

WATER QUALITY SURVEY OF LECONTE CREEK
AND ROARING FORK DRAINAGE ON
MOUNT LECONTE,
GREAT SMOKY MOUNTAINS NATIONAL PARK

Report for the Superintendent
GREAT SMOKY MOUNTAIN NATIONAL PARK

U. S. Department of the Interior
National Park Service
Uplands Field Research Lab

WATER QUALITY SURVEY OF LECONTE CREEK
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INTRODUCTION

Mount LeConte in the Great Smoky Mountains National Park receives heavy visitor use each year. Many of the visitors are day hikers, but many others remain overnight near the summit of the mountain, either at LeConte Lodge or a shelter. The Rainbow Falls Trail and the Trillium Gap Trail are the principle access routes to the summit on the north face of the mountain. The former trail is the primary route used by guided horse parties and pack trains, although the Trillium Gap Trail also receives horse traffic. Both trails receive considerable foot (hiker) traffic.

LeConte Lodge is located at an elevation of 6,593 feet on the north face of Mount LeConte. The lodge complex consists of 23 buildings. Spring water is pumped to a storage tank and then gravity fed for use at the lodge. Waste water from nontilet sources at the lodge is discharged to a drainfield located northwest of the complex. Although flush toilets have been used at the lodge in the recent past, only pit toilets are used now. Surface and subsurface drainage from the lodge complex appears to flow into the Roaring Fork watershed.

The impact of visitor use on the vegetation around the lodge complex was studied by Rosemary Nichols in 1976. Some work was done on the contamination of the spring water, and Leconte Creek and Roaring Fork by fecal coliform and fecal streptococcus bacteria. Similar bacterial studies were conducted by Silsbee et al. (1976) as part

METHODS

The water quality of each stream was assessed by the following parameters: temperature, total alkalinity, pH, conductivity, turbidity, and bacteria (total coliforms, fecal coliforms, and fecal streptococcus). Each of these parameters was determined at specific sites along the streams from the headwaters (about 5,800 feet above mean sea level) to about 2,000 feet. Additional analyses were made on water samples taken from overflow out of the water storage tank, the spring, and the drainfield near LeConte Lodge (Figure 1).

Standard methods and procedures were used in each chemical and physical test. The number of bacteria were determined following the techniques outlined by the Millipore Corporation (1975). Water samples were filtered in the laboratory. Bacteria were reported as numbers per 100 milliliters of water.

Figure 1. Location of the study area in the Great Smoky Mountains National Park and locations of the samples sites (●) on LeConte Creek and Roaring Fork. The location of LeConte Lodge, the spring, drainfield, and storage tank is also shown. Elevations are given in feet.

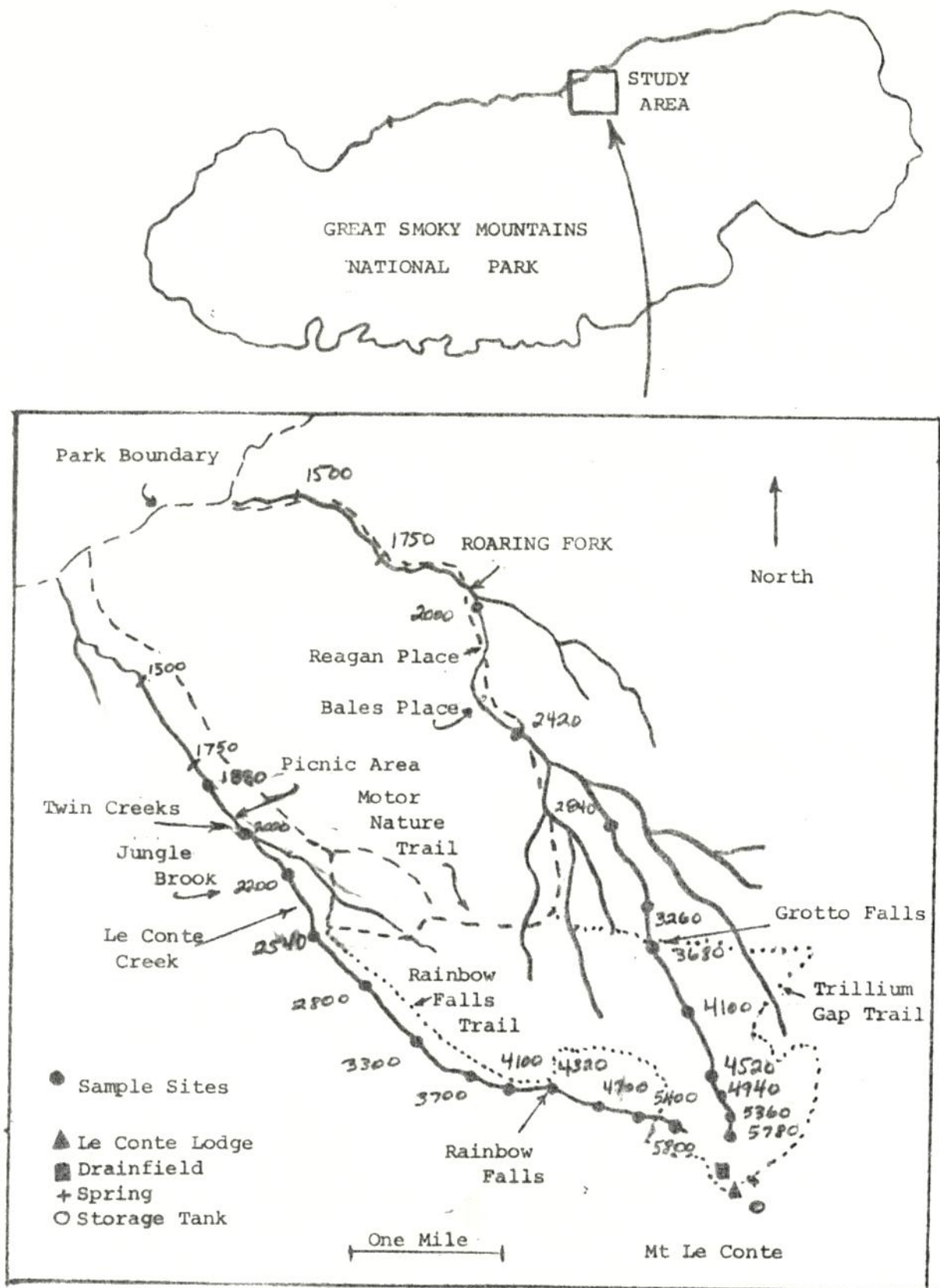


Figure 1

RESULTS AND INTERPRETATIONS

I. LeConte Creek and Roaring Fork

A. Temperature

The temperature of both streams increased with decreasing altitude (Figure 2). Temperatures of the two streams were similar at the same altitudes, ranging from about 7 to 8 C° at the headwaters and about 12 C° at the base station.

B. pH

The pH of both streams increased from about 5 at the headwaters to about 6 at the base stations (Figure 2). The relatively low pH of the headwaters probably resulted from drainage out of Anakeesta strata. The increase in pH with decreasing altitude probably reflects dilution of the main stream waters via ground and tributary waters.

C. Conductivity

The conductivity of both streams tended to decrease with decreasing altitude (Figure 2). The highest conductivities were found in the headwater areas of both streams, the maximum values being 18 and 20 μ mhos for Roaring Fork and LeConte Creek, respectively. These relatively high values were attributed to drainage from the

Figure 2. Relationship between elevation and the temperature (C), pH, conductivity ($\mu\text{hmos}/\text{cm}^3$) and turbidity (JTU) of Roaring Fork ($\square$) and LeConte Creek ($\bullet$) on Mount LeConte, October 7, 1977.

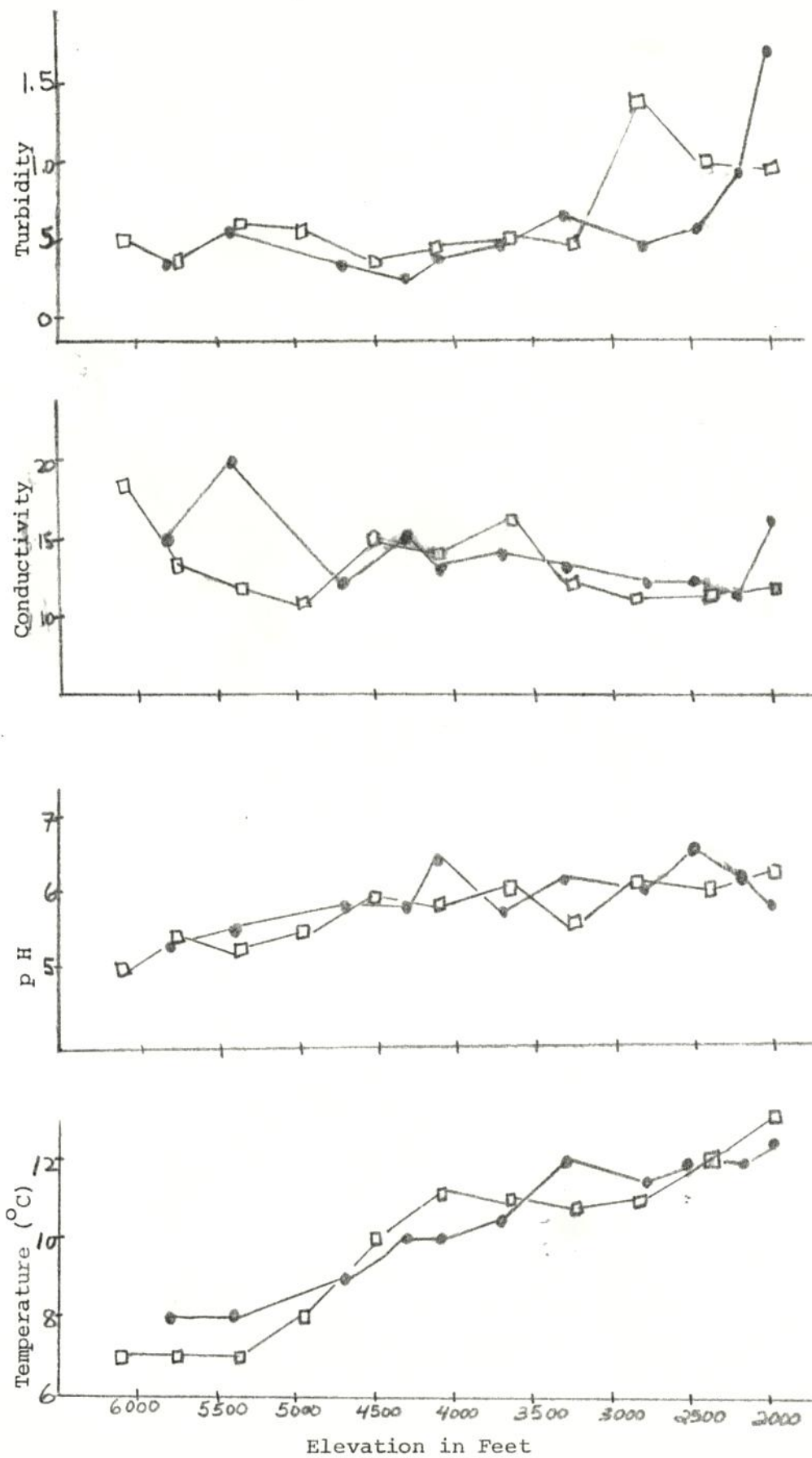
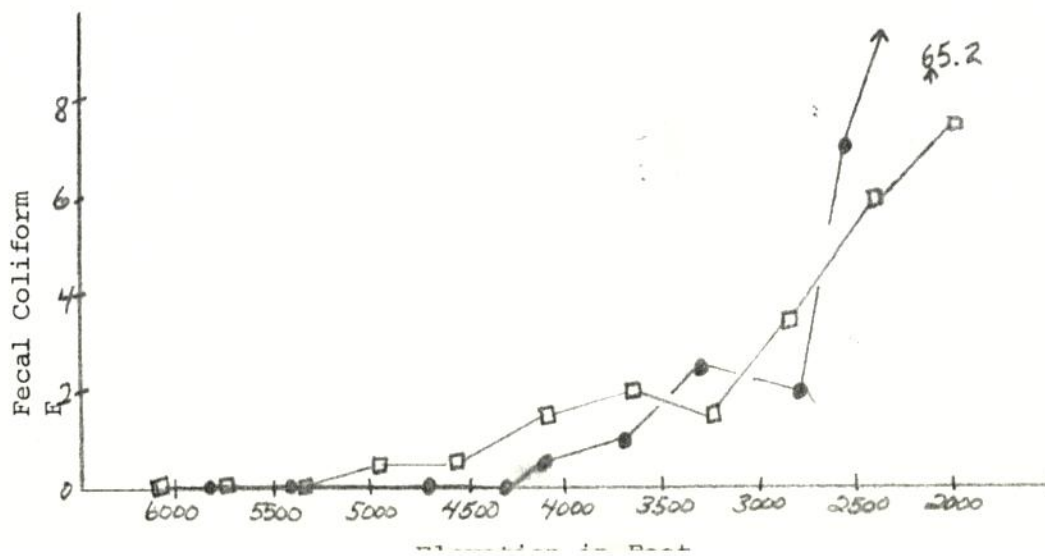
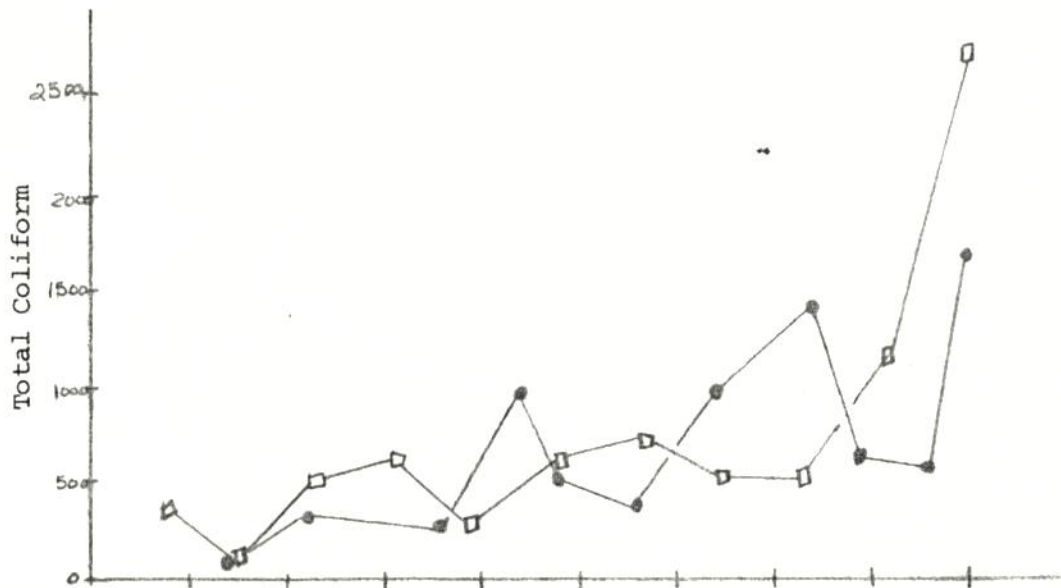
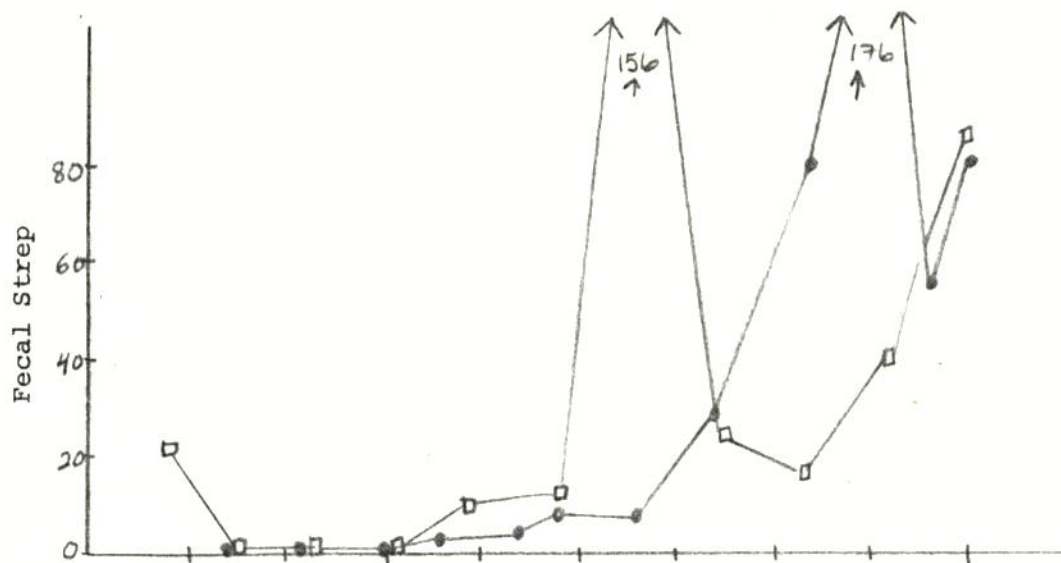


Figure 2

Figure 3. Relationships between elevation and the numbers (per 100 milliliters) of total coliforms, fecal coliforms, and fecal streptococcus bacteria in Roaring Fork ($\square$) and LeConte Creek ($\bullet$), October 7, 1977.



Anakeesta strata. At stations lower than 5,360 feet in elevation the conductivity ranged from 11 to 16 μ mhos for each stream.

D: Turbidity

The turbidity of Roaring Fork ranged from about .4 to .6 JTU from the headwaters to an elevation of 3,260 feet. (Figure 2) Samples taken adjacent to the road ranged from .9 to 1.4, however.

The turbidity of the LeConte Creek ranged from about .25 to .65 from the headwaters to an elevation of 2,540 feet. Samples taken below Jungle Brook and the picnic area were 0.9 and 1.7 JTU, respectively.

E. Total Coliform Bacteria

The numbers of total coliforms increased with decreasing altitude in each stream. (Figure 3) Except for the low elevation stations, total coliforms were less than 1,000 per 100 milliliters of water. The counts increased, however, on Roaring Fork along the Motor Nature Trail. A substantial increase in total coliforms occurred on LeConte Creek near the trailhead (2,540 feet), and below the picnic area (1,880 feet).

F. Fecal Coliform Bacteria

In Roaring Fork the numbers of fecal coliforms increased with decreasing altitude (Figure 3). The maximum numbers (4.8 and 6) occurred at the two sample stations adjacent to the Motor Nature Trail.

No fecal coliform bacteria were found in LeConte Creek from 5,780 to 4,320 feet (just below Rainbow Falls). The numbers of bacteria increased steadily with decreasing altitude below 4,100 feet, however, the largest number (65.2) occurring below the picnic area (1,880 feet).

G. Fecal Streptococcus Bacteria

In both streams the number of fecal streptococcus bacteria generally increased with decreasing altitude (Figure 3). In Roaring Fork, high values were found just below Grotto Falls and along the Motor Nature Trail. In LeConte Creek, the numbers were highest from just above the trailhead (2,540 feet) to the picnic area (1,880 feet).

II. Roaring Fork at Grotto Falls

The water quality of Roaring Fork just below Grotto Falls on October 10 and November 5 was not much different from that found on October 8 (Table 1). The fecal coliform counts ranged from <1 to

Table 1. Water quality of Roaring Fork below Grotto Falls.
Bacterial data expressed as numbers per 100 milliliters of water.

Date	Temp. (C°)	Dissolved oxygen (mg/l)	pH	Turbidity (JTU)	Total Alk. (mg/l)	Hardness (mg/l)	Conduc- tivity (µmhos)	Acidity	Total coli- forms	Fecal coli- forms	Fecal strepto- coccus
Oct. 18	10.4	12.4	6.0	0.5	--	--	16	--	725	4	160
Oct. 10	--	--	6.2	0.1	8	6	11	--	325	13	22
Nov. 5	--	--	6.2	0.6	9	8	27	5	720	.5	10
Nov. 5	--	--	5.9	0.6	10	7	22	4	920	1.5	0

13. Numbers of total coliforms and fecal streptococcus were variable, ranging from 325 to 920, and from 0 to 160, respectively.

III. Mount LeConte Lodge Drainfield

On October 7 the flow from the drainfield was low and a water sample could not be taken. Samples were taken on October 10 and 24 and November 5, however (Table 2).

The water quality in the drainfield samples was variable. The October samples were substantially higher in pH, alkalinity, hardness, conductivity, total coliforms, fecal coliforms, and fecal streptococcus than in the November samples. Although weather conditions may have contributed to the differences between the October and November samples (Appendix 1), based upon the present data it appears that a major factor influencing the differences between the October and November samples resulted from the time the samples were taken. The October samples were taken on Mondays, while the November sample was taken on a Saturday. Heavy fall weekend visitor use of the facilities at the lodge could be expected to alter the characteristics of the drainage from the drainfield, probably from increased flow. Such changes would probably not be as evident on Saturday as on Mondays.

Table 2. Water Quality of water flowing from the Mount LeConte Lodge drainfield.
Bacterial data expressed as numbers per 100 milliliters of water.

Date	Temp. (C°)	Dissolved oxygen (mg/l)	pH	Turbidity (JTU)	Total Alk. (mg/l)	Hardness (mg/l)	Conduc- tivity (umhos)	Acidity	Total coli- forms	Fecal coli- forms	Fecal strepto- coccus
Oct. 10	--	--	6.0	3.2	70	78	89	--	325	13	22
Oct. 24	--	--	6.9	0.9	92	83	72	8	372	> 500	--
Nov. 5	--	--	3.8	0.9	8	4	32	13	160	0	10
Nov. 5	--	--	4.0	0.9	8	5	33	12	130	0.5	5

IV. Spring water and storage water at LeConte Lodge

The water quality of the spring water and overflow from the storage tank were not markedly different from that for the headwaters of LeConte Creek and Roaring Fork, except that samples from both sources had higher pH values and that the overflow water was slightly warmer and turbid (Table 3). No coliform or streptococcus bacteria were found in the storage water, as expected, since it is chlorinated.

Table 3. Water quality and bacteria counts of spring water and storage water at LeConte Lodge, October 8, 1977. Bacteria counts are expressed as numbers per 100 milliliters.

<u>Sample Site</u>	<u>Temp. (C°)</u>	<u>pH</u>	<u>Conductivity (µhmos)</u>	<u>Turbidity (JTU)</u>	<u>Total coliforms</u>	<u>Fecal coliforms</u>	<u>Fecal Streptococcus</u>
Spring (below trail)	7.0	5.6	10	.4	195	0	1
Overflow from storage tank (chlorinated)	9.0	5.8	19	.7	0	0	0

DISCUSSION AND CONCLUSIONS

The evidence presented in this report suggests that the water quality of LeConte Creek and Roaring Fork was not substantially affected by drainage from the LeConte Lodge area during the sampling period. The bacterial data presented by Nichols (1977) and Silsbee et al. (1977) are in support of this conclusion (Tables 4, 5, and 6). It is possible, however, that from high visitor use under certain climatic conditions, some degradation could occur. If drainage from the drainfield enters the headwaters of Roaring Fork, for example, our evidence suggests that the impact of the drainage on the water quality of the stream would be variable in regard to chemical and bacteriological components.

The most major degradation of water quality occurs in the lower portion of each watershed. In these areas the creeks are near trails, roadways, and buildings.

Based upon the total coliform counts, the two watersheds are generally suitable for primary contact (<1,000 total coliforms per 100 milliliters) recreation activities (e.g., swimming) by humans, although some of the lower portions of each watershed did not meet this water quality standard as set by the State of Tennessee.

Table 4. Fecal coliform bacteria counts on several dates at various sample stations on Roaring Fork and LeConte Creek.
Data from Nichols (1977)

<u>Stream</u>	<u>Number of fecal coliforms per 100 milliliters</u>				
	<u>5/7</u>	<u>27/7</u>	<u>10/8</u>	<u>20/8</u>	<u>29/8</u>
Roaring Fork					
5,200 feet	0	1.5	3.5	1.5	6.0
3,680 feet (Grotto Falls)	3.6	2.3	2.8	7.5	6.0
LeConte Creek					
5,900 feet	0	0	0	0	0
4,600 feet	0	0	0	0	0
4,320 feet (Rainbow Falls)	0	1.5	2.3	3.8	2.5
2,600 feet	3.0	1.3	0.8	2.5	--

Table 5. Fecal streptococcus bacteria counts on Roaring Fork and LeConte Creek on July 5, 1976.
Data from Nichols (1977)

<u>Stream</u>	<u>Number of bacteria per 100 milliliters</u>
Roaring Fork	
5,200 feet	21.0
3,680 feet (Grotto Falls)	34.0
LeConte Creek	
5,900 feet	3.0
4,600 feet	17.5
4,320 feet (Rainbow Falls)	41.5
2,600 feet	42.5

Table 6. Average numbers of fecal coliform and fecal streptococcus bacteria in water samples taken from the spring at LeConte Lodge and from Roaring Fork and LeConte Creek by Silsbee et al. (1976)

<u>Sample Site</u>	<u>Date</u>	<u>Fecal coliform (per 100 mls.)</u>	<u>Fecal Streptococcus (per 100 mls.)</u>
Spring (Leconte Lodge)	7/5	.7	5
	7/27	0	0
	8/10	.5	--
Roaring Fork (5,200 ft.)	7/5	0	12.5
	7/27	.5	--
	8/10	3.5	--
Roaring Fork (3,680 ft.) (Below Grotto Falls)	7/5	4	34
	7/27	2.5	--
	8/10	2.5	--
LeConte Creek (5,800 ft.)	6/28	0	76.5
	7/5	0	46.5
	7/27	1.5	--
	8/10	2.5	--
LeConte Creek (4,320 ft.) (Below Rainbow Falls)	7/5	2.5	32.5
	7/27	.5	--
	8/10	0	--
LeConte Creek (2,540 ft.)	6/28	1	273
	7/5	.3	42.5
	7/27	1.5	--
	8/10	1	--

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APPENDIX

Maximum and minimum air temperatures and total rainfall each day during October and November 1-5 (1977) at Newfound Gap, Great Smoky Mountains National Park. Data were collected by members

