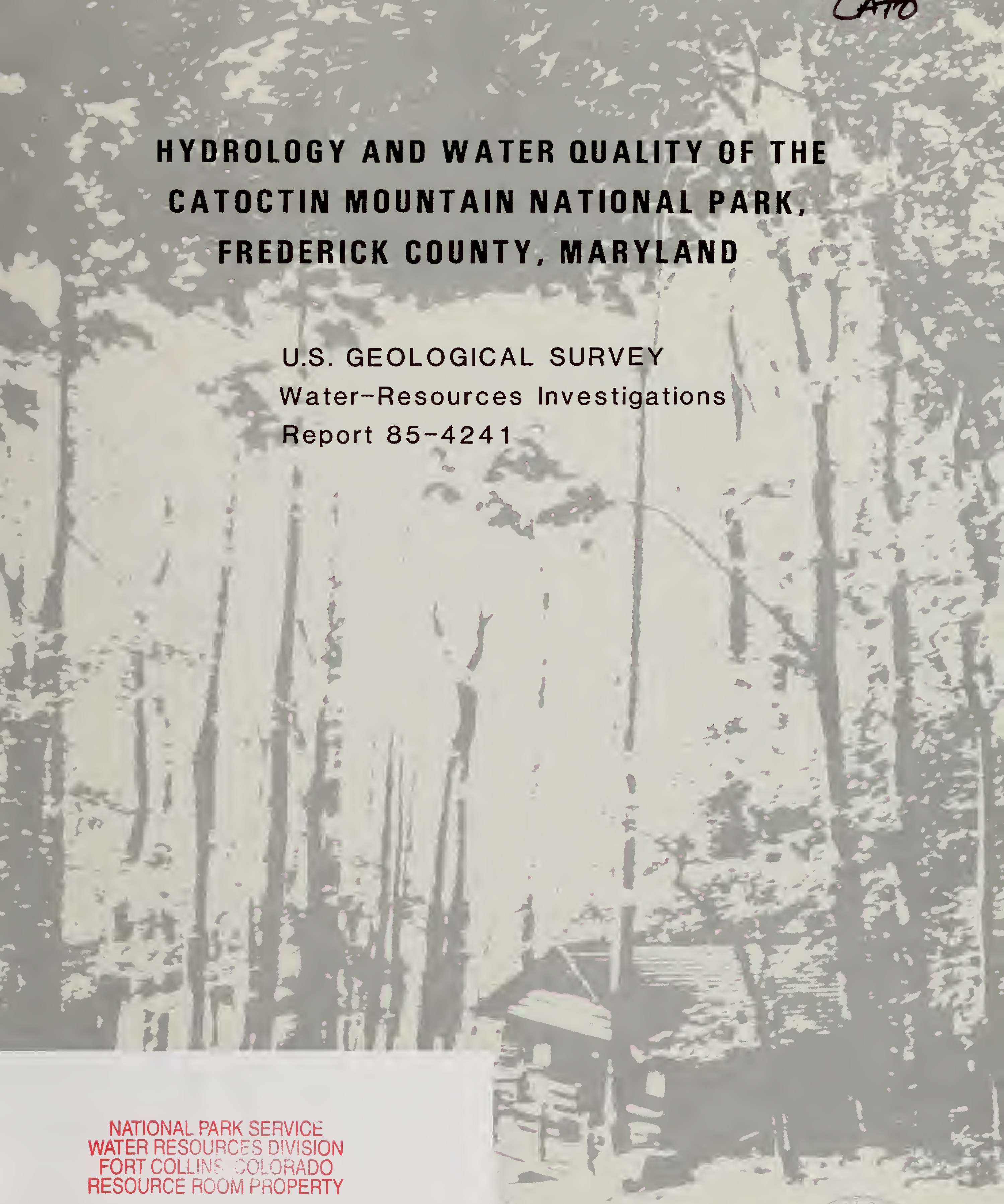
HYDROLOGY AND WATER QUALITY OF THE CATOCTIN MOUNTAIN NATIONAL PARK, FREDERICK COUNTY, MARYLAND

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Report 85-4241



Prepared in cooperation with the
NATIONAL PARK SERVICE

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONVERSION FACTORS AND ABBREVIATIONS

For the convenience of readers who may prefer to use metric (International System) units rather than the inch-pound units used in this report, values may be converted by using the following factors:

Multiply Inch-Pound Unit	By	To Obtain Metric Unit
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
gallon (gal)	3.7850	liter (L)
gallon per minute (gal/min)	0.0631	liter per second (L/s)
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]

HYDROGEOLOGY AND WATER QUALITY OF THE CATOCTIN MOUNTAIN NATIONAL PARK AREA, FREDERICK COUNTY, MARYLAND

By Thomas J. Trombley and Linda D. Zynjuk

ABSTRACT

The Catoctin Mountain National Park area, located in the Blue Ridge physiographic province of central Maryland, is characterized by high local relief, an average annual precipitation of 44 inches, and stony soils underlain by weathered and fractured metamorphic rocks. The park is mostly forested land and includes several camps and roads. The ground-water reservoir consists of regolith and underlying fractured bedrock and is recharged by precipitation. Discharge from the ground-water flow system is mainly to nearby streams adjacent to areas of recharge. Approximately 56 percent of annual streamflow is contributed by ground water.

Wells located at Camp Round Meadow and Staff Quarters No. 5 can sustain pumping rates of 45 to 60 gallons per minute for several hours, with drawdowns of 40 to 50 feet. Water-quality samples from wells, springs, and streams indicate that ground water is slightly affected by septic waste and road salt. Ground water in remote areas is not affected by either source. Concentrations of chloride from road salt and concentrations of nitrate plus nitrite (as N) were below U.S. Environmental Protection Agency drinking-water limits in all ground- and surface-water samples.

INTRODUCTION

Background

Catoctin Mountain National Park is located in Frederick County, Md., in the Blue Ridge physiographic province of central Maryland (fig. 1). Park facilities have expanded and park usage has increased since the mid-1960's. These changes have placed increased stress on the ground-water resources. The park's water supply is derived from wells, and the park's streams, which derive much of their flow from ground water discharged through springs and seeps, are a major spawning area for trout. It is important to determine the effects of park development on water quality and quantity within the hydrogeologic framework of the park. Therefore, in 1983, the U.S. Geological Survey, in cooperation with the National Park Service, began a study to evaluate the hydrogeology and water quality of the park area.

Purpose and Scope

The purpose of this report is to describe the hydrogeology and water quality of the Catoctin Mountain National Park area. The study was accomplished in two phases. The first, which lasted for 6 months, was a reconnaissance of the area to characterize the ground-water flow system and to make a preliminary assessment of ground-water quality. Water levels were measured in wells throughout the park (fig. 2). Also, water samples were collected from 15 wells, 13 springs, and 7 stream sites throughout the park and analyzed for major chemical constituents.

The second phase, which lasted for 15 months, was to compile more complete information at selected sites throughout the park. Three observation wells were drilled at Camp Round Meadow and one was drilled at Staff Quarters No. 5. Aquifer tests were conducted on one production well at Camp Round Meadow and on the observation well at Staff Quarters No. 5. Water samples were collected quarterly from seven wells and five springs for chemical and bacterial analysis.

Previous Studies

The Ecological Services Laboratory of the National Park Service conducted a 3-year study from October 1978 through November 1981; the approach entailed the collection of monthly water-quality data at eight stream sites, five wells, two springs, and two sewage lagoons located in Camp Round Meadow. Results of this study indicated a healthy stream and well system (R.S. Hammerschlag, National Park Service, written commun., 1983), but suggested more detailed study of the ground-water system. Huth Engineers and R.E. Wright Associates (1981) conducted a study to evaluate the adequacy of the water supply, waste-water disposal, and fire protection systems in the park. The results of their study indicated possible low-level septic contamination of the Camp Round Meadow wells, but concluded that the overall water quality was well within national drinking-water standards as determined by the U.S. Environmental Protection Agency (1976).

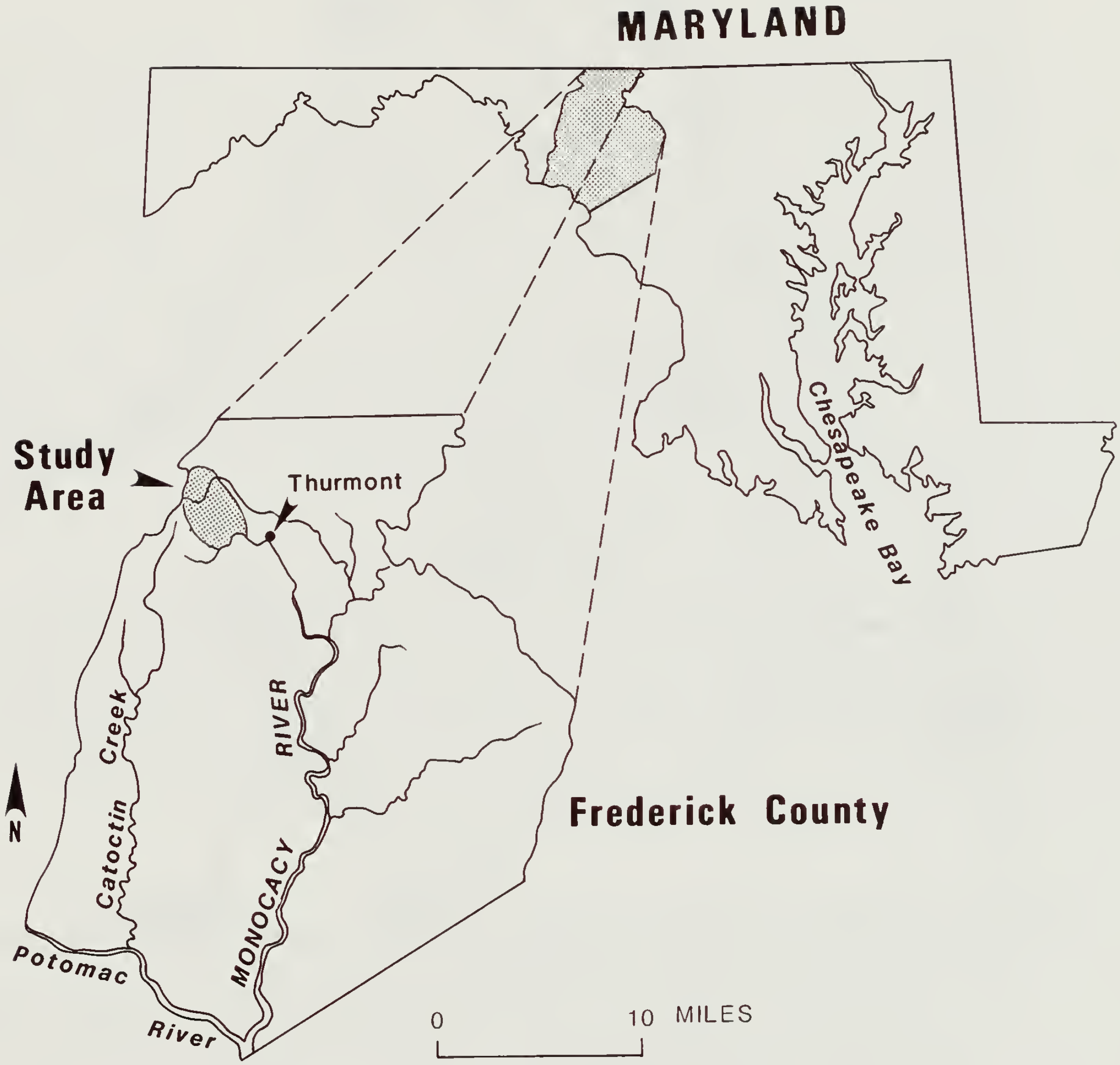


Figure 1. Location of study area.

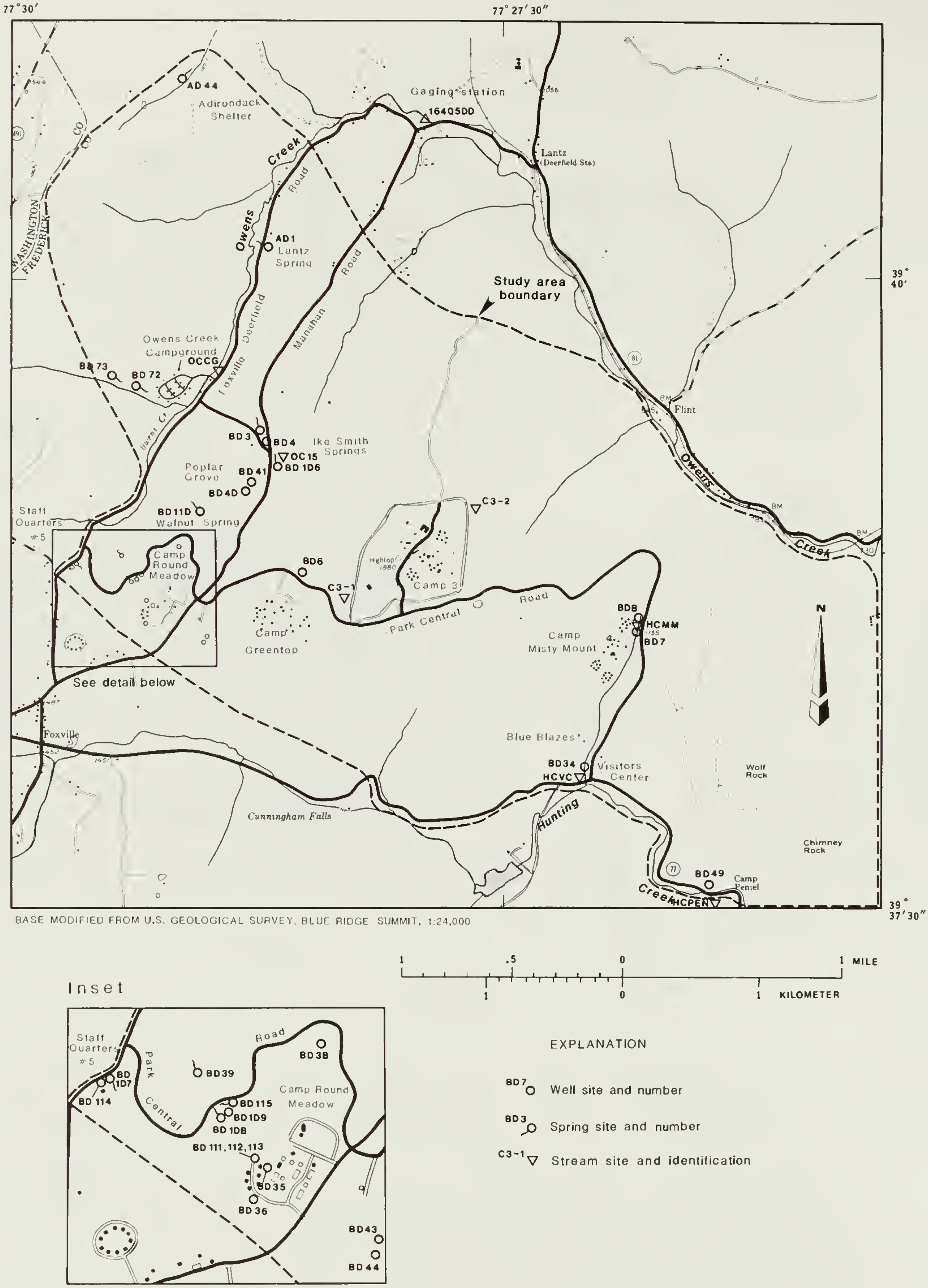


Figure 2. Location of sampling sites.

PHYSICAL SETTING

Topography and Climate

Catoctin Mountain is a discontinuous ridge that extends from near the Pennsylvania-Maryland border to the Potomac River at Point of Rocks, Maryland (Vokes and Edwards, 1957, p. 69). The park area is separated from the main ridge by two streams--in the south by Hunting Creek, and in the west, north, and east by Owens Creek (fig. 3). The terrain is rugged and there is a maximum of approximately 1,080 ft of relief between Camp Peniel (800-ft elevation) and Camp 3 (1,880-ft elevation). Slopes in the park area generally are between 10 and 20 percent, but may be as high as 60 percent.

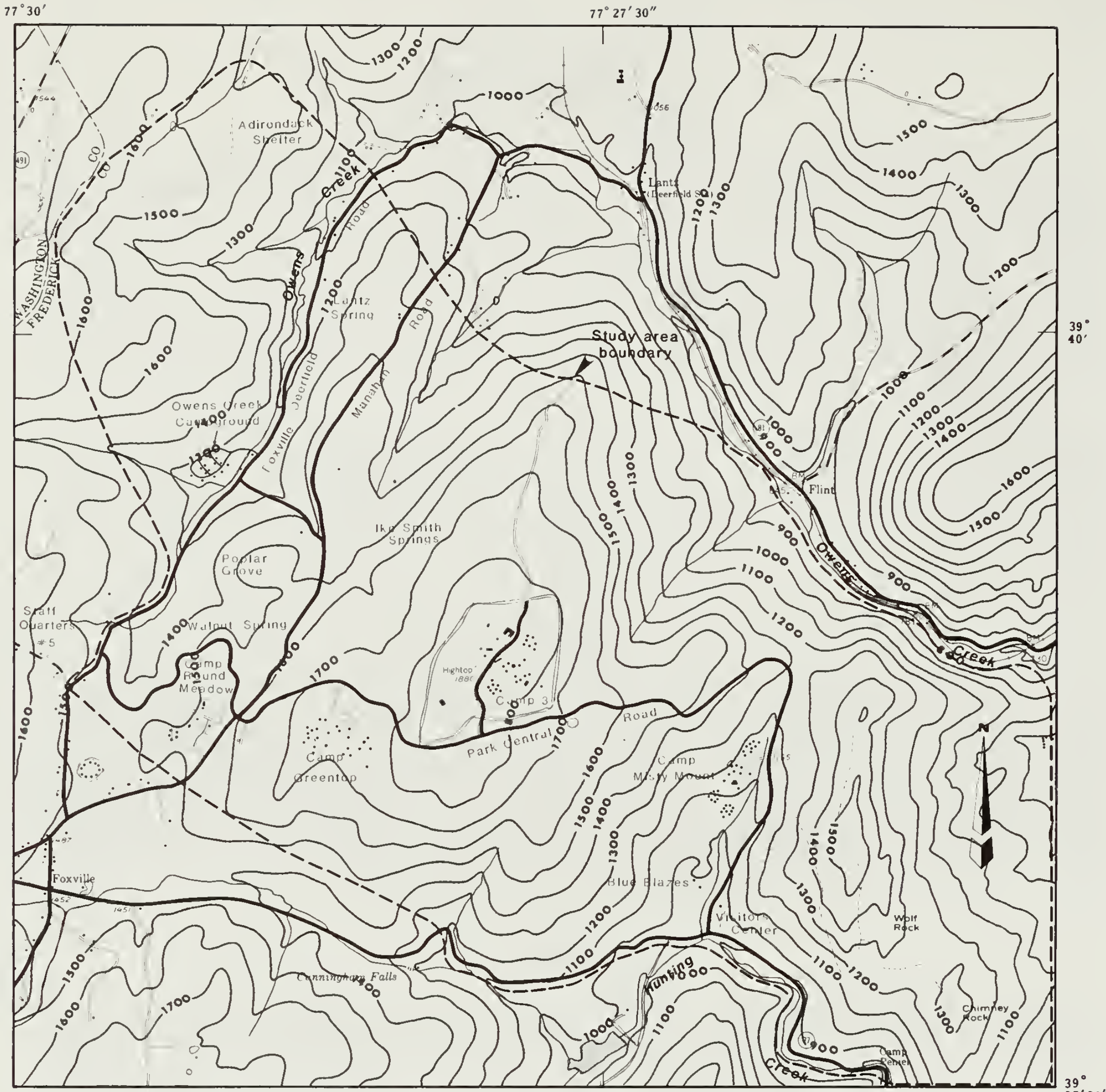
Precipitation in the area is approximately 44 in/yr (U.S. Department of Commerce, 1968). Monthly distribution of the precipitation is fairly even throughout the year with a low of 2.66 in. in February and a high of 4.75 in. in August. Precipitation exceeds 0.01 in. for about 130 days in the average year. Snowfall averages approximately 24 in/yr.

Soils

Soils in the park are characterized in the Soil Survey of Frederick County (Matthews, 1960, map sheets 5, 6, 9, 10) as primarily rough stony land. They are well drained, poorly developed soils containing numerous stones and boulders throughout the profile. In draws and valleys, such as near Camp Greentop and Camp Round Meadow, the soils belong to the Highfield series, which is characterized by well-drained, fairly deep, stony loams containing many stones and some boulders.

Geology

Three rock formations of late Precambrian age (Fauth, 1977) are exposed in Catoctin Mountain National Park (fig. 4). The oldest rocks in the park belong to the Catoctin Formation. Two main rock types are included in the Catoctin Formation in the park--a greenish to greenish-gray and gray metabasalt, which underlies most of the area, and a bluish to grayish metarhyolite in which most of the wells and springs are sited. A small area of porphoritic metabasalt is located south of the study area in Cunningham Falls State Park. The Loudon Formation, also on the southeastern side of the park, has two lithologic subdivisions--a lower member, consisting of a phyllite, and an upper member, consisting of a conglomerate. The Weaverton Formation lies along the southeastern edge of the park and is divided into three members--a lower member, consisting of a graywacke with quartz-phyllite interbeds a middle member, consisting of a thick-bedded to massive, well-jointed, medium- to coarse-grained quartzite; and an upper member, consisting of quartzite and conglomerate. Quaternary terraces are located outside the park area above the Owens Creek flood plain in Lantz, Md.; these consist of alluvial silt and clay deposits containing some sand layers.



BASE MODIFIED FROM U.S. GEOLOGICAL SURVEY, BLUE RIDGE SUMMIT, 1:24,000

1 .5 0 1 MILE

1 0 1 KILOMETER

Contour interval 100 feet. Datum is sea level

Figure 3. Map showing topography of the Catoctin Mountain National Park area.

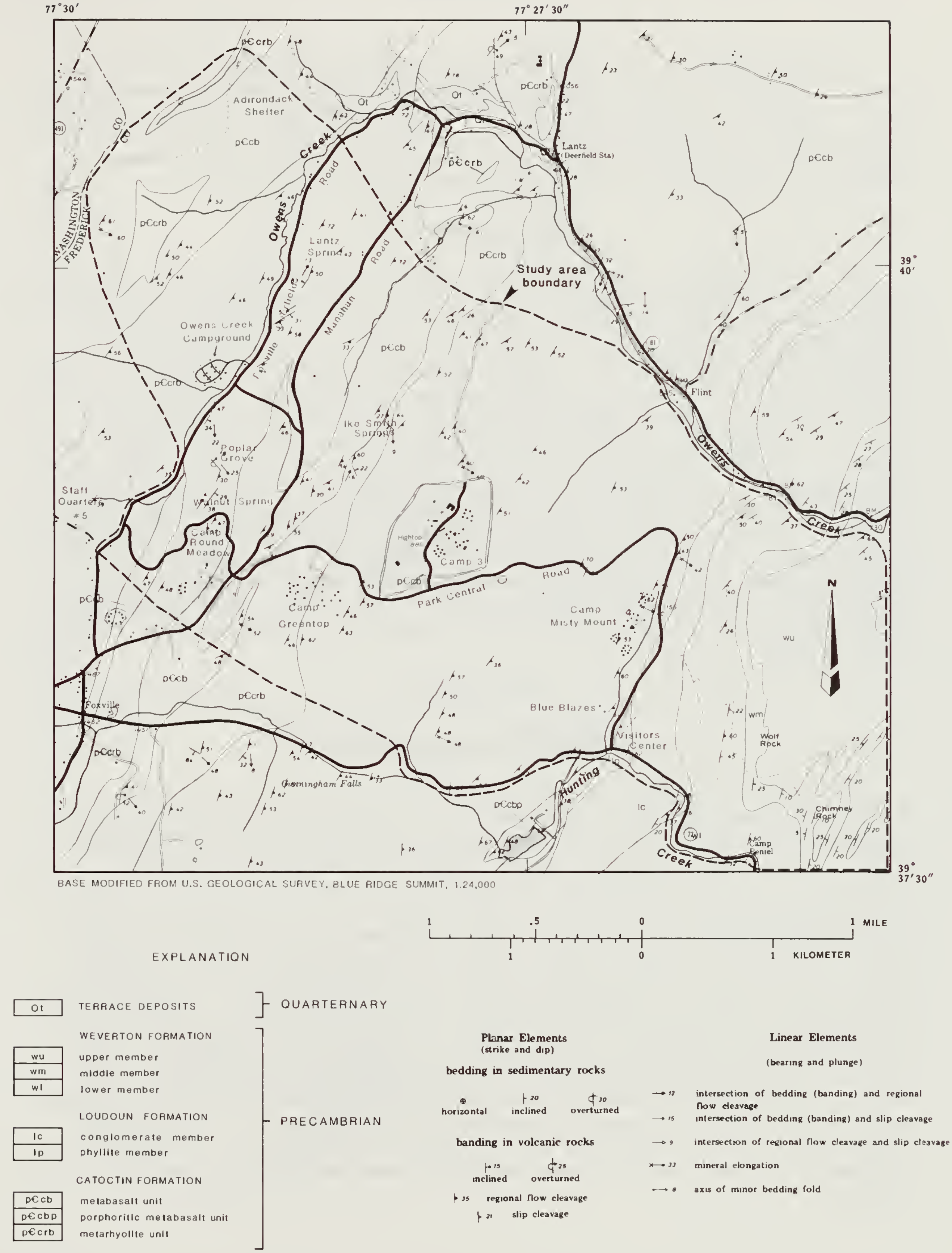


Figure 4. Map showing geology of the Catoctin Mountain National Park area.

The rock units in the park area are highly fractured and folded. The axes of folding and major cleavage planes are northeast-southwest (Fauth, 1977). Cleavage planes and fractures dip approximately 45° SE. In the Camp Round Meadow area, field observations of fracture patterns indicate two nearly vertical systems oriented approximately east-west and northwest-southeast in addition to the tilted northeast-southwest system.

Land and Water Use

Prior to becoming a national park, Catoctin Mountain National Park was primarily forests and farmland. Stone walls, domestic springs, and building foundations can still be seen throughout the park. Today, it is mainly forested with several camps and picnic areas that are used by visitors throughout the year (fig. 2). Septic systems, originally installed in the 1930's, consist of a series of sand filters, septic tanks, and drain fields. Camp Round Meadow has a lagoon system (fig. 5) which treats raw sewage before it is pumped into two sand filters for final treatment. Camp 3, which is occupied year round, has its own septic system. Other camps and picnic areas have concrete vaults that are pumped out periodically. Finally, the entire eastern side of the park has been connected to the municipal sewage system of nearby Thurmont, Md. Several of the roads in and near the park are salted during the winter (fig. 5); they are Foxville-Deerfield Road, Route 77, Manahan Road near Camp Round Meadow, and Park Central Road from Foxville-Deerfield Road to Camp 3, and near the Visitors Center. Park Central Road from Camp 3 to just north of the Visitors Center is not salted.

HYDROGEOLOGY

Description of Aquifer

The framework for the ground-water flow system consists of bedrock overlain by regolith. The thickness of this regolith is related largely to topography; it is thinnest near the top of Catoctin Mountain and along ridges, and thickest in draws and valleys. The regolith consists of all the material above unaltered bedrock and includes transported and nontransported rock material. It is highly porous and permeable and, therefore, is the principal ground-water reservoir. Where the regolith is saturated, ground water occupies the spaces between unconsolidated rock particles. In the unaltered bedrock, however, ground water is present in secondary openings along bedding planes, cleavage planes, joints, and faults. Commonly, these openings were enlarged by weathering from ground water. The number and size of the openings determines the porosity, and the degree to which the openings are interconnected determines the permeability of the bedrock. The number, size, and interconnection of openings decrease with depth below land surface due to the increase in pressure and the decrease in weathering. Porosity and permeability also are related to topographic setting because openings are fewer beneath ridges and more abundant beneath draws and valleys.

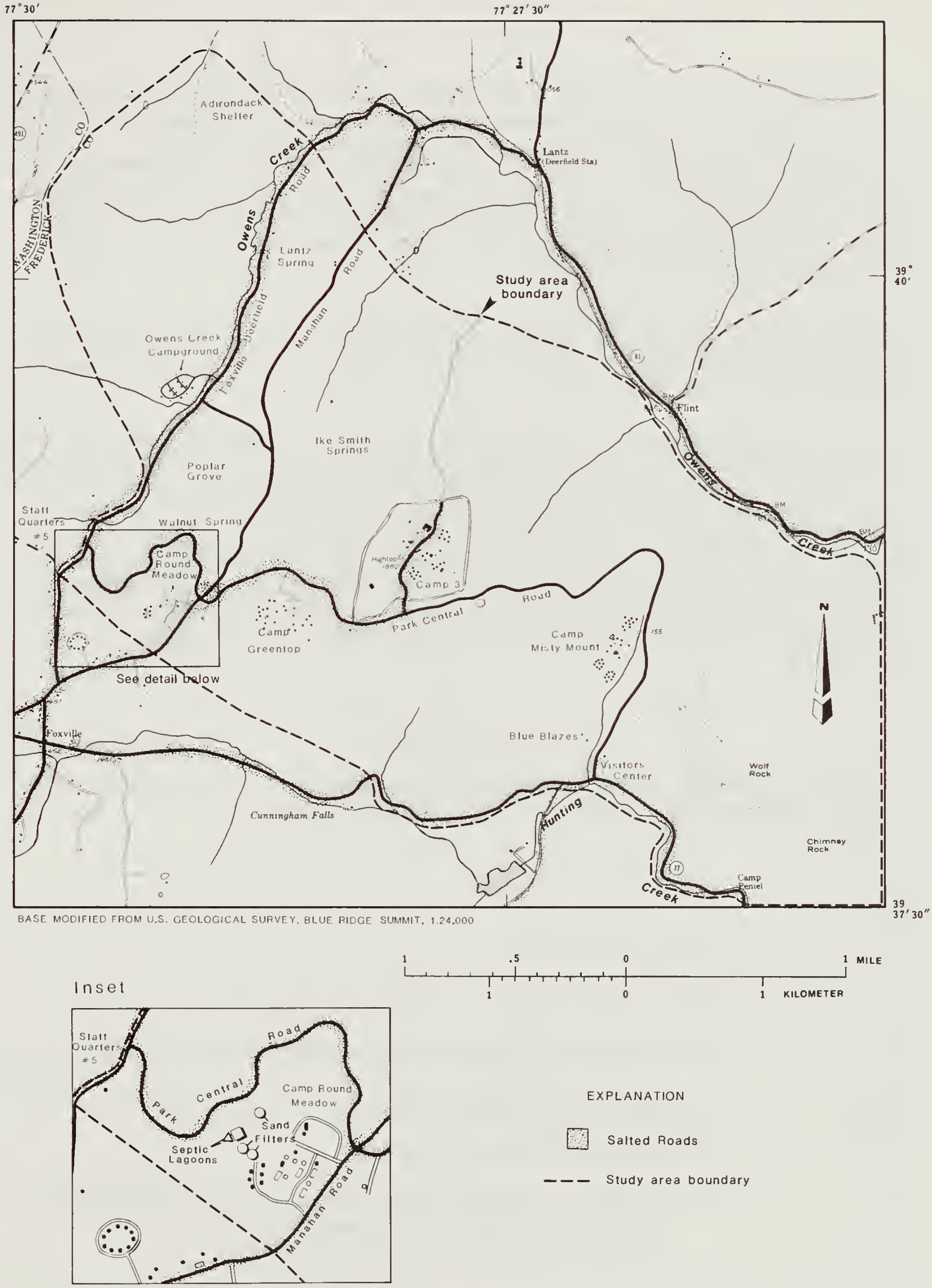


Figure 5. Salted roads and Camp Round Meadow septic lagoon and sand filters

Ground water in the regolith is under unconfined conditions. In contrast, ground water in the secondary openings in unaltered bedrock commonly is under confined conditions because the bedrock that borders the openings is virtually impermeable. However, because there are no well-defined, continuous confining beds in the regolith, and because the degree of hydraulic connection between the regolith and the secondary openings in the bedrock is generally high, the entire ground-water flow system can be considered as one, complex, unconfined aquifer.

The water table generally is a subdued replica of the land surface. It is deepest under ridges and nearest land surface in draws and valleys. It is commonly in the regolith, but the water table can also be in the bedrock, especially under ridges.

The regolith extends to a depth of approximately 200 ft in a well at Camp Round Meadow (fig. 6). At Staff Quarters No. 5, it is approximately 45 ft thick, and open fractures in bedrock extend to a depth of approximately 95 ft. The hydrogeologic section shows the estimated thickness of the regolith and the depth to unweathered bedrock as well as an approximation of the water table under normal pumping conditions. The information on the section is derived from logs of the observation wells at Camp Round Meadow and from aquifer tests on November 29, 1983, and April 17, 1984. Figure 7 is a conceptualization of the ground-water system in the vicinity of Camp Round Meadow.

Water Budget

A water budget is an accounting system for the water entering and leaving a drainage basin (fig. 8). It is defined by:

$$P - SR - BF - GU - ET + \Delta S = 0$$

where

P = precipitation;

SR = surface-runoff component of streamflow;

BF = ground-water base-flow component of streamflow;

GU = ground-water underflow;

ET = evapotranspiration; and

ΔS = changes in storage (includes changes in ground-water levels, accumulation and melting of snow, and freezing/thawing of soil moisture).

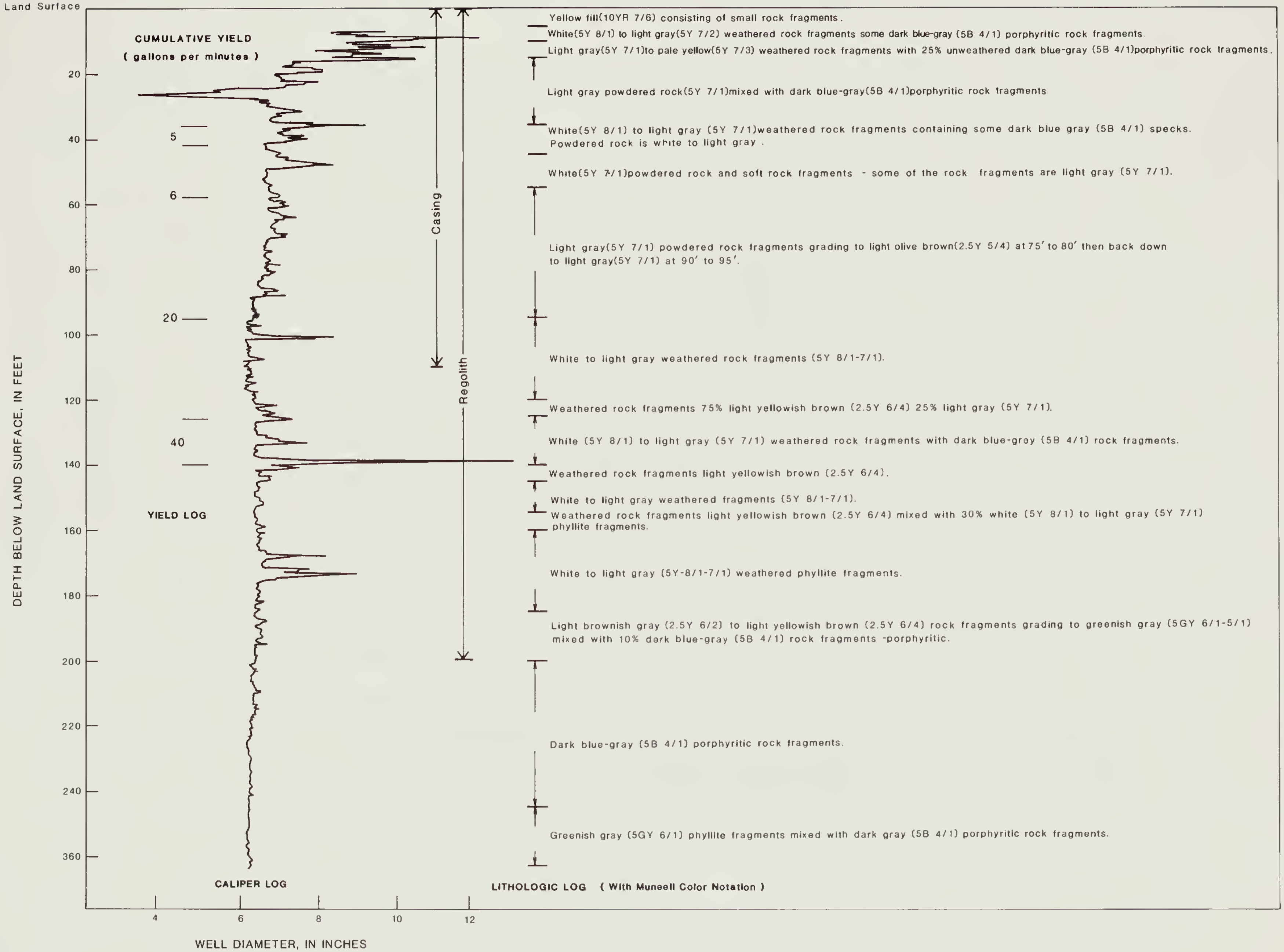


Figure 6. Yield, caliper, and lithologic logs for well BD111.

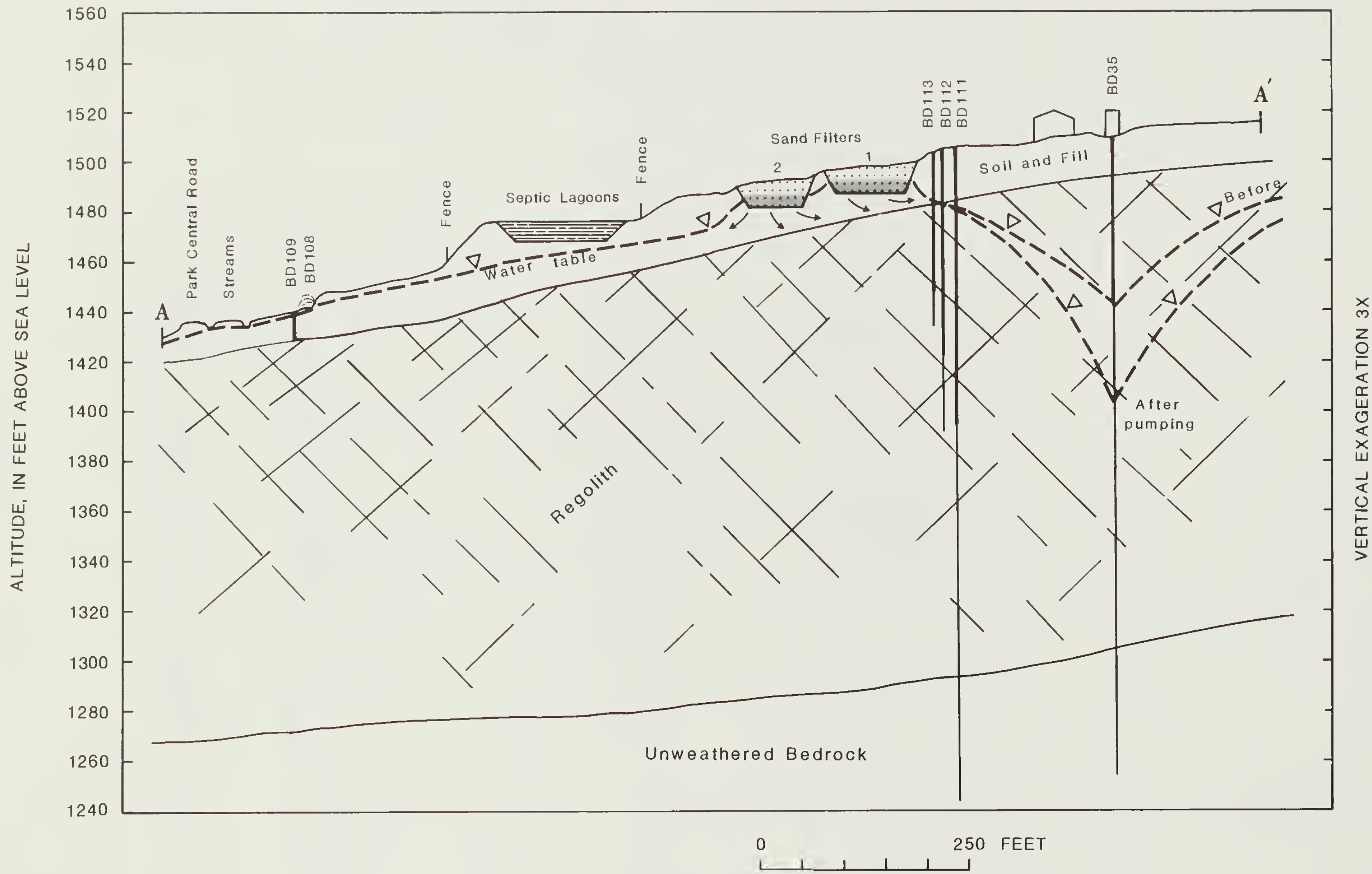
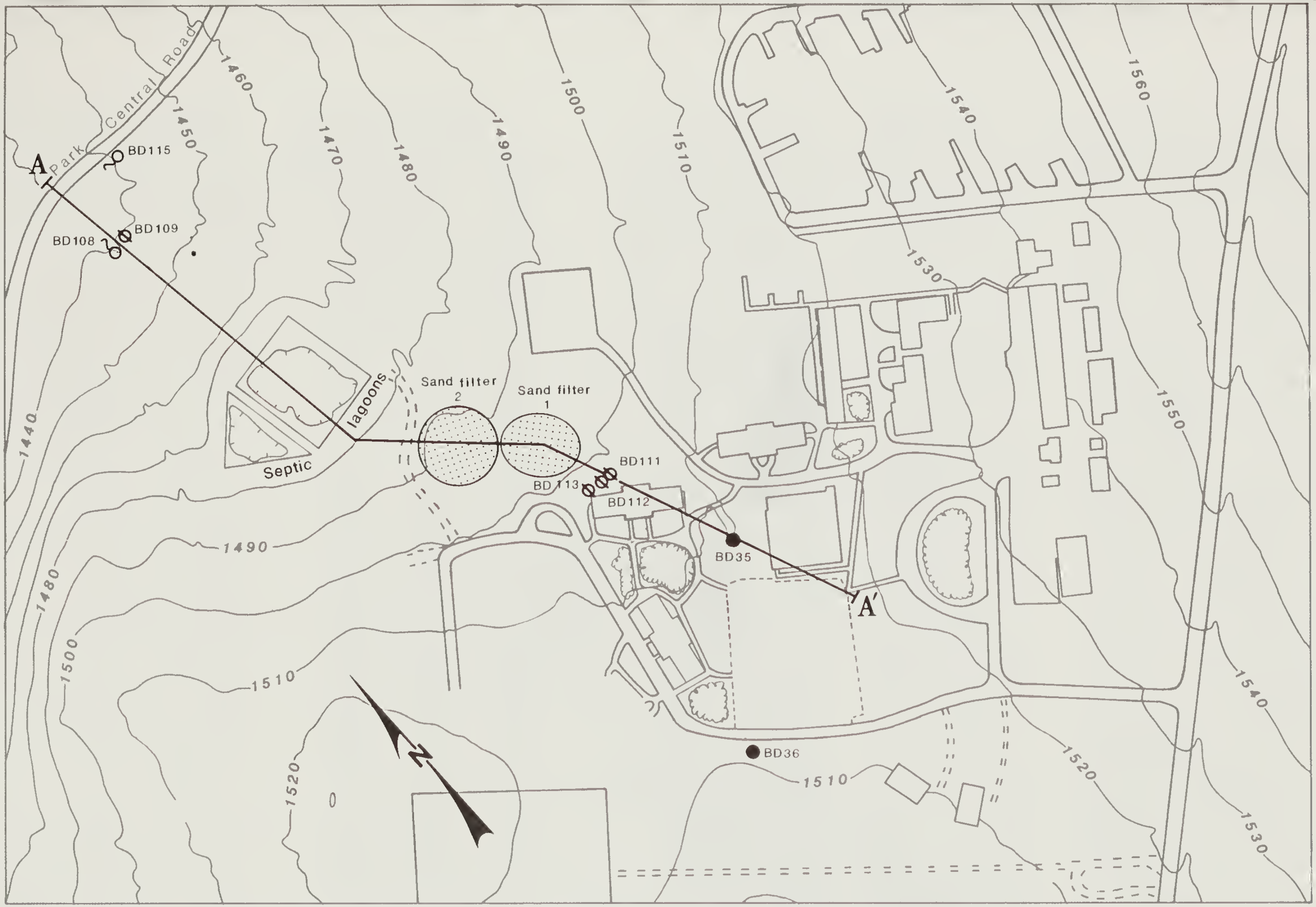


Figure 7. Hydrologic section of Camp Round Meadow.



Base from Air Survey Corporation, Reston Va., 1:600

Contour interval 10 feet, Datum is sea level

EXPLANATION

BD35 ● Production well and number

BD111 ⌀ Observation well and number

BD115 Spring and number

0 250 500 FEET

Figure 7. Continued

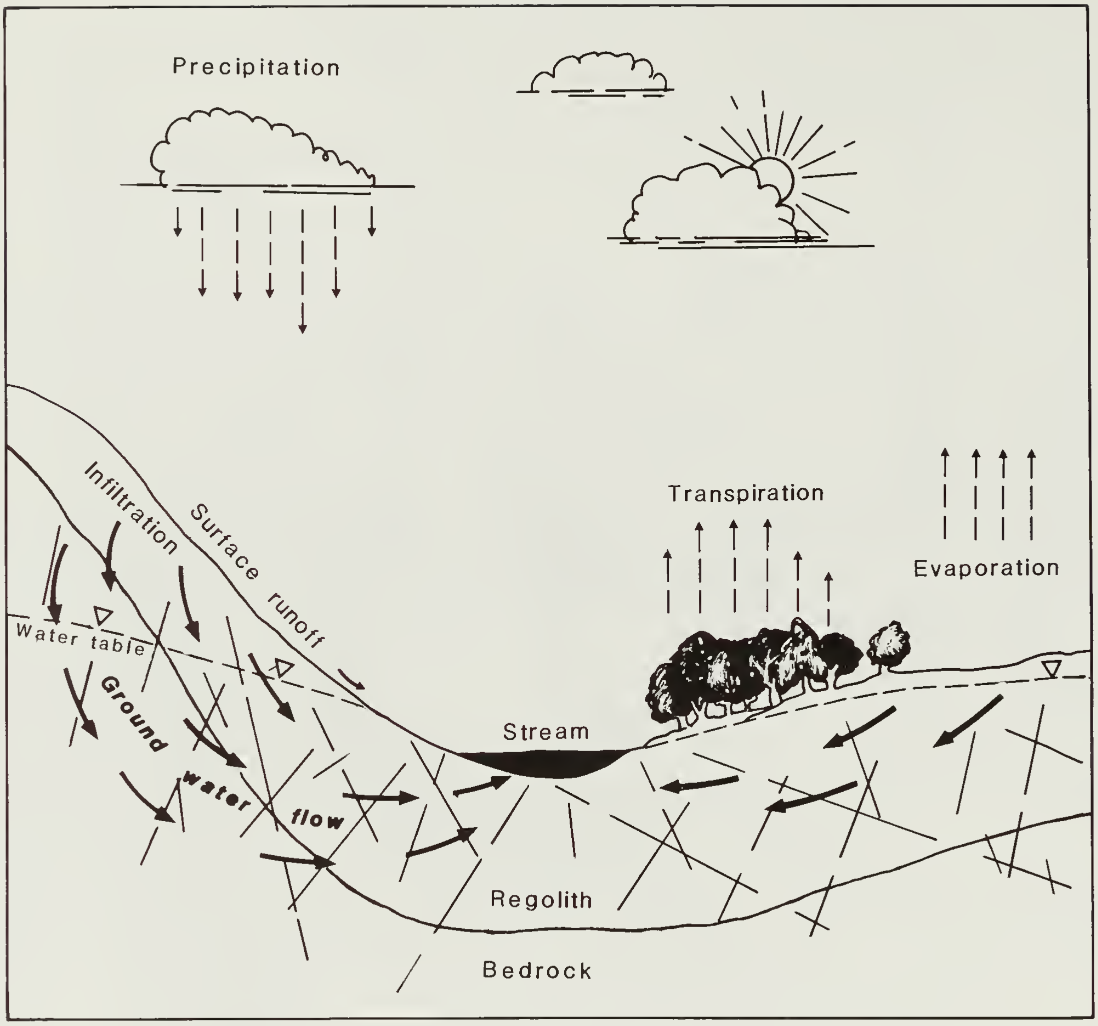


Figure 8. Schematic diagram of the hydrologic cycle.

Figure 9 is an estimate of monthly water budgets for Catoctin Mountain National Park from October 1, 1983, through September 30, 1984. Pumpage from wells is a minor constituent which is not considered here because most of the water is eventually returned through septic systems. Precipitation was determined from rain-gage data supplied by National Park Service personnel at Catoctin Mountain National Park. Surface runoff and ground-water base flow were separated from total streamflow in Owens Creek measured at the U.S. Geological Survey stream-gage station in Lantz, Maryland (adjacent to Catoctin Mountain National Park), using a graphical method described by Linsley and others (1958, p. 156).

Ground-water underflow, evapotranspiration, and changes in storage were not evaluated separately. The sum of these three terms is expressed as the difference between precipitation and observed streamflow. During months when streamflow exceeded precipitation, the excess (January, February, and April) may be due largely to runoff caused by melting snow. During months when streamflow was much less than precipitation (October, July, and August), evapotranspiration probably accounted for most of the difference.

Steady-state conditions were assumed for estimating the annual budget. This allowed the change-in-storage term to be ignored. The assumption was made because water levels in well BD 111 were approximately equal at the beginning and end of the year. Surface runoff accounted for 25 percent (16.8 in.) of the annual precipitation (67.5 in.), ground-water base flow accounted for 32 percent (21.7 in.), leaving 43 percent (29 in.) for evapotranspiration. Based on these figures, approximately 56 percent of total streamflow was contributed by ground water.

Ground-Water Levels

Table 1 lists characteristics of wells throughout the park. Water levels measured in these wells during the study period ranged from flowing, at BD 7, to about 69 ft below land surface at BD 40. Seasonal fluctuations of water level for well BD 111 are shown in figure 10. The highest water levels were in mid-February through April when much precipitation entered the ground-water system (fig. 9), and the lowest water levels occurred in late summer when only a small percentage of precipitation recharged the ground-water system because of high evapotranspiration rates (fig. 9). Declines in water level are primarily because of ground-water discharge to streams.

In addition to water-level fluctuations caused by seasonal climatic conditions, water levels also fluctuate due to pumping. On November 30, 1983, a new well (BD 114) at Staff Quarters No. 5 was pumped for 5 hours. Figure 11 is a plot of the drawdown and recovery resulting from the test. Two inserts in the figure are semi-log plots. The top inset shows both drawdown and recovery plotted as functions of time since pumping started. The bottom inset is recovery plotted against time since pumping stopped. The figure shows a boundary effect where the water level is drawn down rapidly and then starts to level off. As the boundary is reached, the water level begins to decline rapidly again. This boundary effect is seen in both the semi-log plots of drawdown and recovery as a change in slope, and may indicate a change in local hydraulic properties of the rock.

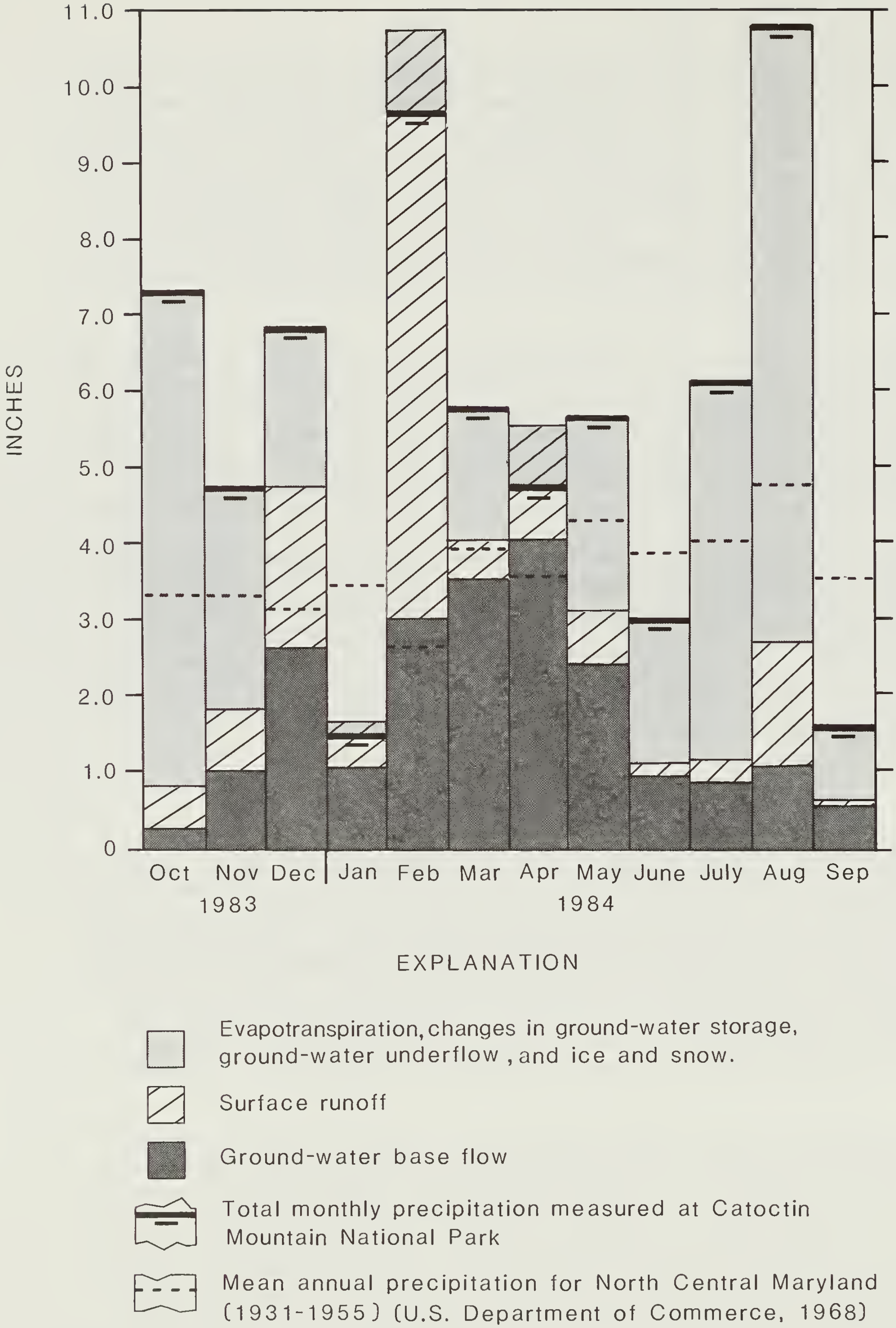


Figure 9. Estimated monthly water budgets for the Catoctin Mountain National Park area.

Table 1.--Characteristics of selected wells in the Catoctin Mountain National Park area

Local No.	Identification No.	Land surface altitude (ft)	Date completed	Depth of well (ft)	Depth cased (ft)	Pumping rate (gal/min)	Specific capacity [(gal/min)/ft] (hours pumped)	Depth of openings (ft)
BD 6	393848077282701	1750	06/07/1955	230	23	25	1.04(24)	65
BD 7	393835077264701	1160	04/19/1955	180	42.5	3.6	0.02(24)	----
BD 8	393837077264801	1180	07/11/1956	127	28	24	0.23(24)	40, 65
BD 34	393804077270501	935	02/05/1959	230	18	32	0.16(24)	----
BD 35	393840077291601	1510.84	06/09/1960	250	66	45	1.07(4)	----
BD 36	393837077291901	1510.47	06/09/1960	250	59	63	----	----
BD 38	393855077290701	1520	05/21/1963	450	86	23	----	100, 214, 380, 410
BD 40	393906077285101	1510	03/09/1966	180	75.5	40	1.4(24)	95, 108, 126, 140
BD 41	393909077284801	1500	03/22/1966	160	46	33	0.83(24)	78
BD 43	393833077290001	1645	03/28/1966	120	27	74	2.7(24)	41, 74
BD 44	393834077296601	1640	06/01/1966	247	45.5	8	0.5(9.25)	53
BD 49	393734077262601	820	04/02/1971	202	43	18	1.5(3.25)	65, 140
BD 109	393849077292201	1425	----	10	10	----	----	----
BD 111	393843077291701	1505.20	10/31/1983	263	110	65	1.7(3.3)	40, 100, 140, 170
BD 112	393843077291702	1505.36	11/09/1983	105	82	----	----	60
BD 113	393843077291703	1505.40	11/09/1983	80	56	----	----	61
BD 114	393853077284901	1488	11/09/1983	143	84	60	1.1(5)	18, 40, 60, 85, 93

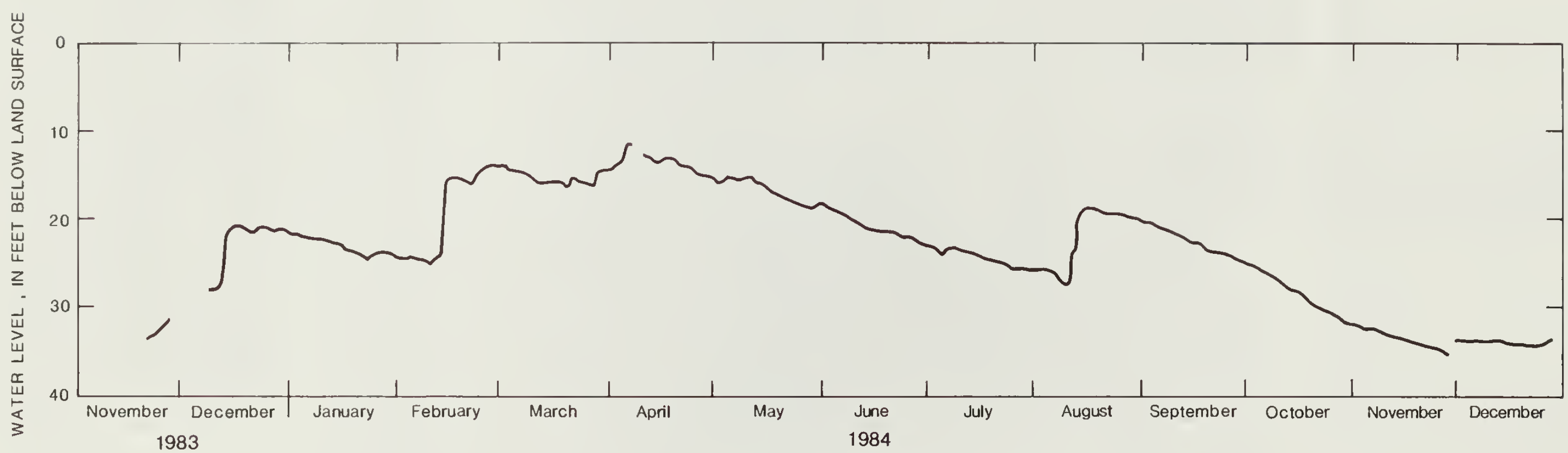


Figure 10. Daily high water level in well BD111, November 22, 1983, through December 31, 1984.

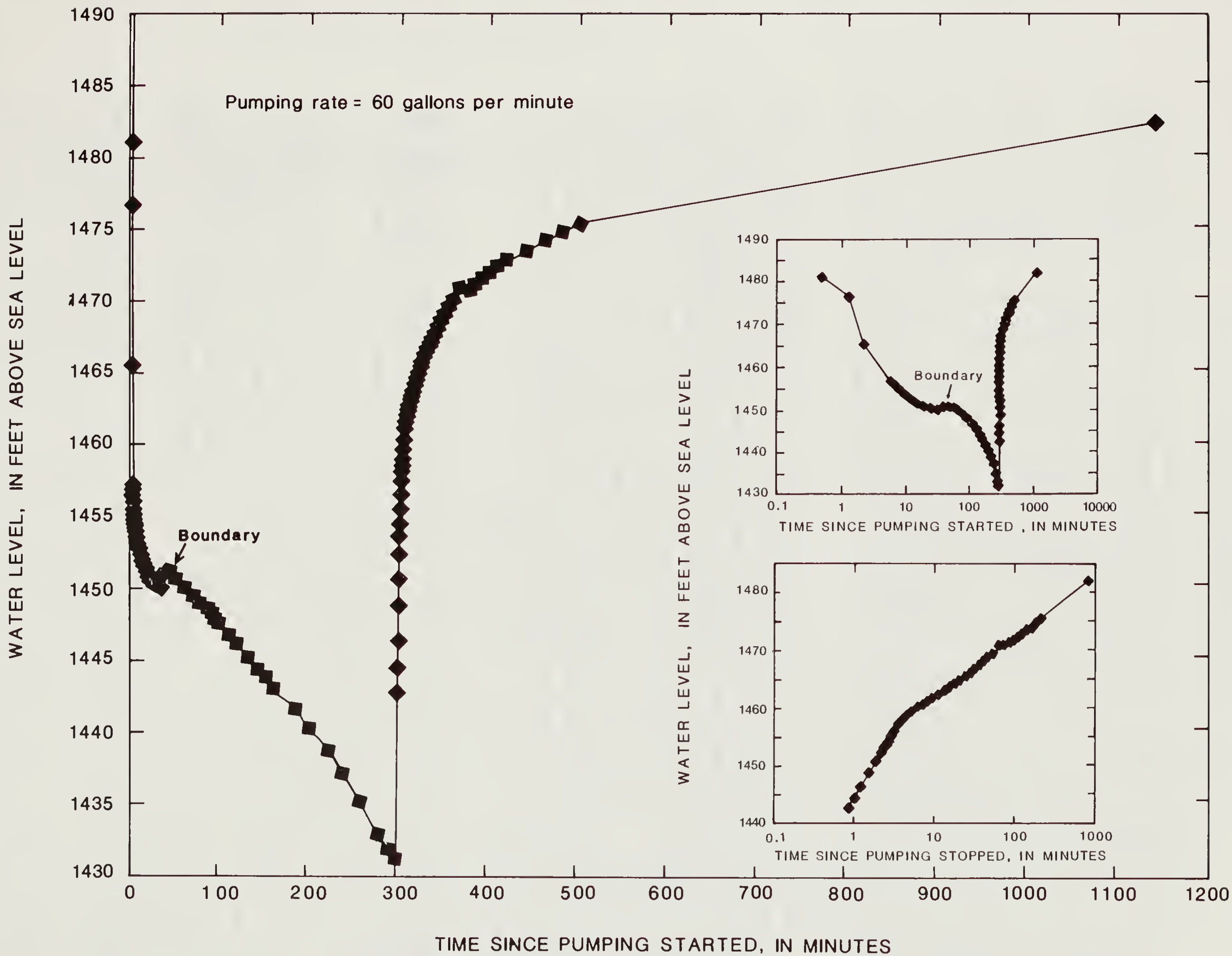


Figure 11. Water levels in well BD114 during aquifer test on November 22, 1983.

Effects of Pumping near Camp Round Meadow

Camp Round Meadow, located on the western side of the park (fig. 7), is an area of particular concern because two production wells are located near sewage treatment facilities. Sewage from the camp and from a nearby trailer park is treated in a two-stage aerated lagoon, pumped into one of two subsurface sand filters for final treatment, and then infiltrates to the ground-water system (see fig. 7a). Well BD 35, one of these production wells, is 270 ft from the center of the nearest sand filter and 125 ft from the nearest sewerline. The other production well, BD 36, is 450 ft from the nearest sand filter a sewerline is within a few feet of the wellhouse. Three observation wells (BD 111 to 113) were drilled in a cluster approximately 70 ft from the center of sand filter no. 1, located 200 ft from BD 35 and 400 ft from BD 36. Well BD 111 is 263 ft deep; well BD 112 is 105 ft deep; and well BD 113 is 80 ft deep. A 1,000-gallon-capacity pump pit and a 1,500-gallon-capacity solids tank used for septic waste from two locations are located 150 ft from BD 36.

An aquifer test was conducted at well BD 35 on November 29, 1983. The well was pumped at 45 gal/min for 240 minutes. An analysis of the data suggests that filtered sewage may be moving toward this production well. Figure 12 is a graph of the water levels measured at the pumping well and at the three observation wells. Although the observation wells are only 10 ft apart, they did not have similar water levels. The deepest well (BD 111) had the lowest water level, and the shallowest well (BD 113) had the highest water level. Thus, there was a slight downward flow gradient, suggesting that shallow ground water may have been flowing downward as well as laterally. There was no apparent drawdown in these observation wells during the test due to rising water levels (fig. 13) resulting from 1.07 in. of rain on November 24 and 25, and 0.63 in. of rain that fell between 4:00 a.m. on November 28 and 3:00 a.m. on November 29.

Water levels in all three observation wells were higher than in the pumped well, indicating that ground water was flowing toward BD 35 from the northwest where the sand filters are located to the southeast (fig. 7); the set of fractures and cleavage that dip to the southeast is a potential pathway for water after percolating through the sand filters.

When the production wells (BD 35, BD 36) located at Camp Round Meadow are being pumped, the water level in BD 111 drops approximately 0.5 ft (fig. 13). To determine how much of this drawdown is caused by each production well and what the effect is on the other two observation wells, an aquifer test was conducted at BD 111. After the two Camp Round Meadow production wells were idle for a day, well BD 36 was turned on and pumped at its normal rate beginning at 8:30 a.m., on April 17. BD 35 was turned on at 12:30 p.m. Both production wells were shut down at 4:50 p.m. Water levels in the observation wells were monitored during the test. The total drawdown in well BD 111 during the test was 0.57 ft (fig. 14). Drawdown from pumping BD 36 was 0.14 ft (25 percent). Therefore, assuming negligible well interference, drawdown from pumping BD 35 was 0.43 ft (75 percent). The nearest production well (BD 35) had the greatest effect on water levels in BD 111, which is drilled to approximately the same depth as BD 35. The effects on BD 112 and BD 113 were less because they are not as deep as BD 111 and do not tap the same fractures.

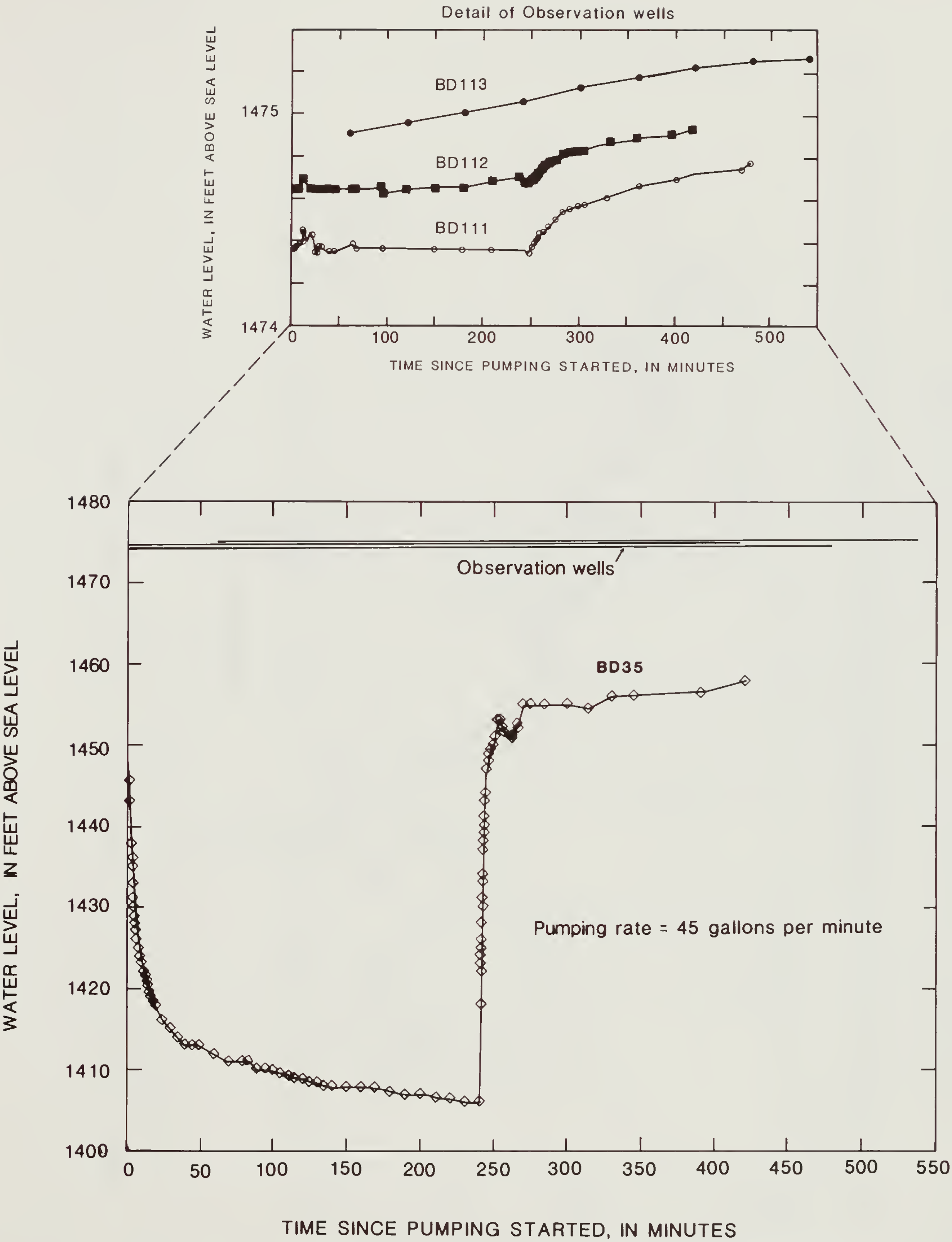


Figure 12. Water levels at Camp Round Meadow wells during aquifer test of well BD35, November 29, 1983.

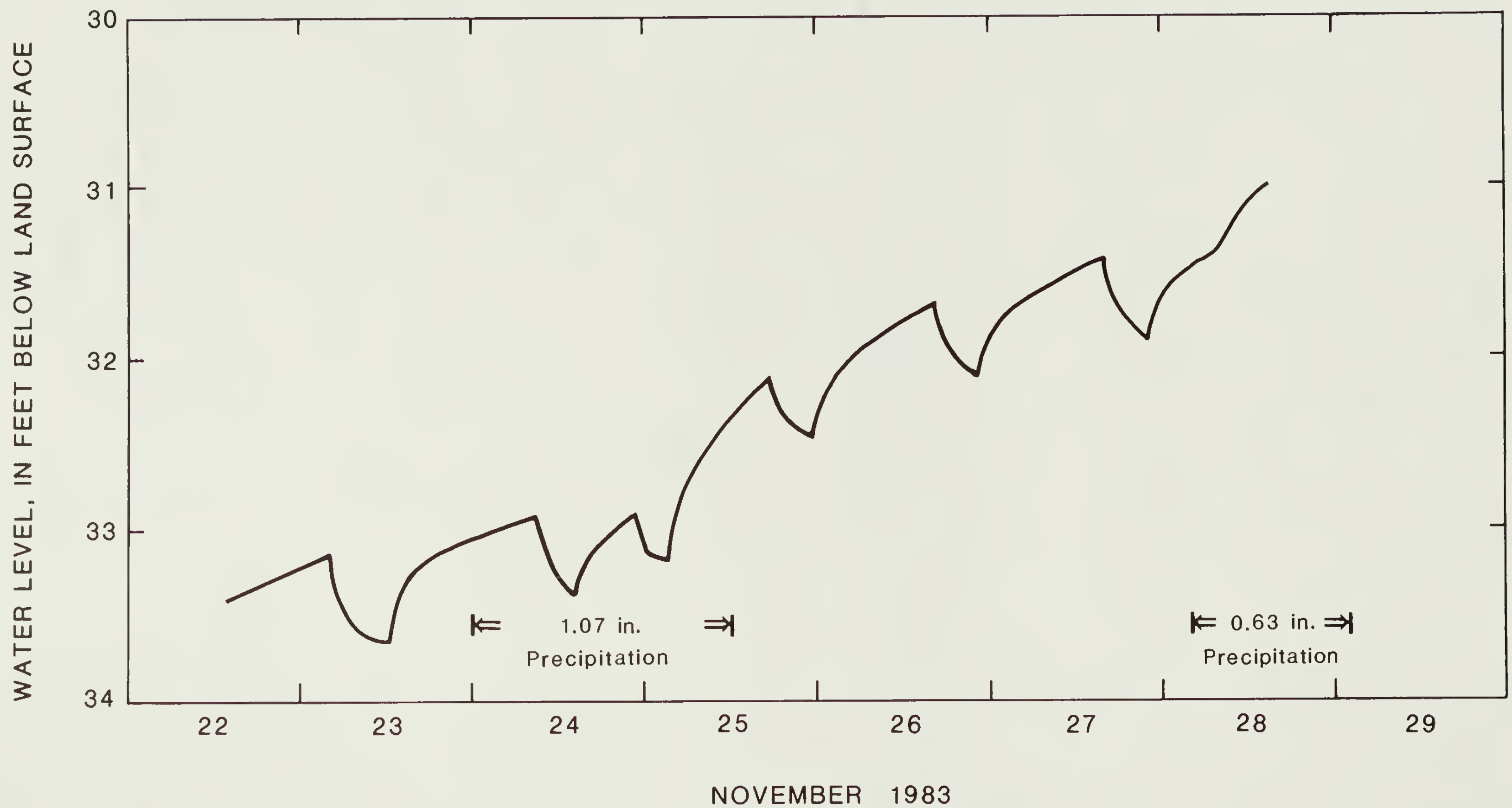


Figure 13. Water levels in well BD111, November 22-28, 1983.

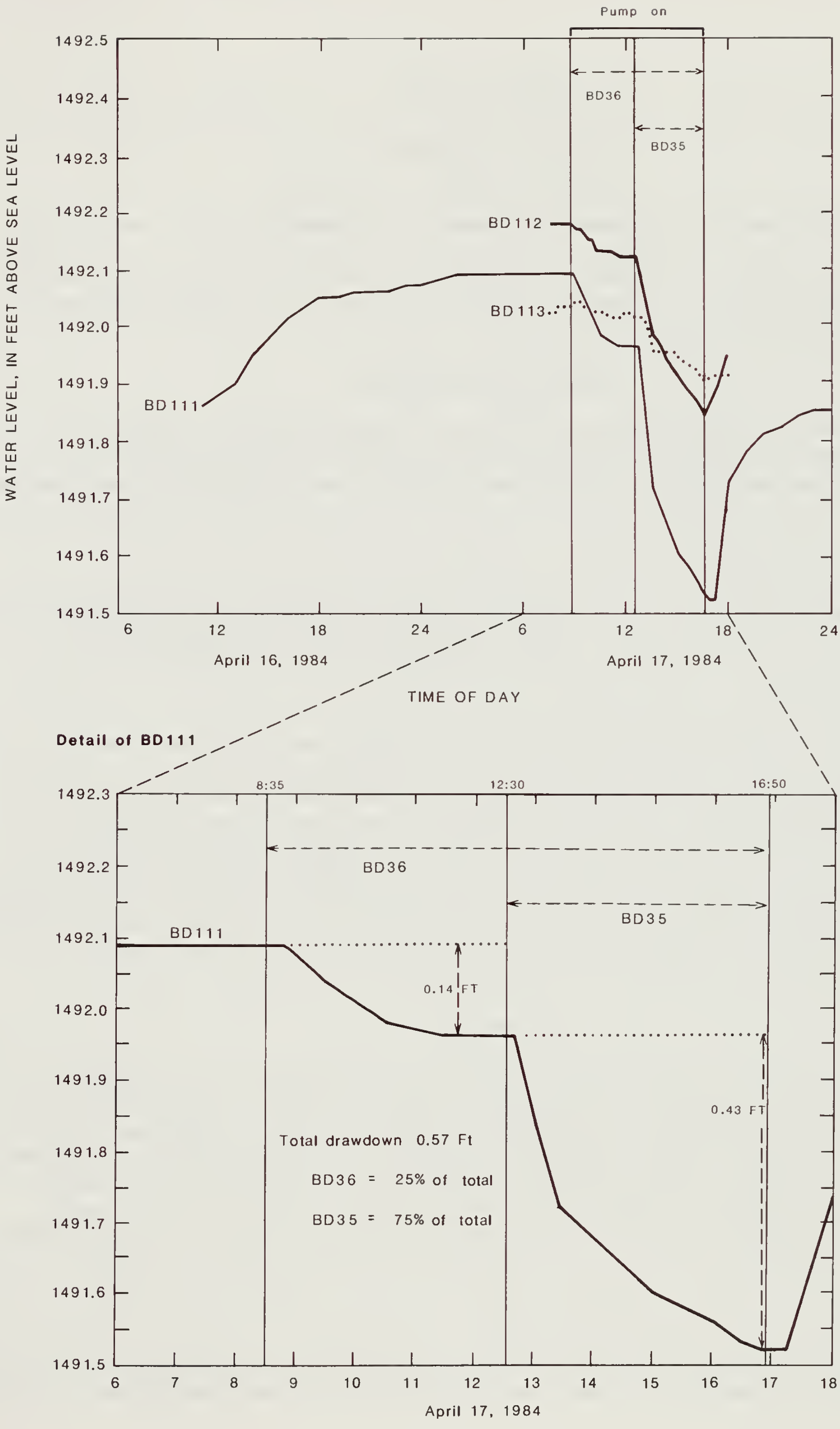


Figure 14. Water levels at Camp Round Meadow observation wells during aquifer test, April 16-17, 1984.

WATER QUALITY

Sampling Strategy

A two-phase approach was used to sample and analyze water from springs, wells, and streams in the park. In phase 1, an initial set of samples was collected to characterize the general water quality of 15 wells, 13 springs, and 7 stream sites. In phase 2, seven wells and five springs were selected for continued analysis. Samples from these sites were collected quarterly from October 1983 through December 1984.

Methods of Analysis

Wells were pumped prior to sampling to evacuate two to three well-casing volumes of water and until pH and specific conductance values stabilized. Spring samples were collected directly from the spring pipe inserted 2 to 3 ft into the ground near the spring outlet. Streams were grab-sampled near the center of the stream.

Measurements of air and water temperature, specific conductance, alkalinity, and pH were made in the field. Water samples were analyzed for major chemical constituents by U.S. Geological Survey laboratories in Reston, Virginia, or Atlanta, Georgia, using methods described in Skougstad and others, 1979.

Throughout the project period, water samples were analyzed for fecal-streptococcus (FS), fecal coliform (FC), and total coliform (TC) bacteria using the membrane-filter method (American Public Health Association, 1976; and Greeson and others, 1977). In addition, selected fecal streptococcus colonies were tested to confirm that they were Streptococcus faecalis (S. faecalis) using miniaturized tests designed by Analytab Products (API 205)[1]. A gelatin liquifaction test (Mates, 1983) was then performed on confirmed S. faecalis colonies to determine if they were S. faecalis variety liquifaciens which has limited sanitary significance because it is not necessarily of fecal origin and may persist in water below 12°C (Geldreich, 1970).

Chemistry

Table 2 (p. 26) gives field measurements of properties, laboratory-determined concentrations of major chemical constituents, and biological results for water samples collected throughout the park during the study period. Figure 15 relates calcium concentration to alkalinity, and figure 16 relates chloride concentration to nitrite plus nitrate concentration. Median seasonal values derived from data in table 2 are plotted. Sample sizes for the median seasonal value range from one to four. During periods

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[1] Use of brand names in this report is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

when more than one sample was collected, the median was calculated progressively for each day, then each week, month, and season. Seasons were represented as follows:

Winter:	January - March
Spring:	April - June
Summer:	July - September
Autumn:	October - December

None of the sample concentrations measured during the study (table 2) exceeded the U.S. Environmental Protection Agency standards for drinking water (1976). The maximum recommended chloride concentration is 250 mg/L; above this level, water tastes salty. This is almost two and one-half times the maximum level measured in the park's water. The maximum recommended nitrite plus nitrate (as N) concentration for drinking water is 10 mg/L or almost twice the maximum level measured in the park. On the other hand, just because these sites do not exceed standards now, does not mean that they will not do so in the future.

Two reaction lines are shown in figure 15 representing reactions of calcium carbonate with ionic hydrogen and with carbonic acid. The principal reaction appears to be with ionic hydrogen, which may be partially derived from acid precipitation (Katz and others, 1985).

Figure 16 is divided arbitrarily into six types based on the degree of contamination by chloride and nitrite plus nitrate from various sources for wells, springs, and streams in the park. Chloride can be used as an indicator of road salt. Nitrite plus nitrate (as N) chloride can be used as an indicator of septic contamination. Sources of fecal contamination may be human or animal. Human septic sources are indicated by elevated nitrite plus nitrate and chloride concentrations, and the proximity of sewage treatment facilities. Animal sources are indicated by elevated nitrite plus nitrate concentrations in areas with no sewage treatment facilities nearby. A lack of fecal bacteria in samples may be misleading because they may be filtered out by the soils.

Natural water (type I) consists of well and spring samples where nattural weathering of soil and rocks is believed to be the primary source of chloride and nitrite plus nitrate in the water. These conditions generally exist at wooded sites, well away from salted roads and septic systems. Maximum concentrations are 3 mg/L and 0.3 mg/L for chloride and nitrite plus nitrate, respectively. Samples of this type are from the "Jim Brown" wells, from wells at Camp Misty Mount (BD 7, BD 8) and Camp Peniel (BD 49), and one spring sample from Owens Creek campground (BD 73).

The low-chloride, intermediate nitrite-plus-nitrate water (type II) contains chloride concentrations of less than 3 mg/L, and nitrite plus nitrate concentrations ranging from 0.3 mg/L to 2 mg/L (as N). These sites, also in wooded areas, may be affected by animal waste and decaying plant and animal matter. This type includes well samples from Camp Peniel (BD 49), Poplar Grove (BD 40, BD 41), and one from the "Jim Brown" observation well (BD 44). Samples from springs include those from the Lantz spring (AD 1),

Table 2.--Water-quality data for the Catoctin Mountain National Park area, for the period 1983-84

LOCAL IDEN-TI-FIER	DATE OF SAMPLE	TIME	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (STAND-ARD UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	COLI-FORM, TOTAL, IMMED. MEM.FIL (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARD-NESS (MG/L AS CACO3)
										WELL
BD 6	83-04-26	1300	22.0	9.0	150	5.8	<1	--	15	68
	83-06-06	1345	24.0	9.0	245	5.8	<1	--	>200	66
BD 7	83-04-25	1215	5.0	11.0	46	6.1	<1	--	3	18
	83-06-02	1300	17.0	11.0	51	6.4	<1	--	4	23
BD 8	83-04-25	1100	3.0	9.0	47	6.1	<1	--	23	19
	83-06-02	1115	17.0	10.0	59	6.4	<1	--	<1	25
	83-07-25	1140	22.0	11.0	46	5.6	<1	--	36	18
	83-11-04	1130	3.0	8.0	46	6.4	<1	<1	<1	26
	84-03-07	1100	-1.0	9.0	75	6.4	<1	<1	<1	30
	84-05-09	1310	12.0	10.0	45	6.2	<1	<1	<1	18
	84-08-08	0930	25.0	13.5	52	5.8	<1	<1	<1	20
	84-11-29	1500	5.0	11.0	51	6.2	<1	<1	<1	22
BD 34	83-06-02	0930	14.0	11.0	163	6.9	<1	--	1	69
	83-07-13	1115	26.0	12.5	168	6.6	<1	<1	<1	68
BD 35	83-05-03	1315	18.0	15.0	200	5.5	<1	--	<1	49
	83-06-13	1000	25.5	13.0	206	5.4	<1	--	<1	60
	83-07-19	1115	--	--	230	5.6	<1	<1	<1	55
	83-10-31	1430	17.0	8.0	221	5.9	<1	<1	<1	74
	83-11-01	1200	15.0	15.0	220	6.2	<1	<1	<1	85
	84-03-06	0950	.0	10.0	201	5.8	<1	<1	<1	62
	84-03-08	0900	.0	10.0	194	5.7	--	--	--	--
	84-03-20	0830	5.0	13.0	195	6.0	<1	<1	<1	64
	84-03-30	0915	.0	10.0	158	5.9	<1	<1	<1	60
	84-04-10	1000	5.0	10.0	243	5.9	<1	<1	<1	58
	84-04-17	1230	15.0	13.0	245	5.7	<1	<1	>200	62
	84-04-24	1315	6.0	17.0	375	6.4	<1	<1	<1	60
	84-05-10	1015	10.0	11.0	202	5.5	<1	<1	<1	64
	84-08-07	1150	27.0	13.5	285	5.7	<1	<1	<1	75
	84-12-04	0915	10.0	11.0	221	5.9	<1	<1	<1	83
BD 36	83-05-03	1230	18.0	13.0	205	6.0	<1	--	>200	72
	83-06-13	1005	25.5	13.0	205	6.2	<1	--	<1	77
	83-07-19	1130	--	--	200	5.9	<1	<1	<1	86
	83-10-31	1435	17.0	8.0	189	6.3	<1	<1	<1	69
	83-11-01	1205	14.0	15.0	176	6.3	<1	<1	<1	71
	84-03-06	0947	.0	10.0	445	7.9	<1	<1	<1	98
	84-03-08	1015	-4.0	10.0	255	6.5	<1	<1	<1	110
	84-03-20	0915	5.0	12.5	226	6.5	<1	<1	<1	94
	84-03-30	0930	.0	10.0	172	6.7	<1	<1	<1	93
	84-04-10	1010	5.0	10.0	285	6.7	<1	<1	<1	120
	84-04-17	1235	15.0	13.0	260	6.4	<1	<1	<1	99
	84-04-24	1300	6.0	17.0	450	7.1	--	--	--	78
	84-05-10	1030	10.0	11.0	203	6.3	<1	<1	<1	93
	84-08-07	1145	27.0	13.0	280	6.4	<1	<1	<1	95
	84-12-04	0930	10.0	11.0	224	6.4	<1	<1	<1	96

HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY, CARBON- ATE IT-FLD (MG/L - CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHATE, ORTHO, DIS- SOLVED (MG/L AS PO4)	IRON, DIS- SOLVED (UG/L AS FE)
SAMPLES												
49	14	8.2	13	1.0	19	5.9	32	--	--	1.2	--	--
47	13	8.2	16	.84	20	6.0	20	--	--	1.2	.09	--
0	3.1	2.6	1.7	.42	22	.1	1.5	--	--	.04	--	--
0	4.7	2.8	1.7	.39	--	.1	1.3	--	--	.05	.11	--
0	3.2	2.6	1.7	.30	21	.4	3.6	--	--	.10	--	--
0	4.0	3.6	2.1	.36	--	1.9	2.3	--	--	.11	.09	--
0	3.1	2.5	2.0	.45	19	.2	2.4	--	--	.10	.18	--
1	4.4	3.6	2.5	.30	25	1.8	4.3	13	45	.15	.71	<3
0	5.1	4.3	2.4	.30	31	3.5	2.6	13	50	.24	.06	11
0	3.1	2.6	1.5	.30	20	.8	2.2	11	33	.11	--	6
0	3.3	2.8	1.6	.30	21	.7	2.5	12	36	.13	.18	17
2	3.7	3.1	1.9	.30	20	1.0	2.3	13	37	.15	.06	3
15	11	10	6.0	.30	--	2.4	13	--	--	.09	--	--
4	11	10	6.1	.42	65	2.4	16	--	--	.20	--	--
27	12	4.8	10	2.1	22	7.1	17	--	--	3.6	--	--
33	15	5.6	12	1.6	27	6.0	19	--	--	4.3	.80	--
16	11	6.6	11	1.0	39	5.3	16	--	--	4.1	.18	--
38	20	5.9	10	1.6	36	6.2	31	18	110	3.9	.09	30
34	24	6.0	8.9	1.6	51	6.6	26	27	130	3.7	.03	36
26	15	5.9	12	1.8	36	6.5	35	14	110	3.6	--	130
--	--	--	--	--	--	--	--	--	--	--	--	--
28	17	5.2	10	1.9	36	6.5	29	17	110	3.4	--	710
37	14	6.1	12	1.9	23	5.8	38	14	110	3.8	--	33
18	13	6.2	22	2.0	40	8.6	39	12	130	3.4	--	250
39	14	6.5	15	2.0	23	8.9	41	12	110	3.0	--	180
0	15	5.4	53	1.9	119	8.1	37	14	210	3.4	--	160
45	15	6.5	13	2.0	19	5.1	42	13	110	3.3	--	45
55	18	7.3	12	1.9	20	6.9	45	15	120	3.6	--	45
38	23	6.2	13	1.5	45	6.8	33	17	130	3.5	--	54
15	23	3.5	9.6	2.2	57	3.3	4.3	--	--	3.0	.02	--
14	25	3.2	8.5	1.4	62	4.0	11	--	--	3.3	.14	--
28	29	3.0	8.9	1.6	58	2.0	14	--	--	2.5	--	--
45	22	3.3	8.8	1.5	50	2.5	18	17	88	2.7	.18	11
17	24	2.8	6.6	1.3	54	2.3	13	18	100	2.8	.06	6
0	32	4.4	65	1.6	209	5.5	24	18	280	3.0	.03	190
25	36	4.4	9.5	1.5	83	5.8	25	18	150	3.2	--	76
26	31	4.1	7.5	1.6	68	6.5	21	18	130	3.3	--	370
22	31	3.8	7.0	1.5	71	5.4	19	18	130	3.3	--	34
20	43	4.0	7.5	1.4	104	6.9	19	20	160	3.1	--	320
25	33	4.0	7.3	1.6	74	5.8	22	18	140	2.9	--	200
0	24	4.3	70	1.8	203	5.5	28	16	270	3.3	--	11
26	31	3.9	7.1	1.5	68	5.0	21	19	130	3.0	--	75
28	31	4.2	8.3	1.6	67	4.3	24	18	130	3.1	--	9
33	32	3.8	8.5	1.3	63	4.2	21	18	130	3.0	.03	140

LOCAL IDEN-TI-FIER	DATE OF SAMPLE	TIME	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (STAND-ARD UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	COLI-FORM, TOTAL, IMMED. MEM.FIL (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARD-NESS (MG/L AS CACO3)
										WELL
BD 38	83-05-03	1215	18.0	13.0	124	6.1	<1	--	95	--
	83-06-13	1010	25.5	13.0	161	6.6	<1	--	<1	64
	83-07-19	1145	--	--	168	6.2	<1	<1	<1	66
	83-10-31	1440	17.0	8.0	160	6.2	<1	<1	<1	44
	83-11-01	1210	14.0	15.0	155	6.8	<1	<1	<1	77
	84-03-06	1010	.0	10.0	154	6.6	<1	<1	<1	66
	84-05-10	1045	10.0	11.0	157	6.7	<1	<1	<1	81
	84-08-07	1200	27.0	13.5	143	6.6	<1	<1	<1	49
	84-12-04	0945	11.0	10.0	108	6.2	<1	<1	<1	46
BD 40	83-05-02	1120	16.0	9.5	72	6.0	<1	--	12	27
	83-06-13	1235	24.0	10.5	71	6.1	<1	<1	<1	26
	83-07-18	1145	25.0	10.0	71	5.8	<1	<1	<1	28
	83-11-03	1500	16.0	12.0	65	6.3	<1	<1	<1	29
	84-03-08	1300	-6.0	9.0	61	6.1	<1	<1	<1	28
	84-05-09	1515	10.0	10.0	67	6.0	<1	<1	<1	27
	84-08-09	1300	29.0	11.0	70	6.4	<1	<1	<1	29
	84-11-29	1215	2.5	10.0	69	6.2	<1	<1	<1	29
BD 41	83-05-02	1215	16.0	9.5	79	6.2	<1	--	15	31
	83-06-13	1120	24.5	10.5	84	6.3	<1	--	<1	32
	83-07-18	1230	25.0	11.0	85	5.9	<1	<1	<1	32
BD 43	83-04-27	1130	18.0	8.0	21	5.3	<1	--	2	4
	83-06-07	1100	18.5	9.5	23	5.1	<1	--	<1	5
	83-07-25	1100	22.0	8.0	30	4.8	<1	<1	8	7
	83-11-03	1345	15.0	10.5	34	6.1	<1	<1	<1	11
	84-03-08	1235	-6.0	10.0	12	5.7	--	--	--	5
	84-05-09	1000	9.0	9.0	22	5.5	<1	<1	<1	4
	84-08-09	1400	27.0	10.0	34	6.1	<1	<1	>100	8
	84-11-29	1045	1.0	9.0	35	5.9	<1	<1	<1	9
BD 44	83-04-27	1330	23.0	11.0	33	5.6	<1	--	36	10
	83-06-07	1430	18.5	11.0	27	5.7	<1	--	<1	10
BD 49 FR-07-	83-04-18	1030	7.0	10.0	44	6.3	<1	--	27	12
1428	83-06-06	1200	24.0	13.0	50	5.6	<1	--	47	13
	83-07-13	1300	28.0	13.0	55	5.8	<1	<1	<1	15
	83-11-04	1215	3.0	10.0	55	6.2	<1	1	<1	18
	84-03-07	0940	.0	10.0	50	6.3	<1	<1	<1	16
	84-05-09	1400	15.0	12.0	52	6.2	<1	<1	<1	16
	84-08-08	1015	25.0	13.5	54	5.9	<1	<1	<1	15
	84-11-29	1400	6.0	11.0	56	6.1	<1	<1	<1	17
BD 109	83-06-08	1415	19.0	10.0	162	5.8	<1	--	20	45
	83-08-03	1115	26.0	15.0	165	5.6	<1	3	<1	49
BD 111 FR-81-	83-11-02	1215	16.0	13.0	167	7.4	<1	<1	<1	56
1264	83-12-01	1230	10.0	10.0	190	5.8	<1	<1	21	58
	83-12-01	1426	5.0	10.0	190	5.8	<1	<1	<1	60
BD 114 FR-81-	83-11-30	1400	7.0	10.0	200	6.3	--	--	--	77
1284	83-11-30	1620	3.0	10.0	205	6.3	1	32	17	75

HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY, CARBON- ATE IT-FLD (MG/L - CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHATE, ORTHO, DIS- SOLVED (MG/L AS PO4)	IRON, DIS- SOLVED (UG/L AS FE)
SAMPLES--Continued												
--	--	--	--	--	37	--	--	--	--	--	--	--
3	21	3.1	6.0	1.4	61	4.3	10	--	--	2.3	--	--
6	21	3.1	7.7	.96	61	4.3	11	--	--	2.3	--	--
6	13	2.9	5.4	1.5	38	1.8	7.2	21	76	2.5	.06	11
6	25	3.6	6.6	2.0	67	5.1	7.8	23	120	2.6	.15	5
10	21	3.3	5.5	1.8	57	3.8	7.0	22	98	2.3	.06	8
19	27	3.2	5.5	1.8	75	4.5	6.7	22	110	2.5	--	37
4	15	2.9	5.0	1.7	46	2.7	5.7	22	83	2.4	.06	18
9	14	2.8	5.1	1.3	38	2.4	7.9	21	77	2.3	.03	180
0	6.8	2.3	2.7	.57	29	.3	2.1	--	--	1.7	.05	--
1	6.7	2.2	2.4	.35	25	.9	1.5	--	--	1.7	--	--
1	7.3	2.4	2.7	.53	27	.3	2.9	--	--	1.5	.18	--
0	7.5	2.4	2.7	.40	30	.5	3.7	16	51	<.10	.12	240
3	7.2	2.4	2.1	.40	25	.3	1.7	16	45	1.7	.18	20
1	7.0	2.4	2.1	.40	26	.6	1.3	15	45	1.6	.12	14
0	7.8	2.4	2.1	.40	31	1.8	1.5	16	51	1.4	.37	6
5	7.7	2.4	2.4	.40	25	.2	1.9	16	46	1.1	.18	12
0	7.2	3.3	3.7	.75	33	.2	1.8	--	--	1.3	--	--
0	7.4	3.4	3.0	.57	34	.8	2.7	--	--	1.5	.10	--
0	7.4	3.4	3.9	.65	35	.1	2.8	--	--	1.2	.27	--
0	1.0	.45	1.7	.92	6.0	1.1	1.7	--	--	.08	--	--
0	1.2	.45	2.4	1.2	6.0	.4	1.7	--	--	.08	--	--
0	1.8	.68	3.1	1.1	9.0	.5	1.6	--	--	.10	.25	--
0	2.7	1.1	3.3	.80	15	.8	1.9	20	40	<.10	.18	10
0	1.1	.46	1.7	.90	8.0	1.3	1.8	10	22	.25	--	<3
0	1.0	.45	1.7	.90	8.0	.8	1.3	11	22	.13	--	5
0	1.9	.79	2.5	.80	15	9.2	1.2	17	42	<.10	.12	5
0	2.2	.87	2.9	.80	12	.5	.60	18	33	<.10	.09	<3
0	2.5	.88	2.3	.84	12	.6	2.1	--	--	.59	.20	--
4	2.4	.88	2.4	.84	6.0	.2	2.1	--	--	.38	.19	--
0	3.6	.75	2.6	1.1	12	3.4	1.6	--	--	.06	--	--
0	3.9	.75	3.0	1.8	14	3.9	1.7	--	--	.08	.44	--
0	4.6	.81	3.8	1.8	19	3.3	2.5	--	--	.02	.36	--
0	5.6	.95	3.8	1.6	23	4.3	1.8	11	44	.96	.25	450
0	4.8	.88	2.8	1.6	21	3.8	1.3	10	39	.20	.37	420
0	4.9	.83	2.9	1.6	18	4.1	1.3	10	37	.17	.37	470
0	4.7	.81	2.7	1.5	18	4.4	1.3	10	38	.11	.55	980
0	5.2	.87	3.4	1.6	19	4.1	1.1	11	39	<.10	.34	480
11	10	4.6	12	1.7	34	12	9.2	--	--	3.7	.10	--
19	13	4.3	10	1.3	30	7.9	9.8	--	--	5.3	.08	--
8	15	4.6	9.9	1.8	48	10	17	19	110	4.4	.06	94
26	15	4.9	9.8	1.9	32	12	18	18	99	4.4	--	180
29	16	4.9	9.9	1.8	31	11	17	18	98	4.3	--	580
34	19	7.1	7.3	2.1	43	12	23	21	120	3.5	.03	74
32	18	7.3	7.8	2.0	43	11	25	20	120	2.3	.06	72

Table 2.--Water-quality data for the Catoctin Mountain National Park area, for the period 1983-84--Continued

LOCAL IDEN-TI-FIER	DATE OF SAMPLE	TIME	TEMPER-ATURE, AIR (DEG C)	TEMPER-ATURE (DEG C)	SPE-CIFIC CON-DUCT-ANCE (UMHOS)	PH (STAND-ARD UNITS)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	COLI-FORM, TOTAL, IMMED. MEM.FIL (COLS./ 100 ML)	STREP-TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARD-NESS (MG/L AS CACO3)
										SPRING
AD 1	83-04-12	1130	12.0	10.0	60	5.8	<1	--	<1	--
	83-06-06	1200	24.0	13.0	68	5.8	<1	--	85	20
	83-07-12	1045	22.0	9.5	65	5.6	1	1	4	20
AD 44	83-04-19	1215	3.0	6.0	62	6.2	<1	--	47	20
	83-06-07	1200	19.0	12.0	62	5.8	<1	--	6	25
BD 3	83-04-11	1215	9.0	7.0	90	6.3	<1	--	1	--
	83-06-01	1330	17.0	9.0	80	6.3	1	--	8	30
BD 4	83-04-11	1030	9.0	8.0	59	6.0	1	--	<1	--
	83-06-01	1410	17.0	9.0	55	6.1	<1	--	14	18
	83-07-28	1250	23.0	9.0	59	5.8	1	1	22	19
	84-03-08	1230	-5.0	7.0	57	5.9	<1	<1	<1	19
	84-05-10	1330	16.5	10.0	60	6.0	<1	<1	<1	19
	84-08-09	1015	28.0	12.0	66	6.0	2	33	46	22
	84-11-30	1330	11.0	8.5	65	5.9	1	30	<1	22
BD 39	83-05-09	1145	9.0	9.0	108	5.8	14	--	94	38
	83-06-14	1230	31.0	10.0	112	5.7	<1	<1	1	40
	83-07-28	1030	23.0	9.0	120	6.0	<1	<1	<1	41
	83-11-02	1000	15.0	10.5	108	6.2	<1	<1	<1	41
	84-03-07	1230	5.5	10.0	110	6.1	<1	<1	<1	41
	84-05-09	0900	9.0	10.0	106	6.3	<1	<1	<1	41
	84-08-08	1200	28.0	13.5	113	6.0	<1	<1	<1	40
	84-11-30	1400	10.0	11.0	122	5.9	1	<1	--	44
BD 72	83-05-10	1040	9.0	8.0	53	6.2	<1	--	19	20
	83-06-07	1315	21.0	10.5	54	6.0	<1	--	6	19
	83-07-12	1200	19.0	11.0	50	6.0	4	<1	<1	18
BD 73	83-05-10	1030	9.0	8.0	75	6.2	<1	--	17	26
	83-06-07	1300	21.0	10.5	72	6.1	4	--	140	26
	83-07-12	1130	24.5	11.5	74	5.9	<1	<1	32	26
	83-11-04	1100	3.0	7.0	75	6.6	>60	>80	24	29
	84-03-06	1140	.0	11.0	72	5.8	<1	25	<1	27
	84-05-10	1300	16.5	12.0	72	6.0	<1	52	<1	26
	84-08-08	1500	35.0	15.0	86	5.8	<1	3	11	27
	84-11-30	1500	11.0	11.0	83	6.3	<1	51	4	30
BD 106	83-04-11	1130	--	8.0	52	6.0	<1	--	1	--
	83-06-01	1015	15.0	9.5	49	5.5	<1	--	51	25
	83-07-27	1030	23.0	13.0	56	5.4	4	2	2	19

HARD-NESS, NONCAR-BONATE (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)	SODIUM, DIS-SOLVED (MG/L AS NA)	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	ALKA-LINITY, CARBON-ATE IT-FLD (MG/L - CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHATE, ORTHO, DIS-SOLVED (MG/L AS PO4)	IRON, DIS-SOLVED (UG/L AS FE)
SAMPLES												
--	--	--	--	--	13	--	--	--	--	--	--	--
5	4.7	1.9	3.3	.82	15	6.6	2.7	--	--	.56	.39	--
3	4.9	1.9	3.9	.94	17	7.3	1.7	--	--	.68	.21	--
9	4.2	2.3	1.8	.40	11	6.5	1.9	--	--	1.2	.21	--
10	5.2	2.8	2.6	.65	15	5.3	2.2	--	--	1.5	.35	--
--	--	--	--	--	24	--	--	--	--	--	--	--
6	7.1	2.9	3.9	.84	24	6.1	2.1	--	--	1.1	.10	--
--	--	--	--	--	11	--	--	--	--	--	--	--
0	4.2	1.8	2.4	.47	23	4.4	3.5	--	--	.76	--	--
9	4.6	1.9	2.5	.53	11	1.8	4.6	--	--	.53	.07	--
9	4.6	1.9	2.1	.40	10	5.7	6.6	12	39	.98	.03	9
8	4.5	1.9	2.1	.40	11	5.3	5.0	12	38	.93	--	13
9	5.2	2.1	2.4	.40	12	9.4	7.0	13	47	.97	.15	4
10	5.3	2.1	2.5	1.1	12	4.8	5.4	13	42	1.0	.03	7
10	9.3	3.5	4.8	.56	28	4.9	8.5	--	--	2.4	--	--
18	9.9	3.7	4.9	.47	22	5.4	8.7	--	--	3.1	--	--
18	10	3.7	5.3	.38	23	5.6	6.2	--	--	3.1	.03	--
14	10	3.8	4.6	.30	26	5.0	9.6	19	68	2.8	.09	<3
17	10	3.9	4.2	.40	24	5.0	9.9	19	67	2.7	.06	5
17	10	3.9	4.1	.40	24	5.4	9.9	20	68	2.5	--	7
16	10	3.7	4.0	.40	25	5.0	9.6	19	67	2.6	.12	7
22	11	4.0	4.3	.40	22	5.3	15	20	73	3.3	.06	69
0	4.6	2.1	2.8	.75	20	2.0	2.3	--	--	.55	.04	--
0	4.4	2.1	2.7	.58	21	2.2	2.3	--	--	.46	--	--
0	4.1	2.0	3.0	.81	19	2.1	1.7	--	--	.53	--	--
11	6.1	2.7	2.9	.84	16	6.2	2.2	--	--	2.0	.02	--
10	5.9	2.7	3.3	.72	16	6.5	2.4	--	--	1.9	.52	--
17	6.0	2.7	5.3	1.3	17	6.0	2.5	--	--	2.4	--	--
10	6.7	3.0	3.8	.50	19	7.4	2.4	19	54	.19	.06	6
8	6.3	2.7	2.8	.60	19	7.1	2.0	19	52	2.3	--	6
8	6.1	2.6	2.7	.60	18	8.1	1.9	19	52	1.9	--	13
12	6.3	2.8	3.1	.30	16	6.7	2.3	20	51	2.4	.12	5
14	6.9	3.0	3.2	.40	16	8.1	4.3	19	54	2.5	--	6
--	--	--	--	--	11	--	--	--	--	--	--	--
16	6.3	2.3	2.2	.48	10	4.3	6.3	--	--	1.1	.51	--
9	4.5	1.8	2.5	.38	10	4.3	6.3	--	--	1.1	.46	--

Table 2.--Water-quality data for the Catoctin Mountain National Park area, for the period 1983-84--Continued.

LOCAL IDEN- TI- FIER	DATE OF SAMPLE	TIME	TEMPER- ATURE, AIR (DEG C)	TEMPER- ATURE (DEG C)	SPE- CIFIC CON- DUCT- ANCE (UMHOS)	PH (STAND- ARD UNITS)	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	COLI- FORM, TOTAL, IMMED. MEM.FIL (COLS./ 100 ML)	STREP- TOCOCCI FECAL, KF AGAR (COLS. PER 100 ML)	HARD- NESS (MG/L AS CACO3)
										SPRING
BD 107	83-04-05	1235	--	9.0	390	5.8	4	--	8	92
	83-06-01	1115	19.0	12.5	260	6.2	3	--	23	16
	83-07-19	1100	28.5	13.0	163	5.5	<1	<1	<1	48
	83-11-02	1600	14.0	15.0	171	6.0	<1	32	6	50
	84-03-07	1320	4.0	10.0	385	6.2	8	12	3	100
	84-05-09	1115	9.0	13.0	300	6.3	6	13	62	81
	84-08-08	1330	35.0	16.0	180	6.0	<1	1	6	48
	84-11-30	1015	7.0	12.0	270	6.2	6	>80	--	73
BD 108	83-04-12	1325	10.0	10.0	175	6.0	>60	--	76	--
	83-06-08	1030	19.0	14.0	150	6.6	24	--	25	46
	83-08-03	1030	26.0	14.0	165	5.9	6	2	<1	51
	83-11-02	1125	17.0	12.5	150	6.7	3	>80	21	51
	84-03-06	1320	.0	12.0	162	6.0	1	10	3	53
	84-05-08	1400	16.0	12.0	145	6.0	<1	26	10	47
	84-08-07	1400	31.0	15.0	155	5.9	22	6	8	48
	84-11-30	1115	7.0	12.0	152	5.7	16	>80	--	48
BD 110	83-04-11	1310	9.0	10.0	70	6.1	1	--	23	--
	83-06-01	0900	15.0	9.5	73	5.7	<1	--	<1	72
	83-07-28	1245	23.0	9.0	77	5.3	<1	<1	7	26
BD 115	84-05-11	0930	17.0	10.0	130	6.1	>60	>80	>200	38
										STREAM
Camp 3 (C 3-1) (no. 1)	83-05-31	1230	15.0	12.0	140	6.9	>60	--	>200	57
	83-06-14	1330	31.0	15.0	150	7.1	>60	--	>200	58
	83-08-03	1330	28.0	19.0	180	6.9	190	146	640	57
Camp 3 (C 3-2) (no. 2)	83-05-31	1245	15.0	11.0	263	7.3	>60	--	>200	76
HCPEN	83-07-13	1230	28.0	18.0	82	7.3	9	4	61	29
HCMM	83-07-25	1125	20.0	18.0	90	6.5	78	54	133	37
HCVC	83-07-13	1045	25.0	18.5	85	7.2	15	>80	>800	37
OCCG	83-07-12	1100	22.0	15.5	77	7.2	120	69	37	26
OCIS	83-07-27	1040	23.0	18.0	69	5.9	2	10	35	23

HARD- NESS, NONCAR- BONATE (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)	SODIUM, DIS- SOLVED (MG/L AS NA)	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	ALKA- LINITY, CARBON- ATE IT-FLD (MG/L - CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SILICA, DIS- SOLVED (MG/L AS SIO2)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHATE, ORTHO, DIS- SOLVED (MG/L AS PO4)	IRON, DIS- SOLVED (UG/L AS FE)
SAMPLES --- Continued												
61	23	8.5	12	2.3	32	12	32	--	--	2.5	--	--
0	4.0	1.5	18	2.3	34	7.6	17	--	--	2.4	.15	--
21	12	4.6	11	1.3	27	4.7	21	--	--	2.4	.27	--
19	12	4.8	14	1.7	31	6.3	27	17	100	2.0	--	28
60	26	9.6	31	2.2	44	9.0	91	14	210	2.6	--	<3
38	20	7.5	24	2.0	43	12	55	14	160	2.1	--	12
17	12	4.5	11	1.5	32	5.9	21	16	91	2.0	.06	12
40	18	6.8	22	.50	33	9.2	51	16	140	2.0	.03	4
--	--	--	--	--	39	--	--	--	--	--	--	--
13	12	4.0	10	1.4	34	12	8.5	--	--	3.5	.09	--
19	13	4.4	11	1.0	31	9.4	7.5	--	--	4.5	.04	--
15	13	4.6	11	1.3	36	12	12	15	91	3.8	.12	11
22	13	4.9	9.1	1.2	31	16	13	15	91	3.8	.06	8
21	12	4.2	8.3	1.1	26	14	13	15	83	3.0	--	14
20	12	4.5	9.9	1.2	29	9.3	16	16	86	3.9	.06	9
20	12	4.5	9.8	.60	25	10	14	16	82	2.6	.03	10
--	--	--	--	--	18	--	--	--	--	--	--	--
55	18	6.9	2.8	.92	17	3.0	4.6	--	--	1.8	.14	--
10	6.6	2.3	2.7	1.0	16	1.9	3.7	--	--	1.7	.13	--
18	9.6	3.3	6.8	1.7	20	7.8	11	14	66	3.8	--	15
SAMPLES												
22	13	6.0	4.2	.54	35	9.8	10	--	--	.81	.09	--
23	13	6.2	4.8	.72	35	.7	1.7	--	--	1.7	--	--
17	16	4.2	21	1.9	40	18	18	--	--	2.7	.21	--
20	19	7.0	21	1.7	56	17	14	--	--	2.7	.15	--
6	7.7	2.4	3.6	.60	22	5.0	6.9	--	--	.35	.12	--
7	8.3	3.9	3.6	.45	30	3.8	7.5	--	--	.13	--	--
3	11	2.2	2.6	.46	33	1.7	5.7	--	--	.05	.13	--
3	6.4	2.4	3.6	.85	21	3.0	2.7	--	--	.95	.03	--
12	5.0	2.6	3.4	.45	12	4.2	6.6	--	--	.59	--	--

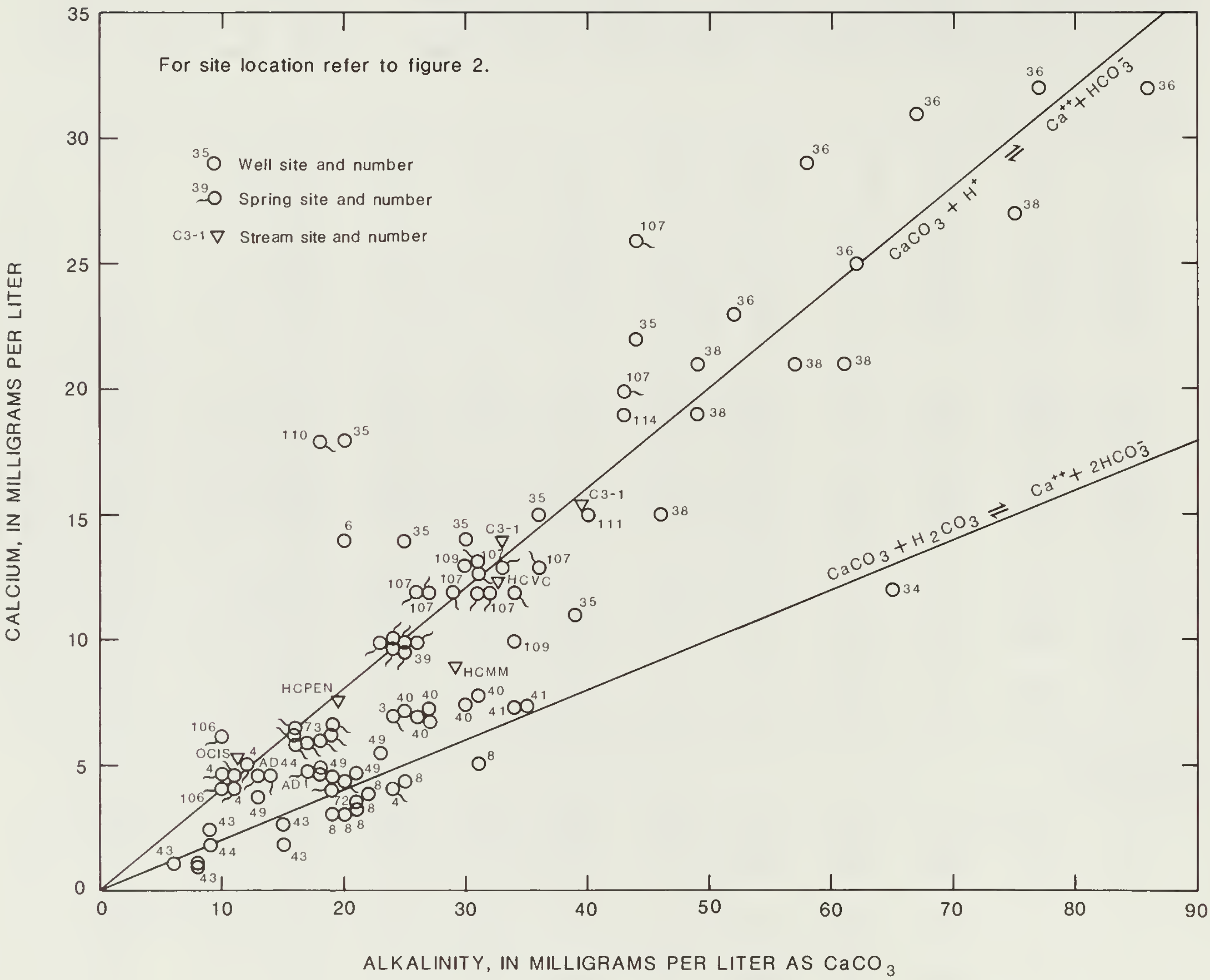

Figure 15. Relationship of calcium concentration to alkalinity for all sites sampled.

the Adirondack Shelter spring (AD 44), the Owens Creek campground springs (BD 72, BD 73), and one sample from the "Ike Smith" springs (BD 3).

Type III water, which has low chloride (less than 3 mg/L) and high nitrite plus nitrate concentrations (greater than 2.0 mg/L, as N) is represented by samples from one spring located near Owens Creek campground (BD 73). It is a poorly developed spring that flows from beneath a loose pile of rocks. Mud and debris was stirred up whenever this spring was sampled.

Type IV water (chloride greater than 3 mg/L and nitrite plus nitrate <0.3 mg/L) includes samples from the Blue Blazes well (BD 34) near the Visitors Center, and one sample each from Camp Misty Mount (BD 7, BD 8) and Poplar Grove. Stream samples are from Hunting Creek tributaries near Camp Misty Mount (HCMM) and from the Visitors Center (HCVC). The Visitors Center sites are adjacent to roads that are salted during the winter. The Camp Misty Mount and Poplar Grove sites may be receiving salt from roads located higher up on Catoctin Mountain at Camp 3.

The high-chloride, intermediate nitrite plus nitrate water (type V) is affected by animal waste and possibly road salt from Camp 3, Park Central Road, Route 77, and Foxville-Deerfield Road. This type includes samples from the "Ike Smith" springs (BD 4, BD 106), Walnut spring (BD 110), Hunting Creek near Camp Peniel (HCPEN), Owens Creek near Owens Creek campground (OCCG), Owens Creek tributary near the "Ike Smith" springs (OCIS), from a stream flowing out from Camp 3 (C 3-1), and from a well located near Camp Greentop (BD 6).

High chloride and high nitrite plus nitrate concentrations (type VI) indicate probable contamination by road salt and human septic waste. The chloride concentrations measured in this type are approximately 2 to 30 times greater than those measured in type I. Nitrite plus nitrate concentrations are 7 to 18 times greater. This type includes two stream samples from near Camp 3 (C 3-1, C 3-2), all of the well and spring samples from Staff Quarters No. 5 (BD 107, BD 114), and from the Camp Round Meadow area (BD 35, BD 36, BD 38, BD 108, and BD 109); it also includes BD 39, which is located downhill from both Camp Round Meadow and from a section of Park Central Road that is salted in the winter.

Figure 17 shows the chloride and nitrite plus nitrate content of water at park sites. Wells at Camp Peniel, Camp Misty Mount, and "Jim Brown" have the best quality of water in the study area (type I). The poorest quality of water is at Camp Round Meadow and Staff Quarters No. 5 (type VI). The water-quality study (1979-81) of streams, wells, springs, and the septic lagoons at Camp Round Meadow by the Ecological Services Laboratory, National Park Service, indicated that water from streams and wells are of good quality and suitable for human consumption and most other uses in the park. The results of a study by Huth Engineers and R. E. Wright Associates (1981) suggested possible low-level septic contamination of the Camp Round Meadow production wells. The chloride and nitrite plus nitrate data in figure 16 support the conclusions of both studies.

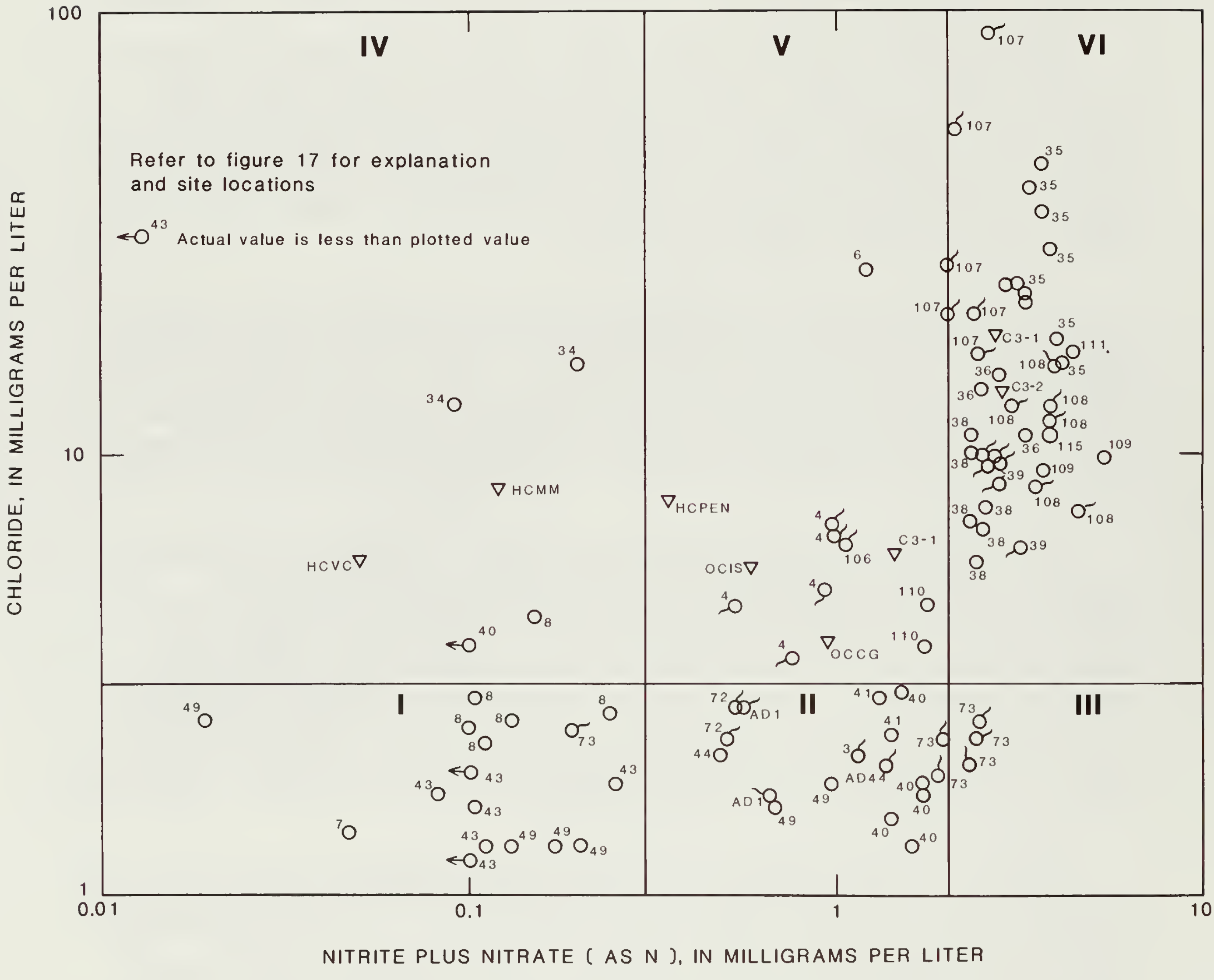

Figure 16. Relationship of chloride concentration to nitrite plus nitrate concentrations for all sites sampled, and corresponding water types.

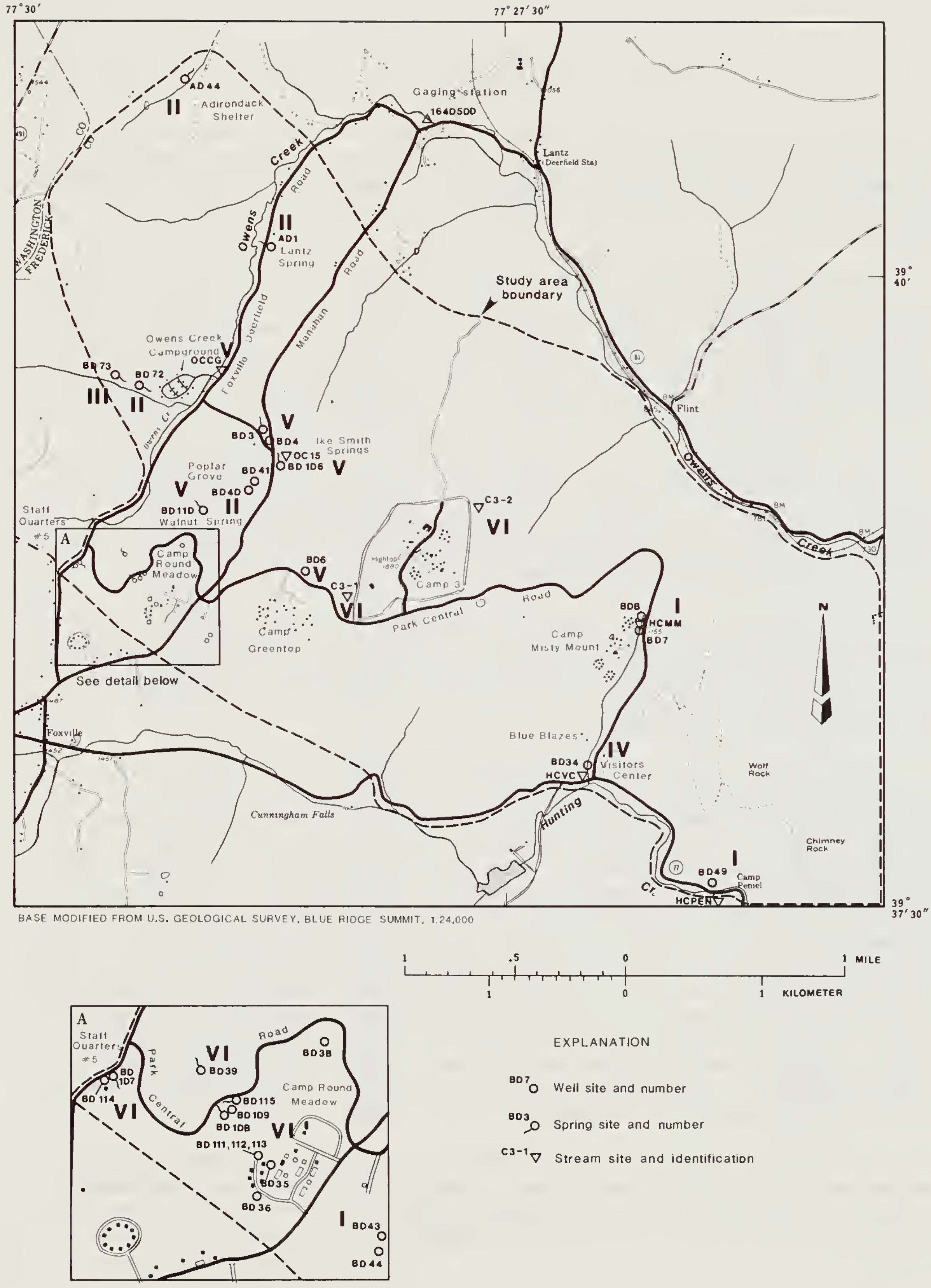

Figure 17. Generalized classification of sampling sites in terms of the six chloride and nitrate water types.

Bacteria

Fecal streptococcus (FS), fecal coliform (FC), and total coliform (TC) bacteria were used in this study as indicator organisms for fecal contamination. These bacteria reside in the intestines of warm-blooded animals. Their appearance in sampled water, therefore, suggests fecal contamination.

Employing the membrane-filter method, plate counts of FS, FC, and TC bacteria were used to compare concentration densities throughout the park (table 2). Results indicate an absence of FC in all sampled wells. Concentrations of less than five colonies per 100 millileters of sample were observed in most of the springs, with the exception of springs near Camp Round Meadow (BD 39, BD 108, and BD 115), Staff Quarters No. 5 (BD 107), and Owens Creek Campground (BD 73), where elevated concentrations occurred.

Fecal streptococcus were observed in all wells and springs sampled throughout the park. Concentrations exceeding 100 colonies per 100 milliliters of sample were observed in Camp Round Meadow wells BD 35 and BD 36, "Jim Brown" well BD 43, and springs near Camp Round Meadow (BD 108 and BD 115), and Owens Creek Campground (BD 73).

Further tests were performed to determine if the FS found in the park water was indeed FS bacteria (table 3). Results confirmed the presence of FS bacteria in springs BD 73, BD 107, BD 108, and BD 115. Apparent FS colonies found in Camp Round Meadow wells BD 35 and BD 36 were determined to be nonstreptococcus species.

The presence of FC and confirmed FS indicates that there is fecal contamination present in Owens Creek spring Bd 73, Staff Quarters No. 5 spring BD 107, and Camp Round Meadow springs BD 108 and BD 115. Owens Creek spring Bd 73 had a very low yield which made it difficult to pump without introducing mud into the sample. The addition of soil bacteria into the water sample may have altered its bacteria concentration. A cow pasture is located uphill from Staff Quarters No. 5 spring BD 107, which may influence its water quality. Camp Round Meadow springs BD 108 and BD 115 are located directly downgradient from the camp's sewage lagoon and sand filters, potential point sources of bacteria from human waste. This is supported by the presence of three seeps in the sand filter areas. The effluent from these seeps was percolating into the ground within a few feet of the seepage areas. Seepage leaching from sand filter 3 (fig. 5) was tested for fecal contamination at a point just before it percolated into the ground and its FS, FC, and TC bacteria concentrations were high.

In summary, bacteria results indicate that springs in the Camp Round Meadow area are being contaminated by septic wastes. Other more remote wells and springs derive lower concentrations of fecal bacteria from animal waste and decaying plant and animal matter.

Table 3.--Results of fecal streptococcus confirmation tests

Station	Sample No.	Date	Catalase (+/-)	Gram Stain (+/-)	Confirmation test results (+/-)	Gelatin liqui-faction (+/-)
Bd 35	L30-1-7	5/08/84	+		Non S	-
Bd 35	L39-1-8	do.	+		Non S	
Bd 35	L40-1-9	do.	+		Non S	-
Bd 35	L27-1-10	do.	+		Non S	
Bd 35	L25-1-11	do.	+		Non S	-
Bd 35	S10-1-12	do.	+		Non S	
Bd 35	S32-1-13	do.	+		Non S	-
Bd 35	S11-1-14	do.	+		Non S	
Bd 35	S34-1-15	do.	+		Non S	-
Bd 35	M36-1-16	do.	+		Non S	
Bd 35	M23-1-17	do.	+		Non S	-
Bd 35	M18-1-18	do.	+		Non S	
Bd 35	M38-1-19	do.	+		Non S	-
Bd 36	M2-1-20	do.	+		Non S	
Bd 36	S4-1-21	do.	+		Non S	-
Bd 108	2-11A142-2	5/16/84	+	+	Non S	
Bd 108	2-11-14	do.	+	+	Non S	
Bd 108	4-13-12	do.	-	+	EFS	-
Bd 108	3-12-13	do.	-	+	EFS	-
Bd 107	S3-15-3	do.	-	+	GFS	-
Bd 107	S1-14-4	do.	-	+	GFS	-
Bd 107	L4-17-5	do.	-	+	Non S	-
Bd 107	L2-16-6	do.	-	+	GFS	-
Bd 115	5-15	do.	-	+	GFS	-
Bd 115	6-16	do.	-	+	GFS	-
Bd 115	7-17	do.	-	+	EFS	-
Bd 115	8-18	do.	-	+	Non S	-
	FS Control	5/04/84	-	+	EFS	-
	FS-L Control	do.	-	+	EFS	+
	FS Control	5/08/84	-	+	EFS	-
	FS-L Control	do.	-	+	EFS	+
	FS-L Control	do.	-	+	EFS	+
	FS-L Control	do.	-	+	EFS	+
	FS Control	do.	-	+	EFS	-
	FS Control	do.	-	+	EFS	-

FS - Streptococcus faecalis
FS-L - Streptococcus faecalis liquifaciens
EFS - Excellent streptococcus faecalis
GFS - Good streptococcus faecalis
Non S - Non-streptoccus species

SUMMARY

Catoctin Mountain National Park, located in the Blue Ridge physiographic province of central Maryland, is characterized by local topographic relief of up to 1,080 ft, annual precipitation of 44 in., and well-drained, stony loam soils. The park area, which is underlain by weathered and fractured metamorphic rocks, consists mostly of forested land with several camp areas and roads. Potential sources of ground-water contamination in the park are from septic systems and road salt.

The park aquifer consists of regolith that overlies bedrock. The ground-water system is recharged by precipitation that infiltrates the soil and percolates to the water table. The water table ranges from land surface at springs and streams to about 70 ft below land surface on ridges; it usually is in the regolith except on ridges. Ground water flows in the regolith and in fractures in bedrock and discharges to nearby streams. About 57 percent of total annual precipitation leaves the park area as streamflow; about 56 percent of the annual streamflow is contributed by ground water that discharges to streams as base flow.

Pumping rates of 45 to 60 gal/min can be sustained at wells in Camp Round Meadow and Staff Quarters No. 5 for periods of several hours with drawdowns of 40 to 50 ft. The effects of pumping can be observed in wells at least as far as 400 ft from pumping wells.

Water-quality samples from wells, springs, and streams indicate that acid precipitation may be affecting the quality of ground water in the park area. Concentrations of chloride and nitrite plus nitrate, and bacterial counts indicate that wells and springs in the Camp Round Meadow and Staff Quarters No. 5 areas are being contaminated by septic waste and road salt, but to a relatively minor extent. Other, more remote wells and springs have fecal bacteria and nitrite plus nitrate concentrations that probably come from animal waste and decaying plant and animal matter. Some wells and springs away from main camp areas have chloride concentrations that indicate contamination from nearby salted roads. Finally, ground water in the Camp Misty Mount, Camp Peniel, and "Jim Brown" areas has low natural concentrations of chloride, nitrite plus nitrate, and bacteria. None of the samples exceeded U.S. Environmental Protection Agency drinking-water standards for chloride or nitrite plus nitrate (as N).

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