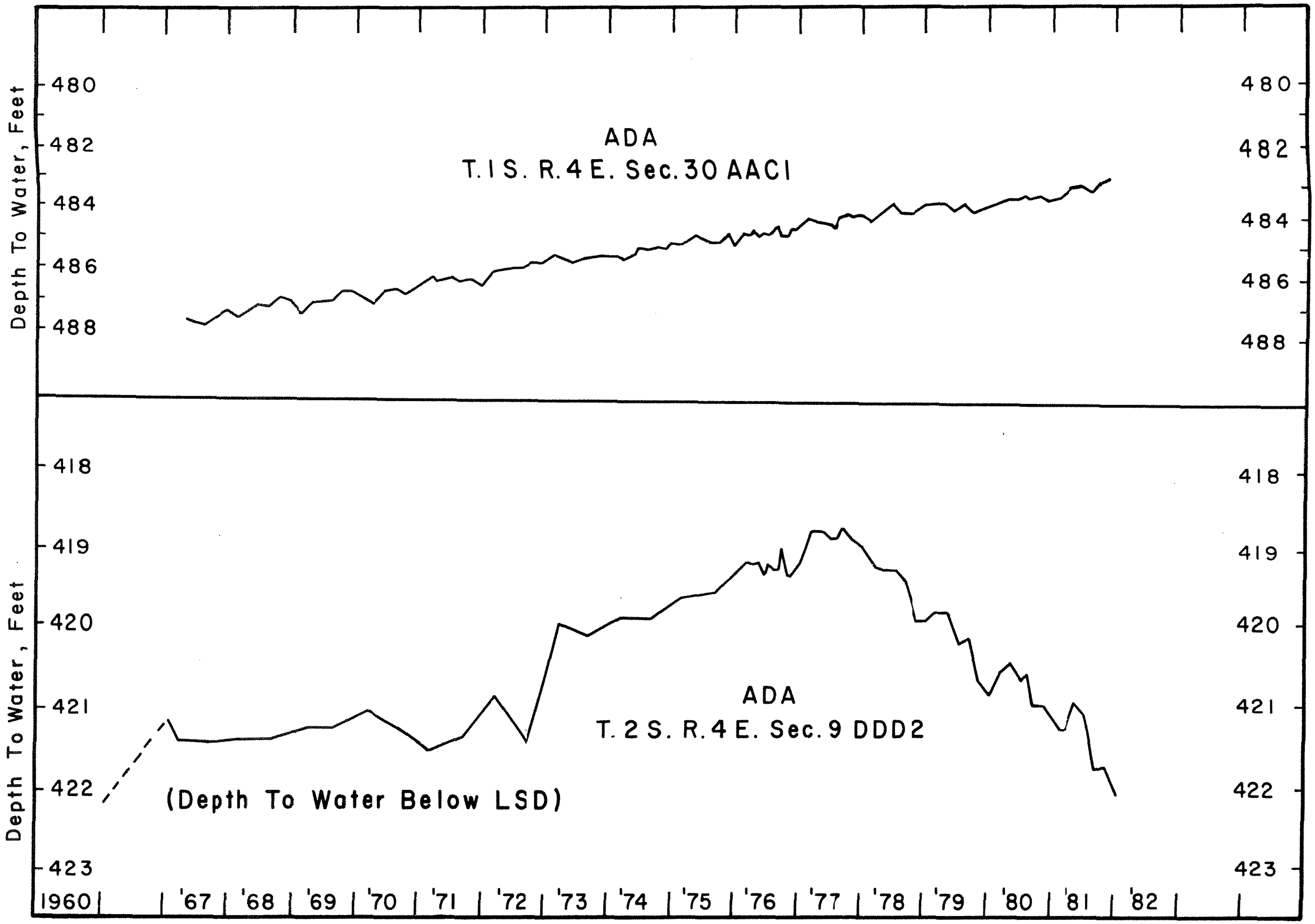


Figure 11. Hydrographs of Wells on the Mountain Home Plateau.

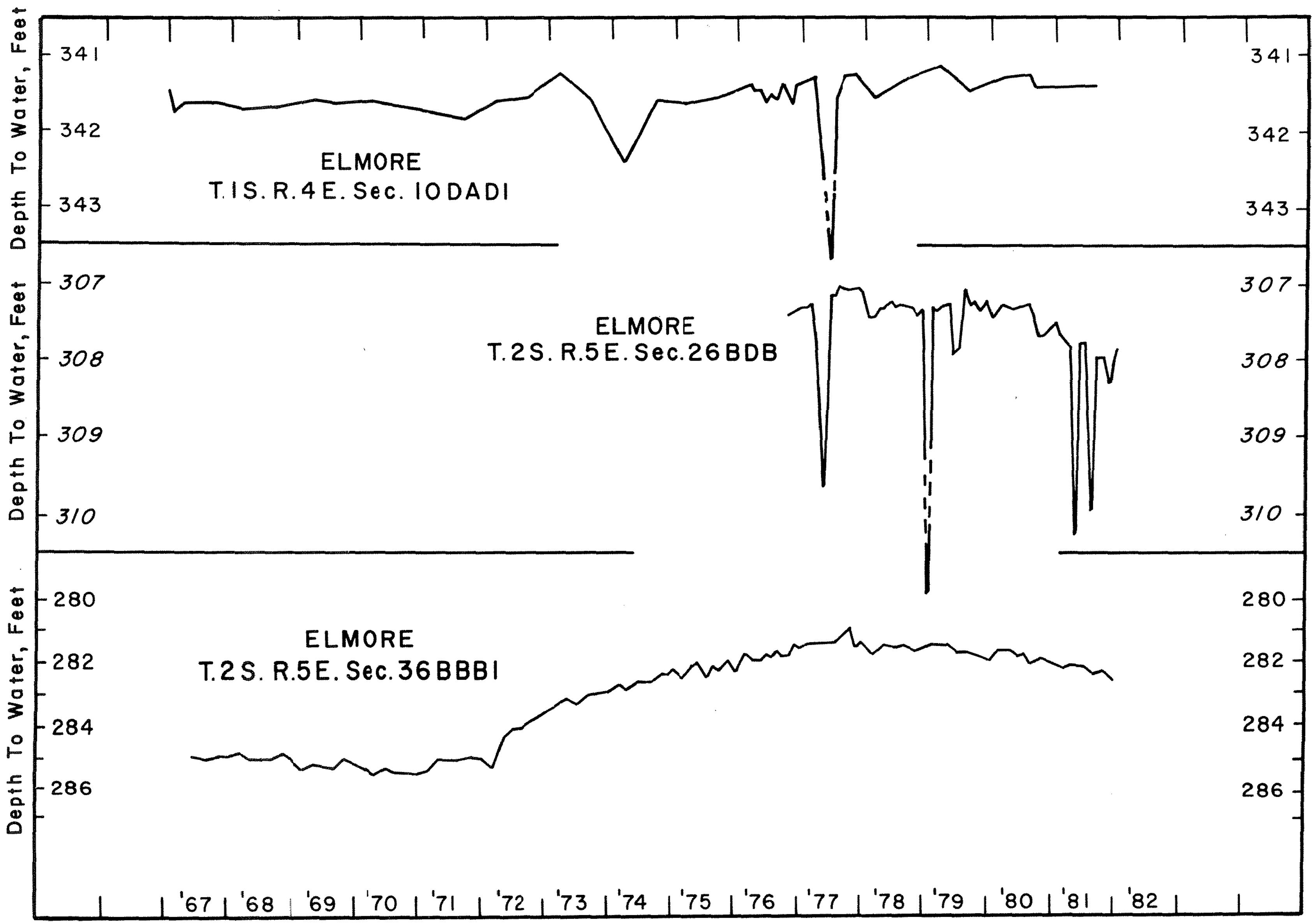


Figure 12. Hydrographs of Wells on the Mountain Home Plateau.

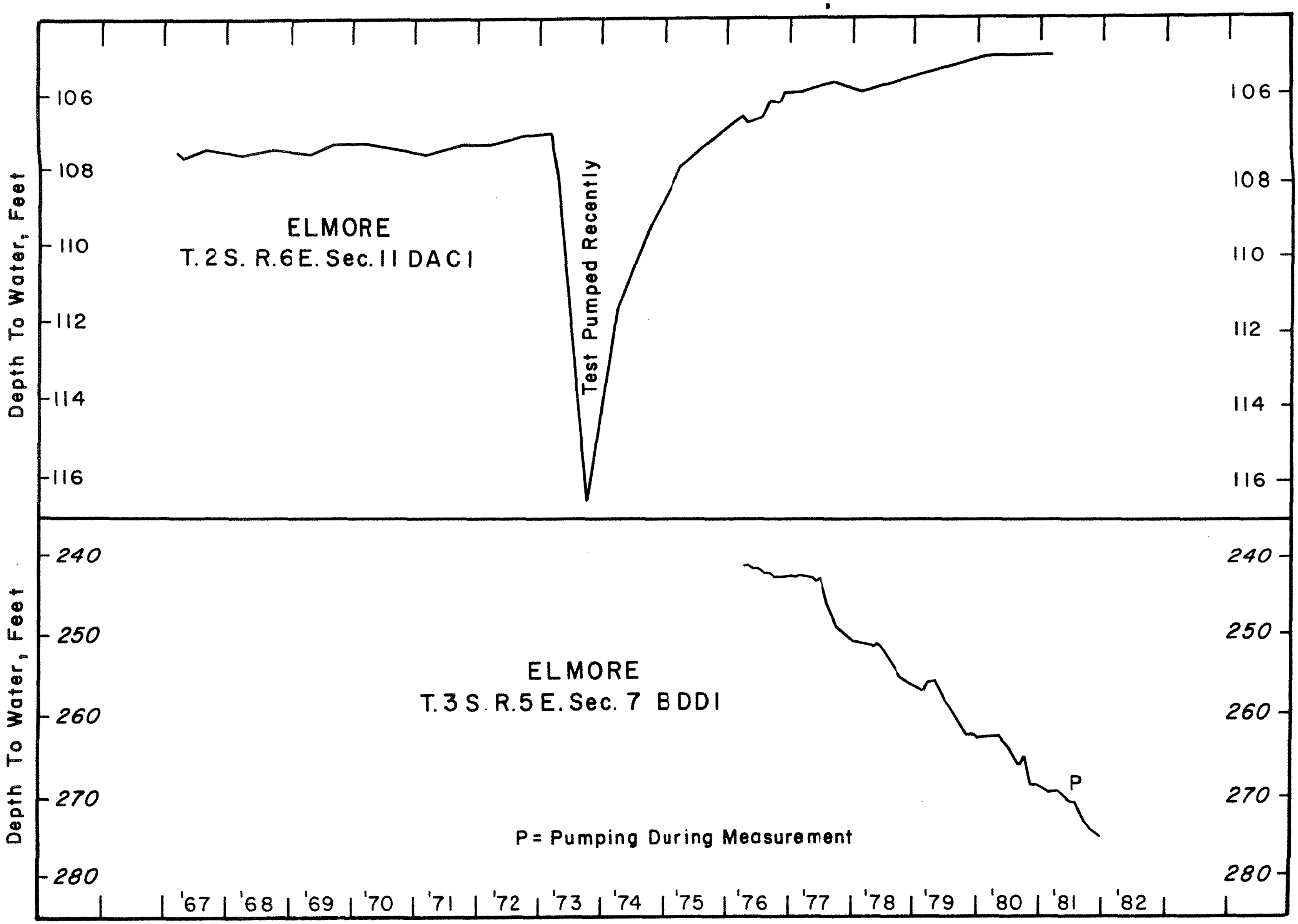


Figure 13. Hydrographs of Wells on the Mountain Home Plateau.

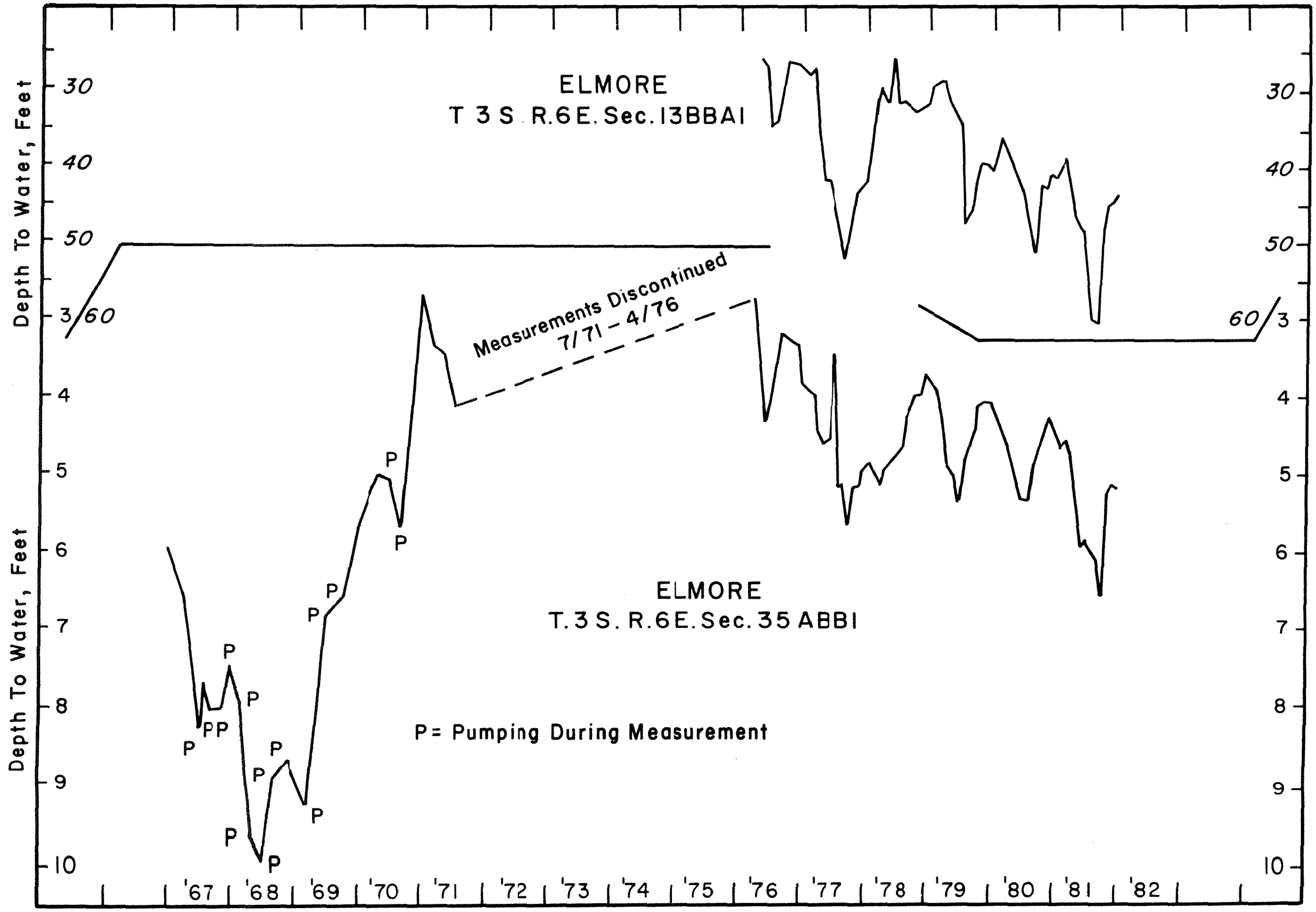


Figure 14. Hydrographs of Wells on the Mountain Home Plateau.

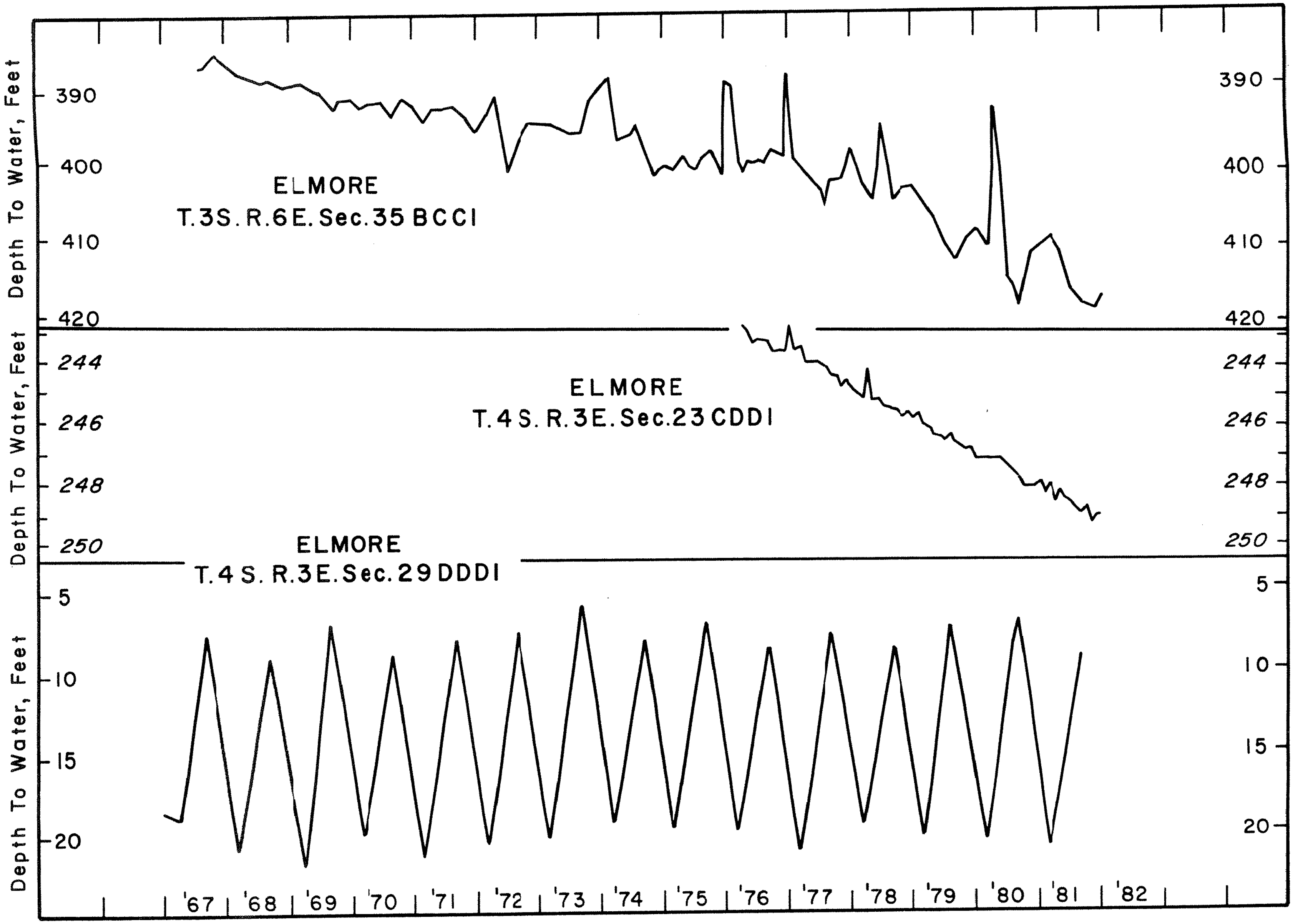


Figure 15. Hydrographs of Wells on the Mountain Home Plateau.

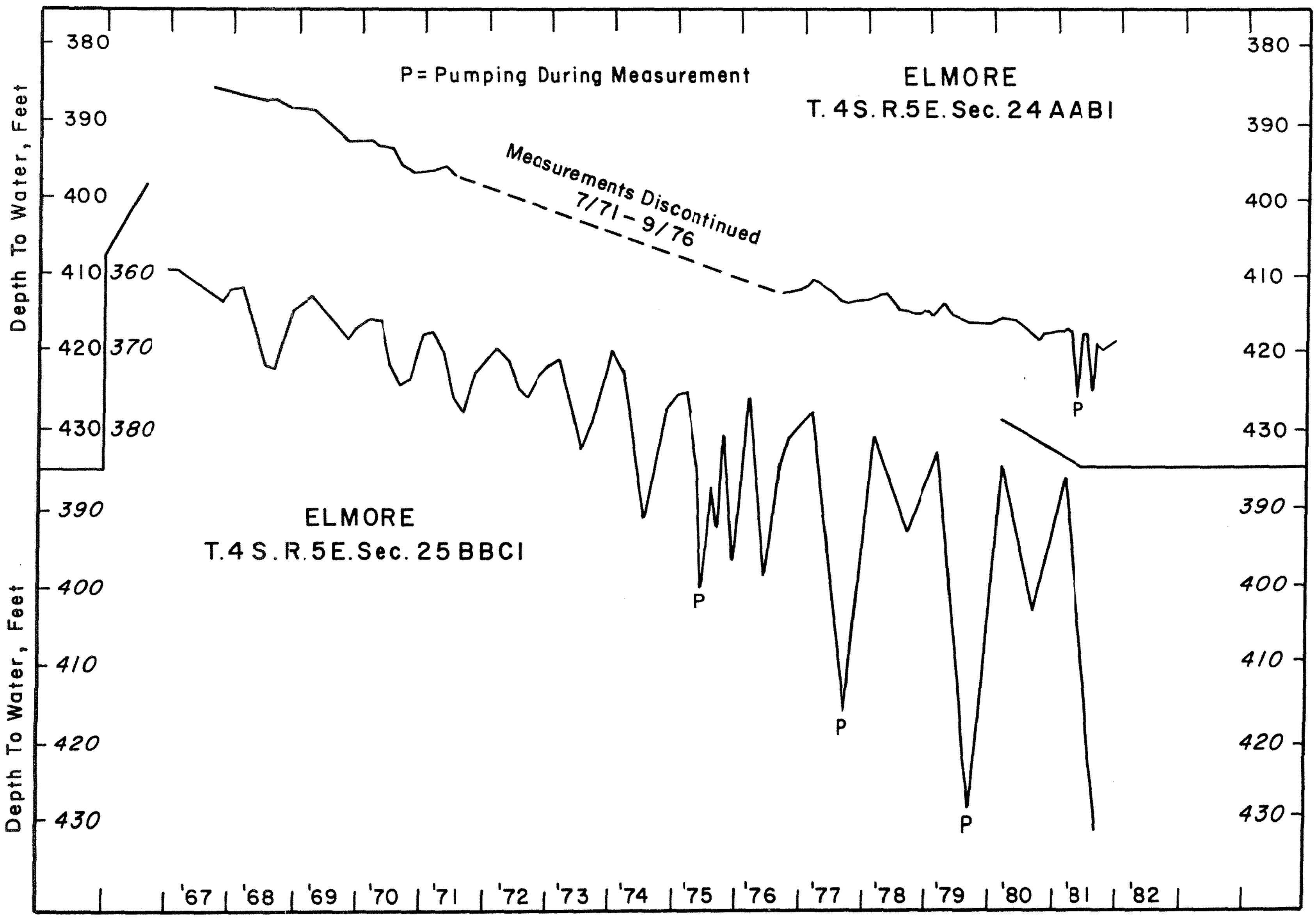


Figure 16. Hydrographs of Wells on the Mountain Home Plateau.

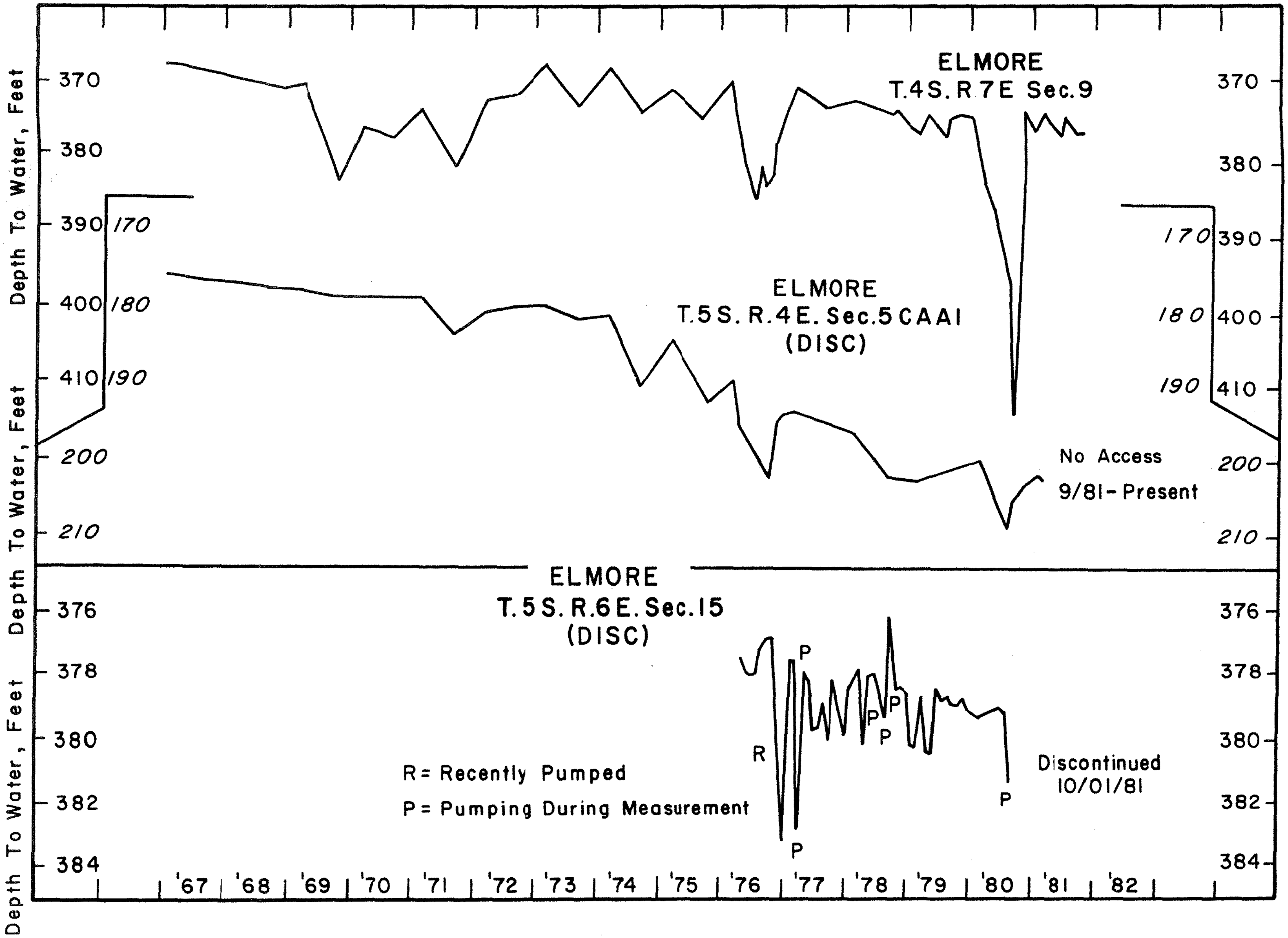
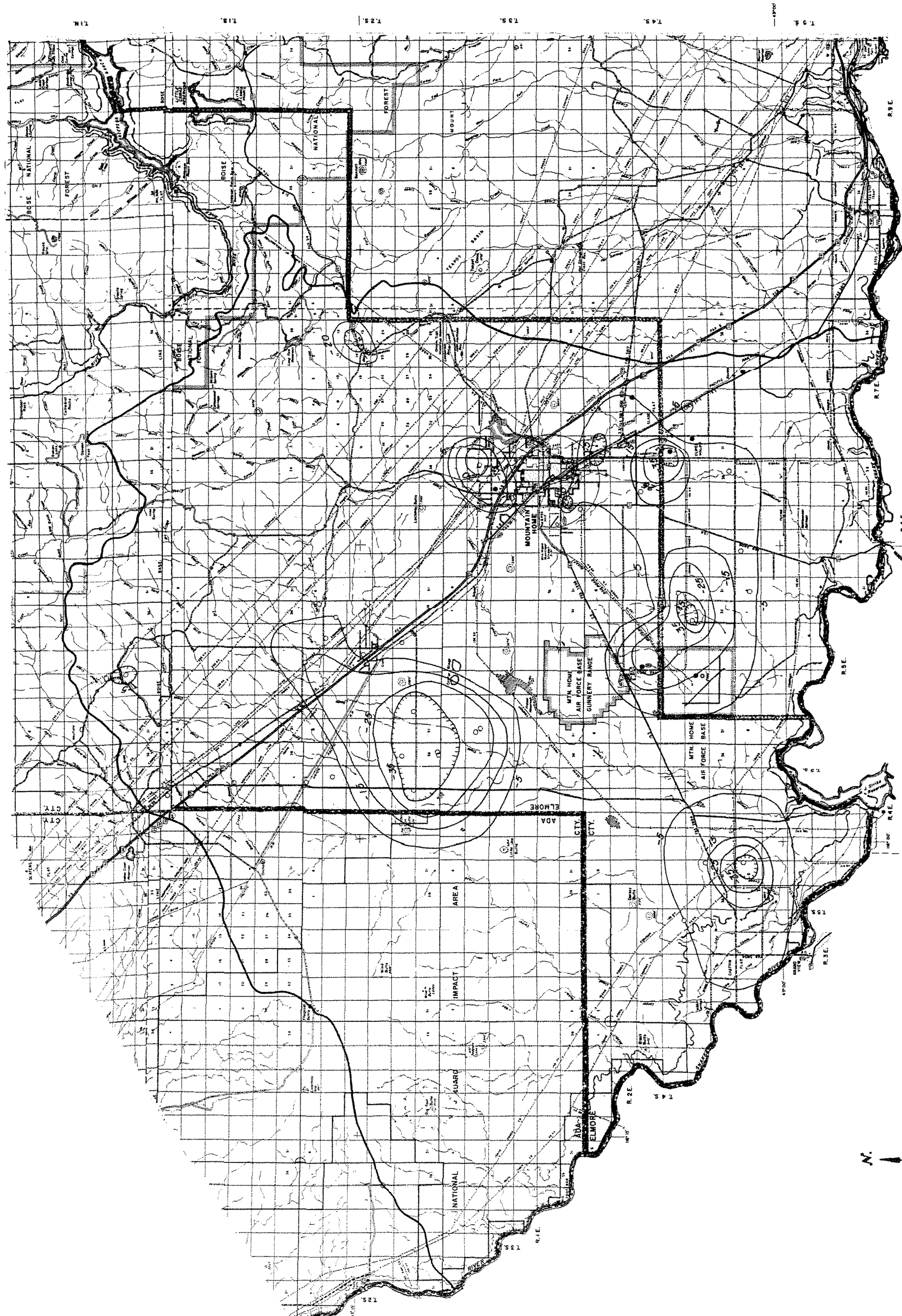


Figure 17. Hydrographs of Wells on the Mountain Home Plateau.

Sec. 35ABB1) (Figure 14). A second well in the section (Sec. 35BCC1), but in the regional system has declined 18 feet over the last five years and almost 31 feet since 1967 (Figure 15). Well T.4S. R.3E. Sec. 23CDD1 is located nine miles west of Mountain Home A.F.B. and over two miles from the nearest production well. The water level has declined over five feet since 1976 (Figure 15). The hydrograph shows a steady rate of decline with little or no recharge. Two observation wells east of the Mountain Home A.F.B. have shown a steady decline since 1967 (T.4S. R.5E. Sec. 24AAB1 and Sec. 25BBC1) (Figure 16). The water levels have declined 34 and 27 feet, respectively. The pumping level at well 25BBC1 in 1975 was approximately 400 feet below L.S.D. but by 1981, the pumping level was below 431 feet. Well T.4S. R.7E. Sec. 9DCC1 has declined almost nine feet since 1967 while well T.5S. R.4E. Sec. 5CAA1 over the same period of time declined 27 feet (Figure 17). Well T.5S. R.6E. Sec. 15BCD1 has declined four feet since 1976 (Figure 17).

Changes in the Ground Water Systems

The change in ground water levels over a 5 year period was contoured to show the areas and the amount of decline (Figure 18). The difference between the mass measurement data collected in the fall of 1976 (Young, 1977) and the mass measurement data collected in the fall of 1981 was used for the change map. Wells where data were collected from the spring of both years were also used for a larger number of data points. A large area south of Mountain Home declined



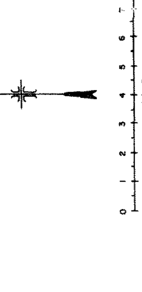


Figure 18. Change in Water Levels in the Regional Aquifer from 1976 to 1981 in Feet.

more than five feet, with two depressions of 35 and 40 feet inside the -5 foot contour. The second largest area of declines occurred in the Cinder Cone Butte C.G.W.A. with declines of more than 35 feet over a large portion of the area. Declines of more than 35 feet also occurred west of Mountain Home A.F.B. Small areas of decline appeared beneath Mountain Home (-20 feet) and northeast of the city (-15 feet). Declines in the regional system have occurred in areas where irrigation development has taken place.

Declines in the perched ground water system occurred mainly in the vicinity of Mountain Home where large domestic development has occurred (Figure 19). Declines varied in amounts from over 50 feet to no decline at all. Two small areas of decline of over five feet were located south and northeast of Mountain Home.

Declines in both the perched and regional ground water systems are due mainly to development of the resource, but lower amounts of precipitation in the mountains over the last several years have also played a part. Table 2 shows the annual precipitation and the departure from normal for precipitation stations located at Mountain Home, Anderson Dam, and Hill City. Precipitation at Mountain Home for the eight years of record shown was above average for all but one year and 14.35 inches above average for the period listed. Precipitation for the station at Anderson Dam was above average only three times over the same time period, but precipitation for the three wet years was almost equal to the lack of precipitation during the remaining five years. The station at Hill

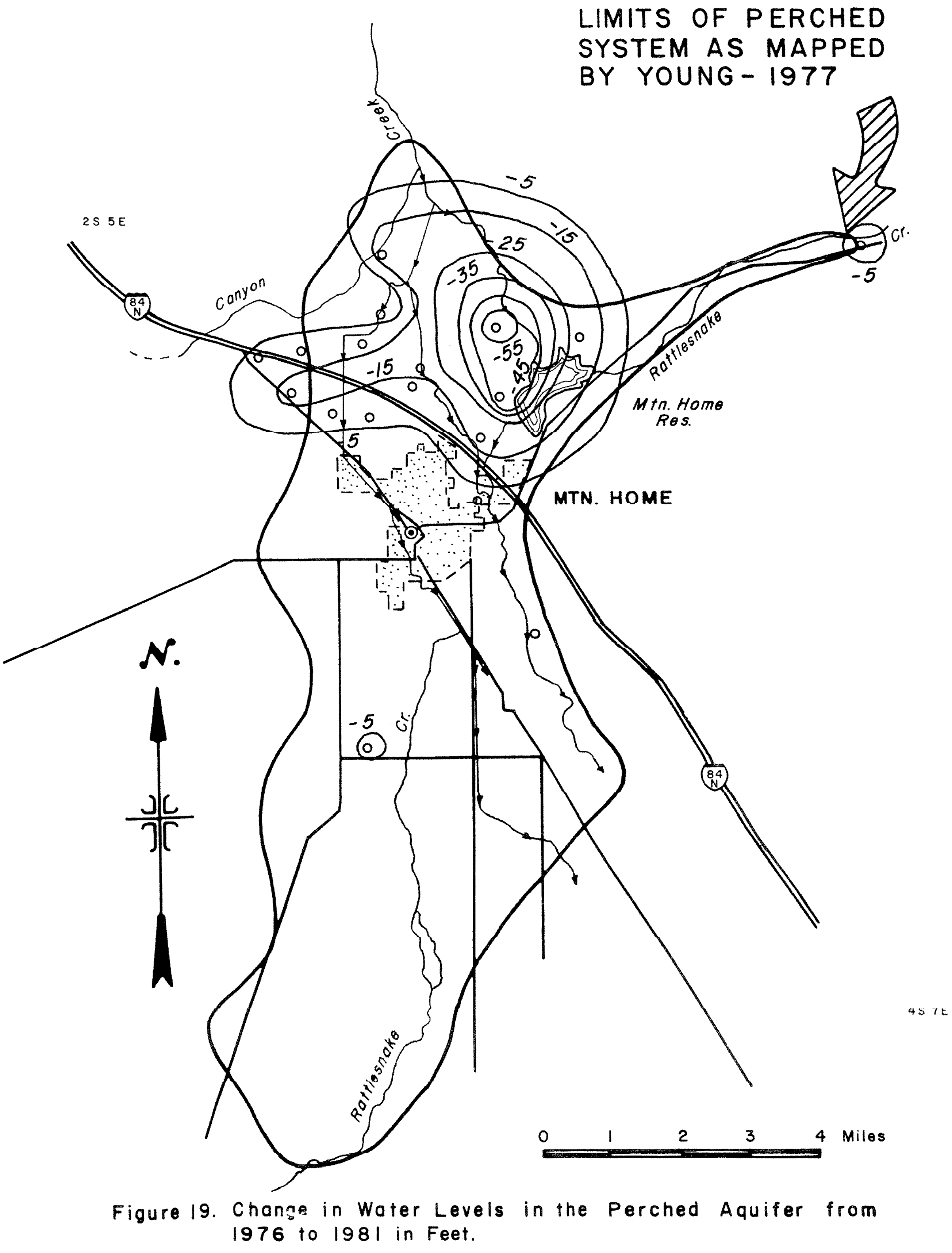


Figure 19. Change in Water Levels in the Perched Aquifer from 1976 to 1981 in Feet.

City was below average for all but one year and 19.21 inches below average for the period listed. Over the last eight years, precipitation was above average for the Mountain Home Plateau but was probably near or below average in the mountains above the plateau. This would lead to near or below average yield from Canyon Creek, Rattlesnake, and Ditto Creek basins. Below average precipitation would also affect the interbasin transfer of water from Little Camas Reservior.

Table 2. Annual Precipitation and Departure from Normal for Stations in Vicinity of Mountain Home Plateau in inches

	Mountain Home		Anderson Dam		Hill City	
Date	Annual Precip	Departure*	Annual Precip	Departure*	Annual Precip	Departure*
1981	12.03	+2.43	22.98	+3.09	17.45	+1.96
1980	10.30	+0.70	22.19	+2.30	13.60	-1.89
1979	19.20	-0.40	15.59	-4.30	10.90	-4.59
1978	12.24	+2.64	19.11	-0.78	13.82	-1.67
1977	9.83	+0.23	19.77	-0.12	12.73	-2.76
1976	12.91	+3.31	14.40	-5.49	9.99	-5.50
1975	13.40	+3.80	28.40	+8.51	14.61	-0.88
1974	11.24	+1.64	17.04	-2.85	11.95	-3.94

* Departure from average annual precipitation based on period 1941-1970.

WATER SUPPLY AND USE

Basin Yield

Recharge to the ground water system is from water derived from precipitation both within and from outside the study area. Imported irrigation water from Little Camas Reservoir and the Snake River are the out-of-basin components. Recharge from within the basin is mainly from precipitation falling on the higher elevations of the mountainous portion of the basin. This recharge can either move directly through the volcanic rocks from the source area to the ground water system under the plateau portion of the area or enter stream channels flowing out from the hills onto the plateau. The water in the streams is either diverted for irrigation or infiltrates to the ground water table as the streams cross the plateau. As a result, only in years of large runoff does surface discharge reach the Snake River.

Recharge from precipitation falling directly on the lowlands of the plateau is thought to be small due to the low amounts of precipitation and high potential for evapotranspiration (Young, 1977 and Rawls and others, 1973). Soil morphological characteristics, described in the soil survey data for the plateau area, also indicate no significant water movement below the root zone (Noe, 1982). Some recharge is believed to occur on portions of the plateau where precipitation falls on rock outcrops. An estimate of this quantity was developed from previous estimates made for a similar purpose for the Snake Plain aquifer. Mundorff and others (1964) used a figure of 26 percent of the annual precipitation on basalt rock surfaces as being recharged to that aquifer. This same fraction of the annual precipitation was used for this study. Areas of rock outcrop or extreme stoniness amount to about four percent of the plateau area. Recharge from this source would be about 4400 acre feet per year over the plateau area.

Water is imported into the Canyon Creek basin for use by the Mountain Home Irrigation District from Little Camas Creek, a tributary of the South Fork Boise River. Flows in Little Camas Creek are stored in Little Camas Reservoir (capacity 17,300 acre feet) and released into the trans-basin Little Camas Canal which carries the water into the East Fork of Long Tom Creek. The water then passes through Long Tom Reservoir before joining Syrup Creek. The two creeks form Canyon Creek from which the Mountain Home Irrigation Company diverts to its reservoir through the Mountain Home Feeder Canal.

Records of Little Camas Canal flow at its head were kept from 1924-29 and 1932-73. Average annual flow during that period was 11,100 acre feet. Diversions are generally made from April or early May through mid-September. Canal flow records below Tunnel No. 9, where the water enters Canyon Creek basin, provided a basis for determining the net import. Based on a correlation of monthly flows at Tunnel 9 with flows at the head, the average net import is about 9500 acre feet per year.

In the southern portion of the study area, water from the Snake River is pumped up to the plateau. Approximately 37,800 acre-ft/yr are diverted for 14,653 acres at an average diversion rate of 2.58 acre-ft/yr (Sutter, 1976).

There are very little data on runoff of the streams in the study area. Measurements of several streams were made for a few months in 1917. In the March-September period of that year, Rattlesnake Creek carried 1800 acre feet and Canyon Creek 35,760 acre feet, 9840 acre feet of which was diverted into the basin in the Little Camas Canal. It was, however, a wetter than normal year as evidenced by the South Fork of the Boise River near Lenox which had annual runoff of 141 percent of normal in 1917.

Records of diversions through the Mountain Home Feeder Canal provide the best basis for estimating Canyon Creek water yield. The feeder canal which transfers Canyon Creek water to Mountain Home Reservoir and the Mountain Home Irrigation District carried an average of 23,200 acre feet per year during a 43 year period ending in 1969. From notes made by personnel of the district, it is estimated that, in addition, an average of roughly 5300 acre feet per year passes the feeder canal headgates and is not diverted. Deducting the average Little Camas Canal import of 9500 acre feet results in a yield estimate for Canyon Creek of 19,000 acre feet per year.

Similar data are not available for the other basins (Rattlesnake and Ditto Creeks and adjacent areas). To estimate their yields, a curve of yield versus mean basin elevation was drawn from sketchy data for nearby watersheds which, when applied to Canyon Creek basin, would reproduce the estimated yield of 19,000 acre feet (5.1 inches) for that basin. This curve was then used with area elevation curves for the two basins to estimate their yields. By this method, Rattlesnake Creek is estimated to yield an average of 3460 acre feet (4 inches) per year and Ditto and adjacent areas 3800 acre feet (2.9 inches) per year.

In October 1981, a gaging station was established on Canyon Creek at the Foothill Road bridge (T.2S. R.6E. Sec. 11, SENWSE ~~SE1/4~~). Eight discharge measurements were made between October 1981 and March 1982 to establish the stage-flow relationship, and a staff gage was read daily. Flows ranged from about two cfs during the fall to 400 cfs in February. Runoff from October through March totaled about 30,000 acre feet. During this period there were no diversions into the basin from Little Camas Creek. Canyon Creek flow was diverted to Mountain Home Reservoir until January 18.

During February when Canyon Creek flows rapidly increased in response to warm wet weather, flow reached the Interstate Highway 84 bridge and continued through to the Snake River. The flow at the former U.S. Highway 30 bridge immediately downstream from I-84 was measured on three occasions to determine channel losses.

Canyon Creek Discharge in CFS

	at Foothill Road	at Old U.S. 30	Diversion	Loss
February 18	330	346		
March 11	252	182		70
April 19	256	179	8	69

On February 18 local runoff was entering the stream between the two sites, but none was occurring on March 11. It appears that about 6000 acre feet of Canyon Creek flow was recharged to the groundwater systems between mid-February and the end of March. Between January 19 and mid-February about 4000 acre feet was recharged from the creek with small amounts occurring in the fall and early winter.

On March 11 roughly half of the flow at the U.S. 30 bridge was passing Idaho Highway 67, west of Mountain Home Air Force Base. Substantial amounts of additional recharge undoubtedly occurred from Ditto, Rattlesnake and other small creeks which drain the foothills.

From notes by personnel of the Mountain Home Irrigation District, it appears that some Canyon Creek water passes the diversion works to Mountain Home Reservoir in most years. Amounts which have occurred in early 1982, however, appear to be much larger than at any time in the past 10 years. Available data indicates that accumulated precipitation from October through March in the general area was about 145 percent of normal.

Based on the apparent losses to ground water in the spring of 1982, a rough estimate of the losses from water passing the diversion to Mountain Home Feeder Canal was made for the 1972 to 1980 period. Of the 5300 acre feet per year, wet year escapement to Snake River is estimated to be 1900 acre feet, with the remainder being recharged.

Irrigated Lands

Irrigated land in the study area was determined from 1975 maps of irrigated lands in Ada and Elmore Counties; these were prepared by the Department of Water Resources and updated by Bureau of Reclamation to include 1979 acreages. With the use of aerial photos, the acreage under cultivation was adjusted to 1980 (Figure 20). Applications and permits for use of ground water on file with IDWR were also determined (Table 3).

Table 3. Developed, Applications for, and Permitted Lands, Mountain Home Study Area (acres)

Ground Water Permits (undeveloped, 1980)		15,517
Pending Applications		10,959
Developed		
Canyon Creek	4,045	
Canyon Creek (GW suppl.)	1,845	
Ground Water	21,637	
Snake River	14,653	
Total Developed		42,180
Total		68,656

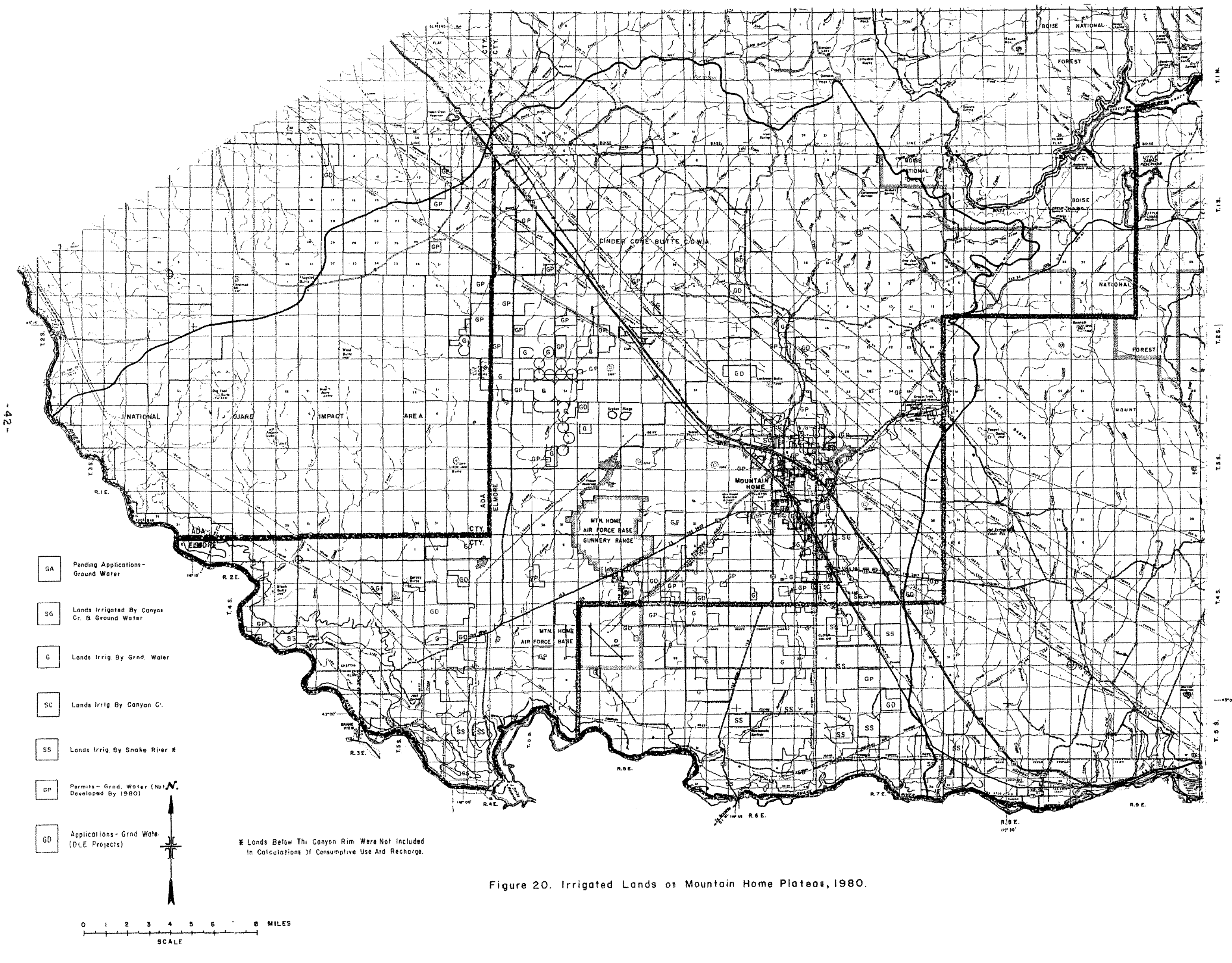


Figure 20. Irrigated Lands on Mountain Home Plateau, 1980.

Utilizing image analysis techniques the crop distribution was estimated for the study area. The 1980 crops on irrigated land were: row crops (25.6%), small grains (47.8%), alfalfa (17.3%), and pasture (9.3%). The row crops and small grain classifications were further divided based on county records (1980 Idaho Agricultural Statistics) as shown in Table 4.

Table 4. Row Crop and Small Grain Classification

Row Crops		Small Grains	
Corn	8.5%	Winter Wheat	45.7%
Beans	24.7%	Spring Wheat, Oats, Barley	54.3%
Sugar Beets	20.2%		
Potatoes	46.6%		

The number of acres per crop type was calculated by multiplying the total number of acres irrigated from Canyon Creek, Snake River, and ground water by the percentage of that crop type for the study area.

Consumptive Irrigation Requirement

The number of acres per crop type was then multiplied by the average annual consumptive irrigation requirement for that crop (Sutter & Corey, 1970). The total consumptive irrigation requirement was then determined for lands served from the three sources as follows:

	Acres	Consumptive Irrigation Requirement (Ac-Ft/Yr)
Canyon Creek (SW)	4,968*	8,800
Ground Water	22,290*	39,500
Snake River	14,653	25,950
		74,250

* Includes half of the lands supplied from both Canyon Creek and ground water.

In addition to the above, irrigation of approximately 1500 acres of lawns and gardens in Mountain Home and at the Air Base uses about 2500 acre feet per year.

Water Balance

The water balance for the study area is shown in Table 5. Under 1980 conditions of use, there was a slight deficit of supply compared to use.

Table 5. Water Balance for Mountain Home Study Area, 1980 Conditions

Source	Supply/Use	Total (rounded) (ac/ft/yr)
Canyon Creek Yield	19,000	
Little Camas Creek (imported)	9,500	
Rattlesnake Creek yield	3,460	
Ditto Creek & Adjacent Areas	3,800	
Snake River Pumping	37,800	
Precipitation on Plateau Rocky Areas	4,400	
		78,000
Use		
Loss to Snake River	1,900	
Use by Crops	74,250	
Use by Municipal, Air Base Irrigation	2,500	
		78,600
Source Less Use		-600

Lands irrigated by Canyon Creek water lie north and south of Mountain Home (Figure 20). Ground water irrigated lands are mainly in the Cinder Cone Butte C.G.W.A. and east and west of Mountain Home Air Force Base (Figure 20). Ground water permits not yet developed lie mostly in the Cinder Cone Butte area as well as north and south of Mountain Home (Figure 20). Applications for ground water use are scattered throughout the study area, but the lands lie mainly northwest of the Air Base.

If the 15,517 acres of ground water permits not yet developed were irrigated (Figure 20), there would be an additional overdraft of 27,500 acre feet per year in the study area or a total overdraft of 28,100 acre feet per year. If ground water applications currently pending are approved, 11,217 acres could be developed (Figure 20) with an additional overdraft of 19,900 acre feet per year or a total potential overdraft of 48,000 acre feet per year.

REASONABLE PUMPING LEVELS

No definite standards have been set in Idaho which fully define what the appropriate measure of reasonableness is or how it will be applied in determining reasonable pumping levels. The statutes, however, do indicate that economic factors should affect the measure of reasonableness.

It is not the purpose of this section to analyze the multitude of factors affecting the definition of reasonableness. Rather this section will provide certain economic information about the study area which is one of the many important inputs to any determination of a reasonable pumping level.

Idaho statutes explicitly recognize two economic factors which should affect reasonableness: (1) protecting early appropriators from water level decline beyond their economic capacity to continue to pump, and (2) achieving full economic development of underground water resources. The following information addresses only the question of economic capacity to pump.

Economic capacity to pump is different for every individual even within a relatively narrowly defined area such as the one under study; it is also constantly changing. Examples of change in important factors influencing economic capacity to pump are shown in Figures 21 and 22. Increases in prices paid in excess of prices received by farmers lessen a farmer's economic capacity to pump. As can be seen in Figure 21, this has been the case since late 1979. The increased cost of electricity alone in the Mountain Home area has had a dramatic effect on economic capacity to pump. It is evident from Figure 22 that the electricity cost per acre to pump from 200 feet today is the same as the cost per acre was in 1975 to pump from 800 feet.

Table 6 shows a representative farm budget summary for a farm with center pivot sprinkler irrigation in the study area. All crops, except potatoes, show a negative return to risk and water. This value represents the amount available, after all other costs are paid, to pay well, motor, pump and electricity costs. On a farm with the crop rotation assumed in line one of Table 6, the overall return to risk and water is $-36.50 per acre. Table 7 is identical to Table 6 except that hand line sprinklers are assumed to be the method of irrigation. Again, potatoes are the only

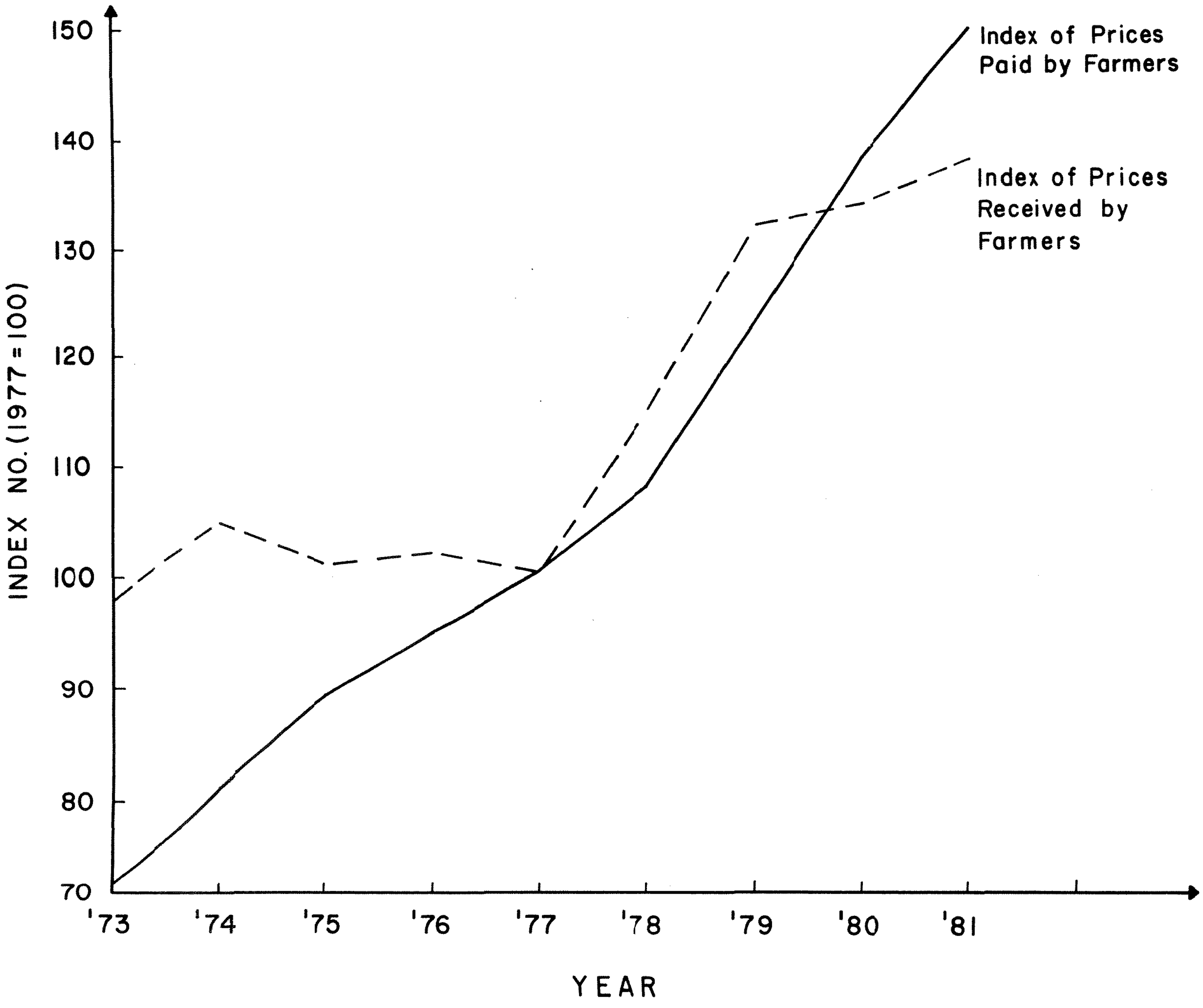


Figure 21. Indices of Prices Paid and Prices Received by Farmers, U.S., 1973-1981.

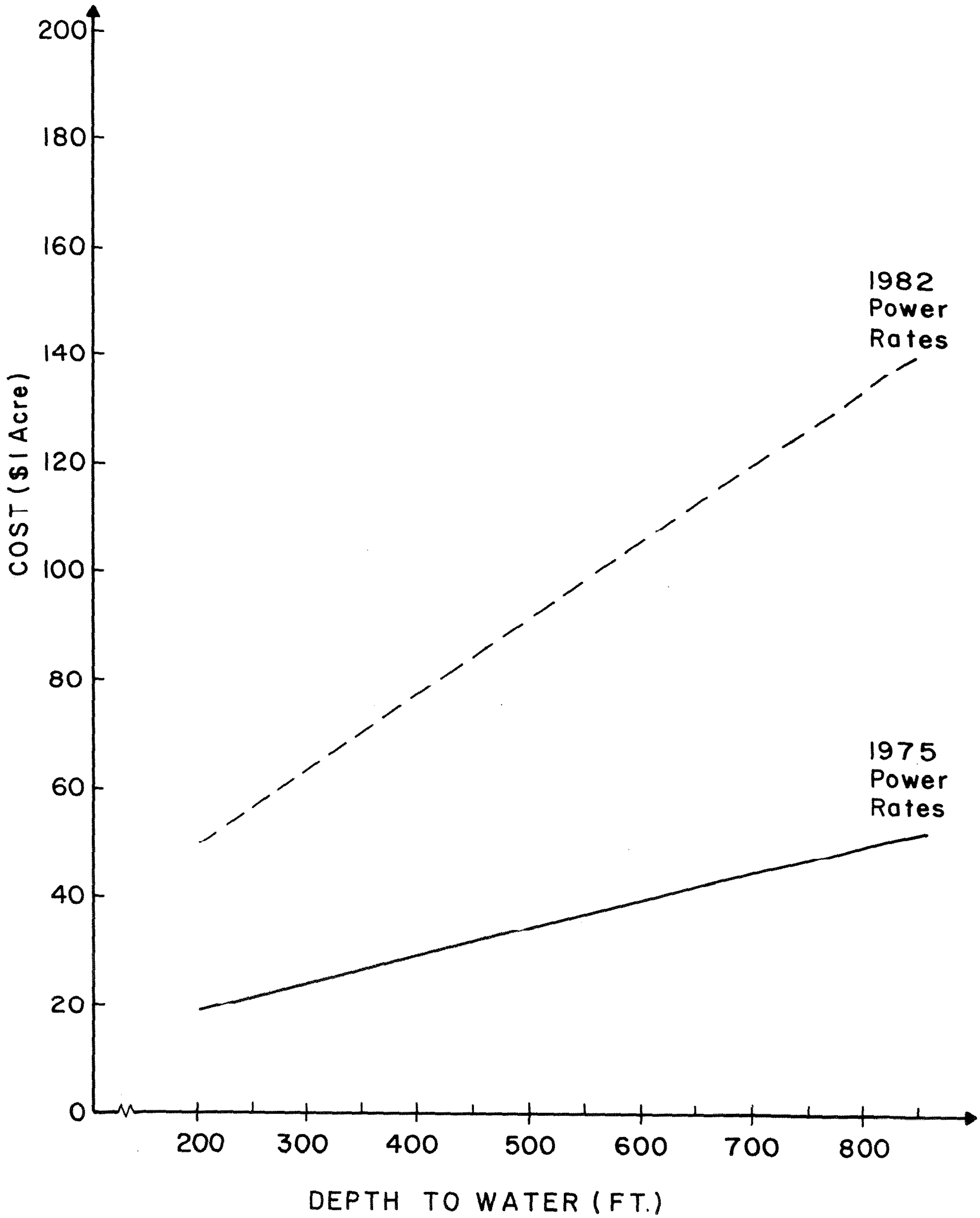


Figure 22. Per Acre Electricity Cost Comparisons for Ground Water Pumping in Idaho Power Service Area, 1975 and 1982.

TABLE 6. Per acre crop enterprise and farm budget summaries for Mountain Home area with center pivot irrigation

	Crop					
	Alfalfa	Wheat	Barley	Potatoes	Sugar Beets	Dry Beans
Percent[1]	25	37	13	12	5	8
Yield[2]	5.5 tons	90 bu.	115 bu.	350 cwt.	20 tons	19 cwt.
Price ($)[3]	46.81	3.18	2.06	3.41	28.68	20.25
Total Revenue ($)	257.46	286.20	236.90	1193.50	573.60	384.75
Costs ($)[4]	343.15	339.04	349.43	813.19	591.46	452.90
Returns to Risk, Management & Water ($)	-85.69	-52.84	-112.53	380.31	-17.86	-68.15
Management ($)[5]	12.87	14.31	11.85	59.68	28.68	19.24
Return to Risk & Water ($)[6]	-98.56	-67.15	-124.38	320.64	-46.54	-87.39

1/ Percentages of crops in the study area. For purpose of this analysis, pasture (8%) is grouped with alfalfa, and corn silage (3%) is grouped with dry beans.

2/ Elmore County average yields except potatoes. Potato yields in the study area are higher than the county average and are assumed to be 350 cwt.

3/ U.S. Water Resources Council current normalized prices for Idaho.

4/ Include all fixed and variable production costs except management costs, costs associated with risk, and fixed and variable costs associated with wells, motors, pumps, and electricity for pumping.

5/ Five percent of total revenue.

6/ Per acre revenue available to pay well, motor, pump and electricity costs. Assuming a farm crop distribution as stated in line one above, farm return to risk and water is - $33.36 per acre.

TABLE 7. Per acre crop enterprise and farm budget summaries for Mountain Home area with hand line sprinkler irrigation

	Crop					
	Alfalfa	Wheat	Barley	Potatoes	Sugar Beets	Dry Beans
Percent[1]	25	37	13	12	5	8
Yield[2]	5.5 tons	90 bu.	115 bu.	350 cwt.	20 tons	19 cwt.
Price ($)[3]	46.81	3.18	2.06	3.41	28.68	20.25
Total Revenue ($)	257.46	286.20	236.90	1193.50	573.60	384.75
Costs ($)[4]	333.18	329.07	339.46	803.22	581.49	442.93
Returns to Risk, Management & Water ($)	-75.12	-42.87	-102.56	390.28	-7.89	-58.18
Management ($)[5]	12.87	14.31	11.85	59.68	28.68	19.24
Return to Risk & Water ($)[6]	-88.59	-57.18	-114.41	330.60	-36.57	-77.42

1/ Percentages of crops in the study area. For purpose of this analysis, pasture (8%) is grouped with alfalfa, and corn silage (3%) is grouped with dry beans.

2/ Elmore County average yields except potatoes. Potato yields in the study area are higher than the county average and are assumed to be 350 cwt.

3/ U.S. Water Resources Council current normalized prices for Idaho.

4/ Include all fixed and variable production costs except management costs, costs associated with risk, and fixed and variable costs associated with wells, motors, pumps, and electricity for pumping.

5/ Five percent of total revenue.

6/ Per acre revenue available to pay well, motor, pump and electricity costs. Assuming a farm crop distribution as stated in line one above, farm return to risk and water is - $23.39 per acre.

crop with a positive return to risk and water and the overall farm return is $-26.53 per acre. An example of the budgets utilized to form summary Tables 6 and 7 is shown in Table 8.

The annual cost per acre of pumping ground water from various depths in the study area, assuming the crop rotation given in Tables 6 and 7, is given in Table 9. Values given in column four of the table are those which must be compared with a farmer's ability to pay for irrigation water. If these values exceed a farmer's ability to pay at a given depth then that farmer is beyond his economic capacity to pump. For example, a farmer growing 100% potatoes and using center pivot irrigation would have an economic capacity to pump from at least 800 feet. This rotation, however, is infeasible from a technical standpoint. In contrast, a farmer growing the crop rotation assumed in Table 6 has a negative return to risk and water and therefore does not have the economic capacity to pump at all. An intensive crop rotation of 50 percent wheat would yield a return to risk and water of $126.74 using center pivot irrigation. The pumping costs associated with this rotation are given in Table 10. As can be seen from the table, the economic capacity to pump of a farmer growing the wheat and potatoes rotation is between 450 and 500 feet below land surface.

It is important to recognize that there are a multitude of assumptions inherent in any representative farm budget analysis such as the ones presented above. Any change in assumptions will lead to a different economic capacity to

Table 8. Farm Budget

Crop: Potatoes County: Elmore

Operation or Item	Per Acre: Times Over		Costs or Receipts	Unit Total
Total Revenue				
Potatoes	350.00 Cwt	@	3.41/Cwt	1193.50
Production Costs:				
Plow Stubble (Moldboard)	1.00	@	13.50/Ac	13.50
Disc and Harrow	1.00	@	7.00/Ac	7.00
Chisel and Mark	1.00	@	7.00/Ac	7.00
Planting Potatoes	1.00	@	48.00/Ac	48.00
Seed Potatoes	20.00 Cwt	@	9.00/Cwt	180.00
Fertilizing Broadcast	1.00	@	3.75/Ac	3.75
N	175.00 Unit	@	0.31/Unit	54.25
P205	80.00 Unit	@	0.22/Unit	17.60
K20	80.00 Unit	@	0.17/Unit	13.52
Spraying Ground Rig	4.00	@	4.50/Ac	18.00
Sencor	1.00 Lb	@	9.83/Lb	9.83
Fungicide (2 appl'ns)	6.00 Pt	@	1.40/Pt	9.00
Zinc	0.00 Unit	@	1.00/Unit	0.00
Cultivating Potatoes	1.00	@	6.70/Ac	6.70
Dig & Load Potatoes	350.00 Cwt	@	0.35/Cwt	122.50
Haul Potatoes	350.00 Cwt	@	0.15/Cwt	52.50
Storage Potatoes	350.00 Cwt	@	0.00/Cwt	0.00
[Labor (included above)				28.64]
Minus: Management (included above)				26.91
Subtotal Production Costs				536.24
Taxes and Overhead (4.50% of Production Costs)				24.13
Overhead: Irrigating				91.08
Labor Cost: Pumping & Irrigating				.79
Interest on Production Cost 13.00% for 9 months				27.71
Annual Land Payment				133.24
Total Costs				813.19
Returns to Risk, Management & Water				380.31
Management (5.00% of Total Revenue)				59.68
Returns to Risk & Water				320.64

TABLE 9. Annual Cost of Pumping Ground Water - Idaho Power Service Area as of March 1, 1982 1/

Depth to Water (ft.)	Electricity Cost/Acre($)	Other Pumping Cost/Acre($) 2/	Total Cost Per Acre($)
200	49.19	22.76	71.95
250	56.26	25.87	82.13
300	63.63	28.98	92.61
350	70.70	34.04	104.74
400	77.77	38.28	116.05
450	84.84	41.39	126.23
500	91.92	45.60	137.52
550	98.99	48.71	147.70
600	105.75	52.55	158.30
650	112.82	55.45	168.27
700	119.58	58.56	178.14
750	126.65	63.49	190.14
800	133.42	66.61	200.03

1/ Based on a crop distribution of 25% of alfalfa, 37% wheat, 13% barley, 12% potatoes, 5% sugar beets and 8% dry beans. Irrigation efficiency is assumed to be 65% and pump and motor efficiency is set at 68%.

2/ Includes fixed and variable costs associated with wells, motors and pumps.

Table 10. Annual Cost of Pumping Ground Water - Idaho Power Service Area as of March 1, 1982[1/]

Depth to Water (ft.)	Electricity Cost/Acre($)	Other Pumping Cost/Acre($)[2/]	Total Cost Per Acre($)
200	46.28	22.76	69.04
250	53.10	25.87	78.97
300	59.91	28.98	88.89
350	66.44	34.04	100.48
400	73.26	38.28	111.54
450	79.79	41.39	121.18
500	86.60	45.60	132.20
550	93.13	48.71	141.84
600	99.66	52.55	152.21
650	106.19	55.45	161.64
700	112.72	58.56	171.28
750	119.25	63.49	182.74
800	125.78	66.61	192.39

1/ Based on a crop distribution of 50% wheat and 50% potatoes. Irrigation efficiency is assumed to be 65% and pump and motor efficiency is set at 68%.

2/ Includes fixed and variable costs associated with wells, motors and pumps.

pump. In addition, while the assumptions utilized in this analysis are hoped to be representative of the study area as a whole, they probably will not be correct when applied to any individual farmer in the area. Uses of water other than irrigation have not been considered.

The above analysis of economic capacity to pump presents results which are not optimistic for the farmers in the study area, yet farmers in the area continue to pump from depths in the 450 to 500 foot range. It is indicated that a farmer's economic capacity to pump depends on the crop rotation utilized. Assuming the most intensive crop rotation which yields the greatest economic capacity to pump, it has been shown that farmers' economic capacity to pump in the study area does not exceed the 450 to 500 foot range if all elements of production receive a return.

CONCLUSIONS

1. The average water supply for the study area is estimated to be 78,000 acre feet per year.

2. Flood runoff to Snake River and consumptive use by irrigated crops and municipal uses was estimated to be 78,600 acre feet per year.

3. At the 1980 level of development, there is an overdraft of about 600 acre feet per year. At that time, there

were 15,517 acres of undeveloped land for which permits to use ground water had been issued. When these lands have been developed, total overdraft will be about 28,100 acre-feet per year. Applications for use of ground water on Desert Land Entry land and ground water applications currently pending total 11,217 acres. If these permits and applications for use of ground water were developed, an additional 19,900 acre feet per year would be consumptively used with a total overdraft of about 48,000 acre feet per year.

4. There are two aquifers in the study area which supply ground water for domestic, municipal, and irrigation usage. The shallow perched system, composed of sediments, is mainly used for domestic and small irrigation purposes. The regional system, composed of basalts and sediments, is used for municipal and large scale irrigation. In the southeast portion of the study area, ground water flow is towards the south while in the northwest portion, the flow is towards the west.

5. Ground water levels in both the perched and regional system have shown declines. Declines varied from less than one foot to more than 55 feet. This is due to over development of the resource and less than average precipitation for the past four to five years in the mountains. Water level rises of approximately two feet have occurred during the past five years in two or three limited areas.

6. The reasonable pumping level in the Mountain Home area is estimated to be approximately 450 to 500 feet below land surface.

RECOMMENDATIONS

Based upon the conclusions drawn, it is recommended that:

1. The area east of the administrative boundary between Basins 61 and 63, north of the Snake River Canyon Rim, south and west of the study area boundaries be designated as either a Ground Water Management Area pursuant to Section 42-233b, Idaho Code, or as a Critical Ground Water Area pursuant to Sections 42-226 and 42-233a, Idaho Code. The suggested boundaries are shown on Figure 23.

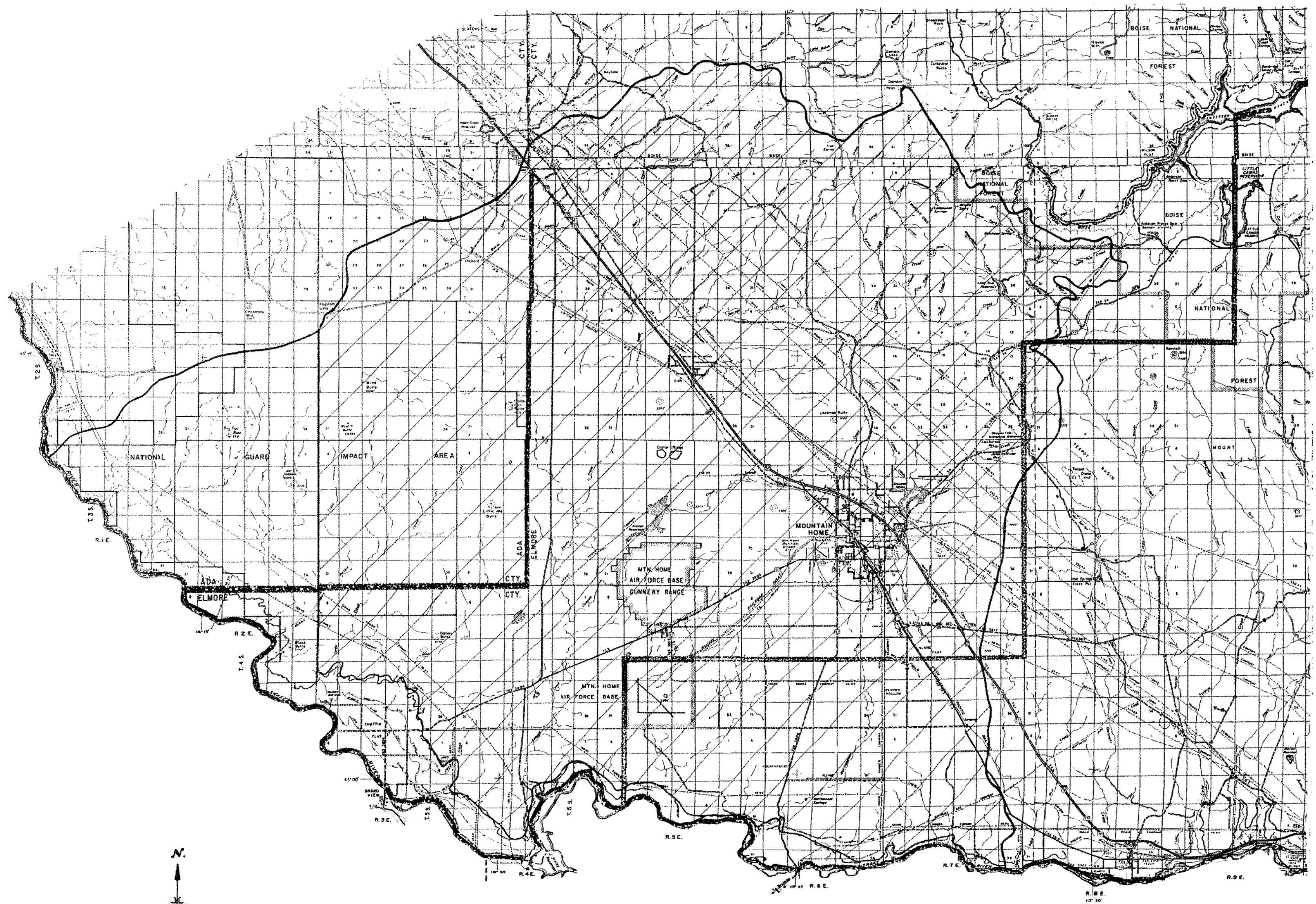
2. Data collection in the Cinder Cone Butte C.G.W.A. and the expanded area should continue. Measurements at the staff gage on Canyon Creek should be continued and trans-basin diversions from Little Camas Creek should also be measured. Ground water levels should be monitored bi-monthly or quarterly at the 15 wells indicated in Figure 6, in addition to the U.S.G.S. observation well network, to observe water level fluctuations after closure of the basin.

3. Management practices should be initiated to correct the imbalance between recharge and withdrawals which has begun and will increase as development continues under permits

already issued.

4. Future wells drilled through the perched system in the designated area should be constructed to case out any perched ground water.

5. Pending applications for use of ground water in the designated area should be not be issued at this time.



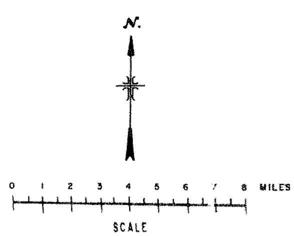


Figure 23. Recommended Critical Groundwater Area Boundary.

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