*NERI, BLUE, GARI

New River Gorge National River
Bluestone National Scenic River
Gauley River National Recreationa Area

National Park Service
U.S. Department of the Interior

Water Quality Monitoring Program 1998-2000
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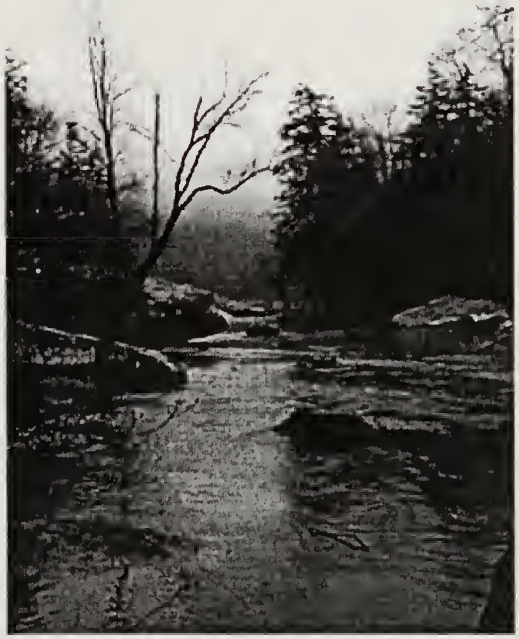

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Water Quality Monitoring Program 1998-2000
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Cover: National Park Service digital images by Kathy Oney. Upper left image is Meadow River (site G05). Upper right image is Bluestone River near Bluestone State Park (site B01). Bottom image is of National Park Service Resource Management employees Karen Vandersall (L) and Lisa Wilson (R) monitoring water quality at New River at Sandstone Falls parking lot (site N04).

United States Department of the Interior
National Park Service
Glen Jean, West Virginia

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EXECUTIVE SUMMARY

New River Gorge National River and Gauley River National Recreation Area contain some of the most popular and demanding whitewater recreation in the eastern United States. New River Gorge National River supports the most significant and highest quality warm water fishery in West Virginia. Bluestone National Scenic River remains one of the last vestiges of relatively undisturbed reaches of riverine habitat in the central Appalachians, and provides outstanding opportunities for solitude. Taken together, these three parks represent some of the most significant water resources in the National Park System.

Situated in the Kanawha-New River basin of the Ohio River drainage, areas in and around the three parks have experienced extensive resource extraction activities. Mining of low-sulfur coal and timbering removed vegetation and led to increased erosion and sedimentation. Development of automobile and rail transportation networks, and communities to handle the influx of people, inflicted further impacts upon the land, and upon the streams draining the land.

As coal and timber were depleted, many people lost their jobs and moved away. Decreased resource extraction allowed re-establishment of natural communities and ecosystems. Lush mixed mesophytic forests now cover most of the three parks. Commercial whitewater rafting, rock climbing, angling, and other outdoor activities now draw hundreds of thousands of visitors to the New River area.

Appalachia has a long history of impoverishment. Today this is reflected in infrastructure that is often less than adequate. Sewage treatment is woefully inadequate in many areas, including the New River watershed in the vicinity of the three parks. In areas with inadequate sewage treatment, untreated or partially treated household sewage commonly ends up in local streams and rivers.

The National Park Service regularly monitors fecal coliform bacteria, an indicator of human domestic waste pollution, in and around the three parks to assess the potential health risk to people engaged in water-based recreational activities. This report presents water quality data collected from 1998 through 2000. Some new sampling sites that were added to the monitoring program during this period, and limited older data from these sites are also presented. Besides the fecal coliform bacteria, this report also contains information on basic field parameters (turbidity, (temperature, dissolved oxygen, conductivity, and pH).

This report provide a general overview of water quality conditions and trends over the monitoring period. These data, when combined with data from previous years, provide a broad basis for evaluating status and trends of water quality in the three parks, and permits National Park Service decision-makers to more accurately assess activities that may impact, or be impacted by, water resources.

ACKNOWLEDGEMENTS

Our thanks is extended to the following people and agencies for their assistance with this study: United States Army Corps of Engineers, Bluestone Dam, Hinton, West Virginia and Summersville Dam, Summersville, West Virginia; United States Geological Survey, Water Resources Division, West Virginia District; West Virginia Department of Natural Resources, Bluestone State Park and Pipestem State Park; West Virginia Department of Environmental Protection Inspectors Larry Robertson and Ron Garrett; National Weather Service, Beckley and Charleston, West Virginia; the family of Charles Page Kuntz; former plant operators Kim Deane and Jack Pennington of the Mount Hope Waste Water Treatment Plant; and the following current plant operators Mike Giannini of the Oak Hill Sewage Treatment Plant; Randy Atwell of the Fayetteville Sewage Treatment Plant; Robert Zimmerman of the Arbuckle Public Service District; and Frank Morris of the White Oak Public Service District.

Completion of this report benefited from the contributions of specialists at New River Gorge National River. Geographic Information System Technician Andy Steel developed the site maps. Computer Specialist Greg Phillips provided expert technical assistance. Our thanks to both of you. Field and laboratory assistance was provided by Kathy Oney, Sara Pyles, Monique Keeney, Jeremy Bandy, James Blankenship, Danny Fraley, Jennifer Dunford and Karen Vandersall. Karen Vandersall reviewed the final draft of the report.

Additional thanks are extended to staff from other Divisions at New River Gorge National River and other individuals whom we may have neglected to mention.

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Map of the New River watershed, showing the locations of Bluestone National Scenic River, New River Gorge National River, and Gauley River National Recreation Area.

INTRODUCTION

PARK ESTABLISHMENT

New River Gorge National River (NERI) was established by Public Law (PL) 95-625 on November 10, 1978. The park was created to conserve and interpret outstanding natural values and objects, and to preserve an important segment of the New River as a free-flowing stream for the benefit and enjoyment of present and future generations.

Gauley River National Recreation Area (GARI) was established on October 26, 1988 by PL 100-534. The park was created to protect and preserve scenic, recreational, geological, and fish and wildlife resources of the Gauley River and its tributary, the Meadow River.

The legislation that established GARI also made boundary adjustments to NERI, and amended the Wild and Scenic Rivers Act (16 USC 1274(a)), to designate Bluestone National Scenic River (BLUE). This designation was made to protect and enhance the natural, scenic, cultural and recreational values of a free-flowing segment of the Bluestone River for the benefit and enjoyment of present and future generations.

MONITORING HISTORY

In 1980 the National Park Service initiated a monitoring program to provide baseline information on water quality in New River Gorge National River. This information would be used to evaluate existing water quality, analyze water quality trends, and provide information useful in evaluating the impacts of various activities on water quality. The National Park Service entered into a cooperative agreement with the West Virginia Department of Natural Resources (WVDNR) to collect the information. Parameters to be monitored were those commonly associated with commercial and domestic pollution.

Samples collected between 1980 and 1984 frequently had high densities of fecal coliform bacteria (Wood 1990a,c). This led to the determination that sewage or animal wastes were a major cause of water pollution within the park. Fecal coliform bacteria live in the lower gut of warm-blooded animals (mammals and birds), and are excreted with the feces. Fecal coliform bacteria are not necessarily pathogenic (disease-causing). However, many other pathogenic microorganisms (including bacteria, protozoa, and viruses) also live in the lower gut and are excreted with the feces. Fecal coliform bacteria, being relatively easy to detect, serve as an indicator of fecal pollution, and are the basis of relevant West Virginia water quality standards. The State of West Virginia standard for waters suitable for primary contact recreation (West Virginia Water Resources Board 1998) is that the density of fecal coliform bacteria not exceed a density of 200 per 100 milliliters (200 FC/100ml) of water. This standard is based on the geometric mean of at least five samples per month. Alternately, waters should not exceed 400 FC/100ml in more than 10% of samples taken during a month. Fecal coliform bacteria can be influenced by temperature, environmental conditions and water type (Pipes 1982).

In 1985 the National Park Service monitored fecal coliform bacteria using Millipore Corporation's Colicount samplers. This method was quick and inexpensive, but not approved by the U. S. Environmental Protection Agency (EPA). In 1986 the National Park Service contracted with the U. S. Department of Agriculture (USDA) Appalachian Soil and Water Research Station in Beckley, West Virginia to analyze fecal coliform bacteria in their laboratory using the EPA-approved membrane filter (MF) technique (SM909C; American Public Health Association 1985, 1992). This effort produced mixed results (mentioned by Schmidt and Hebner 1991; no report prepared; data on file at New River Gorge National River). For 1987-1988, fecal coliform bacteria were monitored by the MF technique under another cooperative agreement with WVDNR. Evaluation of these results (West Virginia Department of Natural Resources 1988, 1989) led to the decision that a less intensive, more extensive, monitoring effort would be more appropriate for New River Gorge National River. In 1989 the National Park Service instructed WVDNR to reduce the number of samples collected per site per month from five to one, while adding additional sites (Wood 1990b).

In 1990, with assistance from the USDA lab, the National Park Service resumed responsibility for bacterial monitoring. In 1991 a newly equipped Water Resources Laboratory was completed at the National Park Service headquarters, and park staff assumed full responsibility for water quality monitoring. Also in 1991, monitoring efforts were extended to GARI and BLUE. Since 1991, the National Park Service has continued the water quality monitoring program for all three parks. The primary focus of this effort remains fecal coliform bacteria. Several reports have summarized the monitoring effort between 1991 and 1997 (Schmidt and Hebner 1991, Hebner 1991a,b, Sullivan 1993a,b,c, Gibson 1993, Purvis and Wilson 1999, Wilson and Purvis 2000).

THE 1998-2000 EFFORT

This report presents water quality data collected by the National Park Service at the three parks between 1998 and 2000 (Appendices 1-3). Results of limited sampling conducted at some sites before 1998 that were not presented in earlier reports is also included. Samples were collected at 34 sites, 24 associated with NERI, and five each associated with GARI and BLUE. Samples were analyzed for basic field parameters (temperature, conductivity, turbidity, dissolved oxygen, and pH), and fecal coliform bacteria. Interpretation of the results focuses on fecal coliform bacteria, and their relationship with factors (turbidity, discharge, recent precipitation, land use, and sewage treatment patterns) shown to be related to changes in the density of fecal coliform bacteria.

METHODS

STUDY AREA

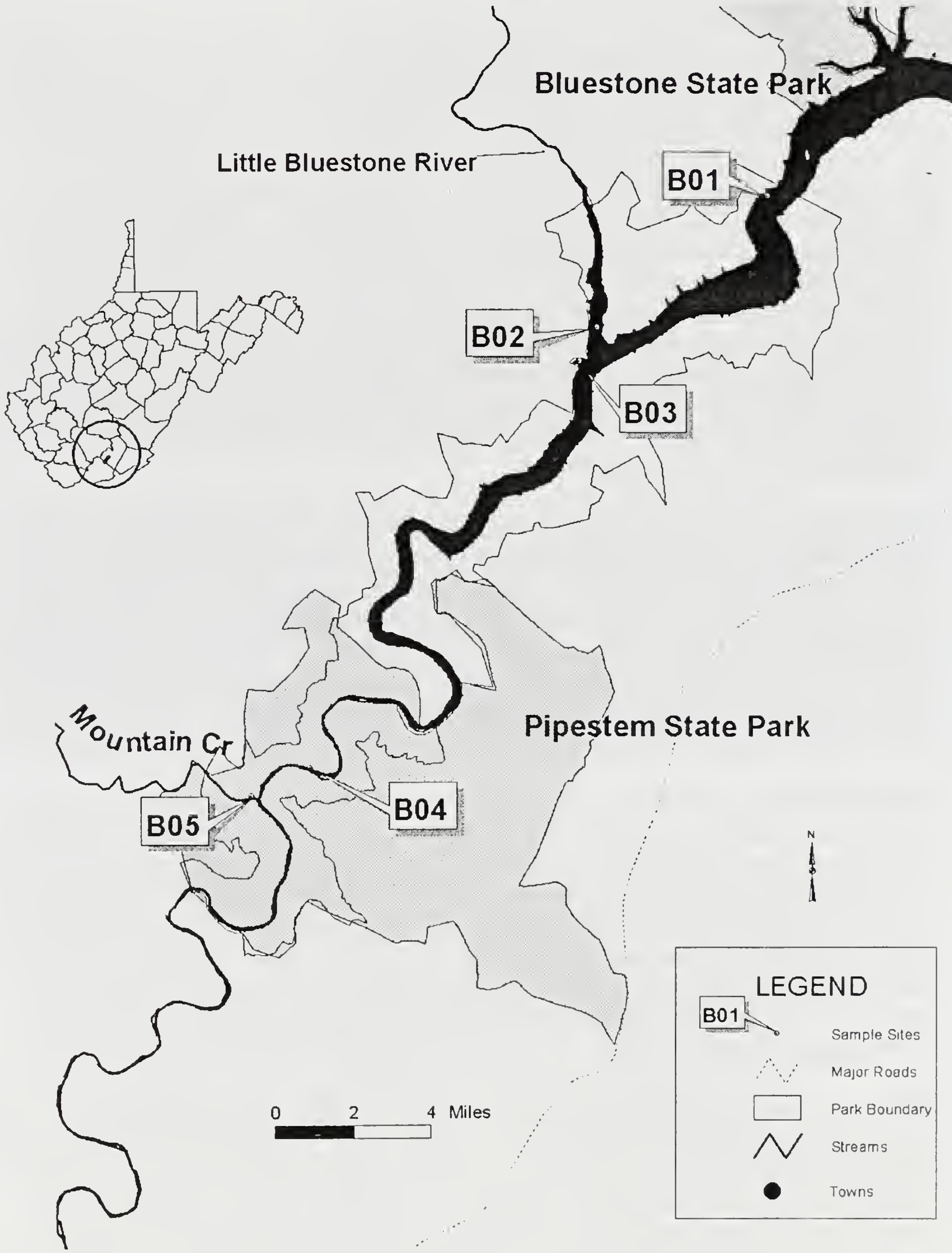
All three parks lie within the Kanawha-New River watershed. The New River begins in the Blue Ridge Mountains near Blowing Rock, North Carolina. The river flows mostly northward 250 miles, through Virginia and West Virginia. The two major tributaries to the New River, the Bluestone River and the Greenbrier River, both enter within a few miles of each other near Hinton, West Virginia. The Bluestone River enters the New River in Bluestone Lake from river left about 3 miles upstream of Bluestone Dam, and about 4 miles upstream of the confluence of the Greenbrier River. The New River then flows north and northwest to its confluence with the Gauley River at Gauley Bridge, West Virginia. Confluence of the New and Gauley Rivers forms the Kanawha River. The Kanawha River flows northwest 97 miles to its mouth on the Ohio River, a tributary of the Mississippi River, at Point Pleasant, West Virginia. The New River watershed includes 5,274 square miles: 756 square miles in North Carolina, 3,044 square miles in Virginia, and 1,474 square miles in West Virginia. The entire Kanawha-New River watershed includes 12,233 square miles.

The Bluestone River originates on the north slope of East River Mountain in Tazewell County, Virginia. It flows northeasterly for 77 miles to its confluence with the New River. The lower 60 miles of Bluestone River are in West Virginia. The western side of the main channel valley has broad, gently sloping ridges, while nearly continuous ridges parallel the eastern side. Therefore, most Bluestone River tributaries enter on the western side of the 461.7 square mile watershed (West Virginia Department of Natural Resources 1983). The Bluestone River is unimpounded, with natural seasonal flows. High flows generally occur from late winter to early spring as a result of snowmelt and precipitation.

Bluestone National Scenic River (Fig. 1) is located between Pipestem State Park on the upstream end and Bluestone State Park on the downstream end, and includes 10.5 miles of the lower Bluestone River. Also, Bluestone National Scenic River is included within the boundary of the WVDNR-managed Bluestone Wildlife Management Area (West Virginia Department of Natural Resources 1983). The Bluestone River within Bluestone National Scenic River sustains a high quality warmwater fishery. Visitors come to the area for the many opportunities to fish, hike, and bike along a river in a natural setting relatively undisturbed by modern influences. Due to the shallowness of the Bluestone River, opportunities for boating in the park are usually limited to high water periods.

Water quality of the lower Bluestone River in terms of fecal coliform bacteria is generally satisfactory for water contact recreation. Domestic, municipal, agricultural, and industrial (including mining) pollution is contributed from developed areas in the upper watershed, above the Scenic River boundary. The minimal impacts observed on the lower Bluestone River may be due to discharge volume and travel time. The former factor may act to dilute pollution, and the latter may permit contaminants to settle out of the water column or become assimilated to acceptable levels.

Figure 1. Bluestone National Scenic River Water Quality Sample Sites



The New River within New River Gorge National River (Fig. 2) is preserved as a free-flowing stream. However, flow is regulated by Bluestone Dam, operated by the U. S. Army Corps of Engineers (COE) for flood control, recreation and low flow enhancement. Although Bluestone Dam is managed on a "run-of-the river" basis with minimal retention time, operation of this facility has lowered the magnitude and reduced the frequency of extreme high flows (Flug 1987). Therefore the New River experiences a seasonal flow pattern. Higher flows generally occur during late winter and early spring, and lower flows occurring through the summer (National Park Service 1996). The New River is also regulated by Claytor Dam in Virginia, operated for power generation on a peaking basis. The distance between Claytor Dam and Bluestone Lake, and operation of Bluestone Dam effectively eliminate peak flows generated by Claytor Dam in the New River within New River Gorge National River.

The 53 miles of the New River within New River Gorge National River begin just below Bluestone Dam, and extend downstream to just north of the U. S. Highway 19 bridge near Fayetteville. Between Bluestone Dam and the downstream end of the park near Fayette Station, 102 streams are tributary to the New River (based on blue-lines from U. S. Geological Survey 1:24000 topographic maps).

The most prominent feature of the New River watershed is New River Gorge. The gorge begins at Sandstone Falls below Hinton, and extends downstream to near the river's confluence with the Gauley River. In many places the gorge walls rise 1,000 feet above the river. The river channel prior to entering the gorge is about 1,000 feet wide and relatively shallow, with a gentle gradient. In the gorge the channel becomes narrower (200-500 ft), deeper, and steeper. These factors contribute to the world class whitewater rafting which draws a quarter million visitors to New River Gorge each year.

Water quality of the New River in terms of fecal coliform bacteria is generally satisfactory for water contact recreation such as swimming, boating, and fishing. Some tributaries are impaired by raw or inadequately treated domestic sewage. For some of these tributaries the problem is chronic, while for others it is more episodic, with the biggest pollution problems occurring during runoff events. Many of these impaired tributaries enter the New River near popular access sites for recreational activities such as whitewater boating and angling. At the mouths of these polluted tributaries, and for some distance downstream, sewage pollution can be a problem in the New River. Some streams are also affected by organic industrial contaminants and acid mine drainage. Unlike other Appalachian areas, coal in the vicinity of New River Gorge National River is generally low in sulfur, and does not lead to much acid mine drainage. Further, some of the extensive limestone areas traversed by the New River and its tributaries help reduce potential acid mine drainage problems, and contribute to a well-buffered, biologically productive ecosystem that supports a high-quality warmwater fishery (West Virginia Department of Natural Resources 1989).

The 107-mile long Gauley River begins in Pocahontas County, West Virginia. The Gauley flows southwest, turning more westerly following inflow of the Meadow River

Figure 2. New River Gorge National River Water Quality Sample Sites

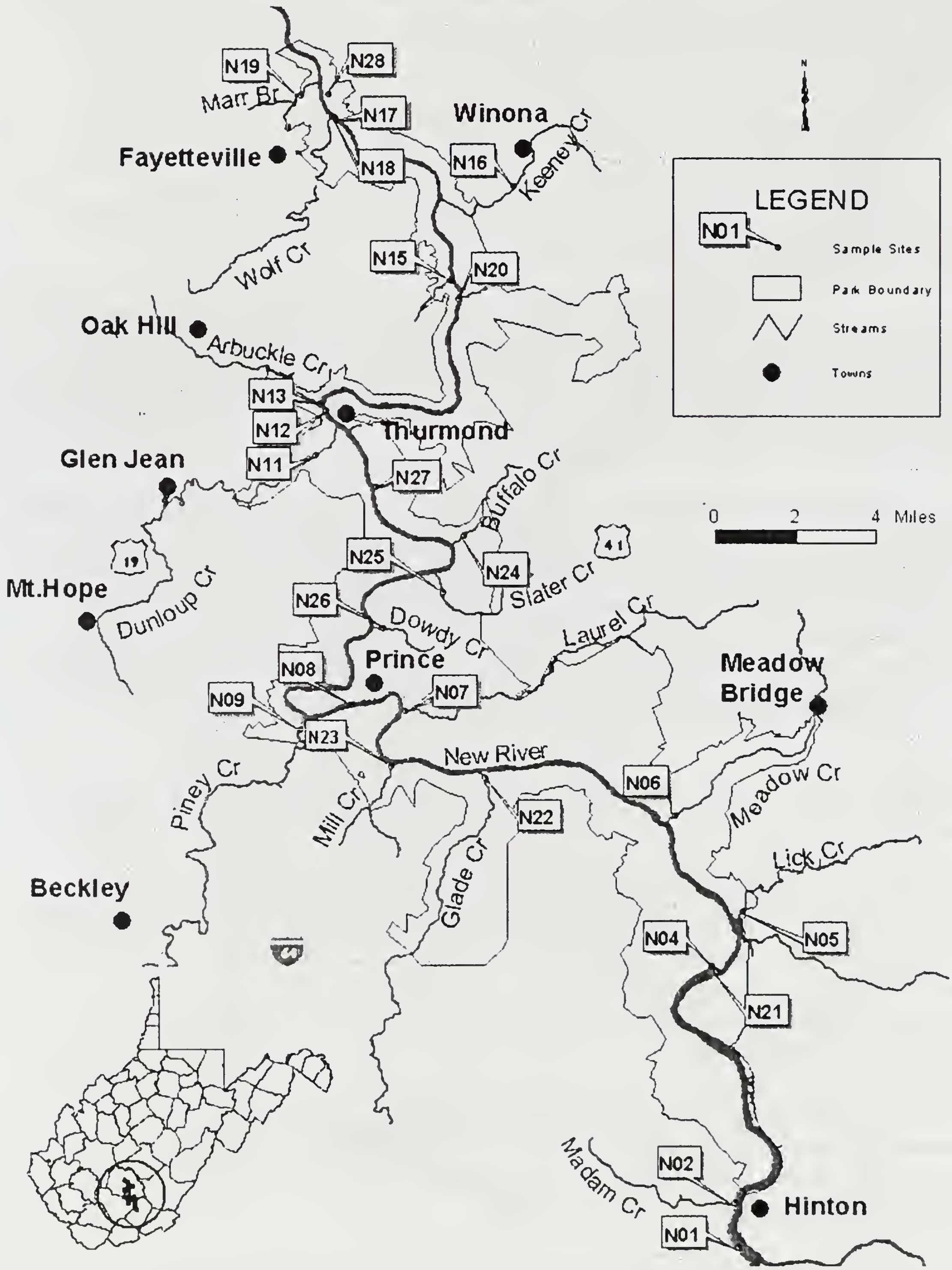
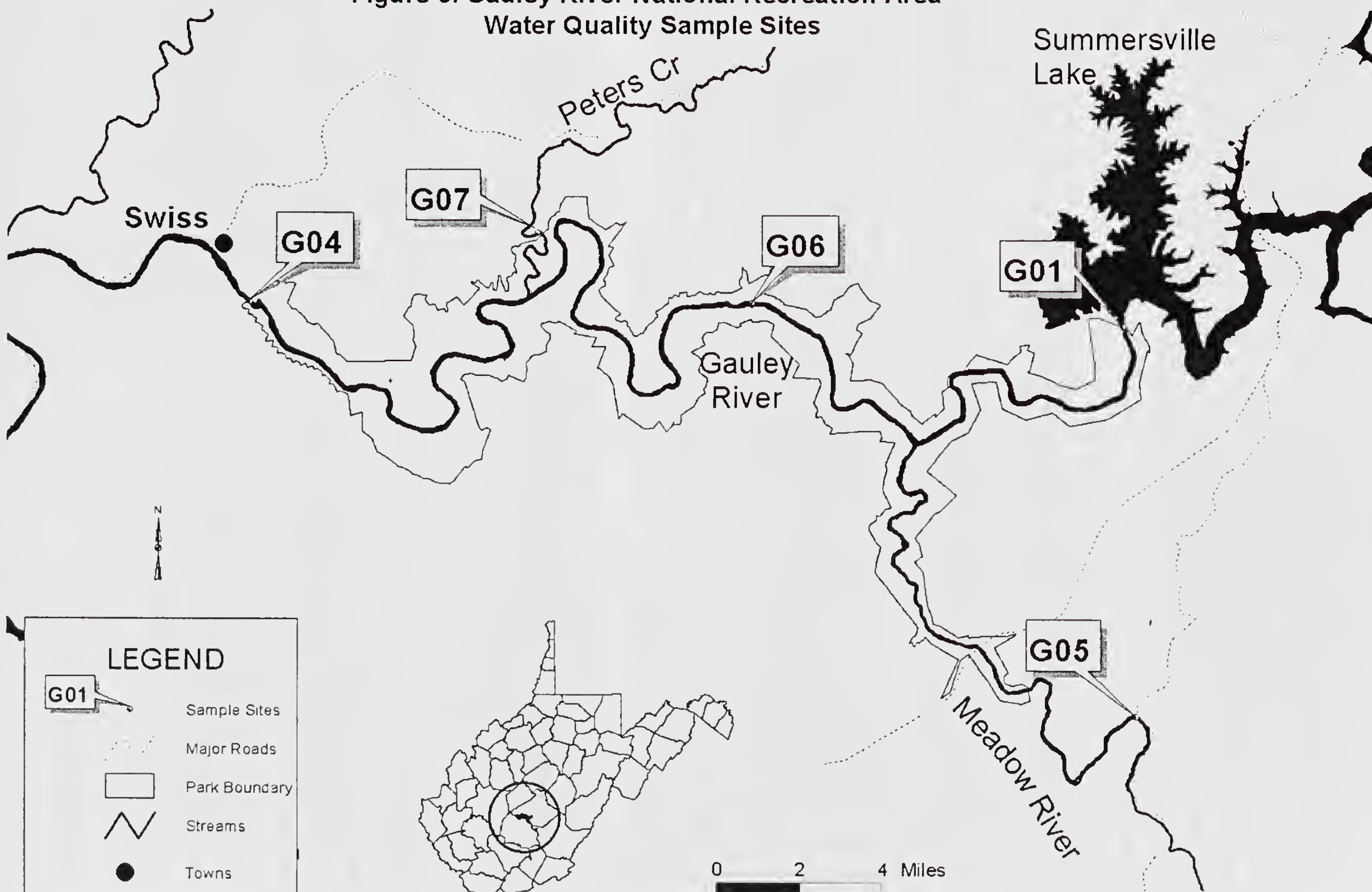


Figure 3. Gauley River National Recreation Area
Water Quality Sample Sites



near Carnifax Ferry. The Gauley then continues west to its confluence with New River. The Gauley River watershed includes 1,422 square miles.

Within Gauley River National Recreation Area (Fig. 3) are 25 miles of the Gauley River and the lower 5.5 miles of the Meadow River. The Gauley River portion extends downstream from just below Summersville Dam to near the community of Swiss. Summersville Dam regulates the flow of Gauley River within Gauley River National Recreation Area. Part of the Water Resources Development Act of 1986 requires the COE to release water from Summersville Dam for recreational activities in the Gauley River below the dam (National Park Service 1993). This occurs during a six-week period in autumn, and creates the famous "Gauley Season" avidly anticipated among whitewater enthusiasts. The Gauley River is noted for outstanding whitewater, and is one of the most technically demanding and commercially popular whitewater rivers in the nation.

The Meadow River is the largest tributary to the Gauley River within Gauley River National Recreation Area. Meadow River flows approximately 50 miles from its origin on Keeney Knob in eastern Summers County to its confluence with the Gauley River. Total drainage area is very close to the 365 square miles within the watershed above the USGS gage Meadow River near Mount Lookout, WV (03190400, hereafter in this report the Meadow River gage) that is about 1,000 feet upstream of the mouth of the river (Ward *et al.* 2000). Major industries in the watershed include coal mining, timbering and agriculture (West Virginia Department of Natural Resources 1984). Above Gauley River National Recreation Area, Meadow River is a slow, meandering stream with abundant wetlands. Within the park, Meadow River has a steep gradient, averaging 88 feet per mile, making it very popular with the most expert kayakers.

The Gauley and Meadow Rivers both provide excellent angling opportunities. A quality warmwater fishery exists in the lower reaches of the Gauley River. Coldwater releases support a fishery for stocked trout in the tailwaters below Summersville Dam (National Park Service 1993).

Water quality in the Gauley and Meadow Rivers in terms of fecal coliform bacteria is generally satisfactory for water contact recreation (West Virginia Department of Natural Resources 1984, Hebner 1991a, Sullivan 1993a,c, Wilson and Purvis 2000). However, inadequate disposal of human and/or animal waste was identified as a major problem in the watershed (West Virginia Department of Natural Resources 1984), and this problem is ongoing. Further, an increasing intensity of land disturbing activities (timbering, mining, gas exploration and agricultural activities) within the Gauley River watershed have led to increased erosion and sedimentation. Mining activities and sewage contamination have impacted Peters Creek, a tributary to the Gauley River within the park.

SAMPLING SITES

Of the five sites within Bluestone National Scenic River, three were on the Bluestone River and two were on tributaries. Of the 24 sites within New River Gorge National

River, seven were on the New River, two were at springs, and 15 were on tributaries. Of the five sites within Gauley River National Recreation Area, three were on Gauley River and two were on tributaries. All sites remained at the same location throughout the study period. Most sites are within park boundaries, but a few are located just outside. Site B01 (Bluestone River at Bluestone State Park) is located downstream of the BLUE boundary. Sites N01 (New River at Hinton Visitor Center), N02 (Madam Creek in Hinton), and N16 (Keeney Creek in Winona) are located just upstream of the NERI boundary. Site G05 (Meadow River) is located upstream of the GARI boundary.

SAMPLING SCHEDULE

Sampling sites within New River Gorge National River were divided into two districts, north and south. Within each district, sites were further divided into two runs, long and short. Thus four runs were required to sample all NERI sites. Sites for GARI and BLUE were each considered their own district (run). Sampling was generally scheduled on a rotational basis.

Sampling usually occurred between April and September for NERI and BLUE, and continued into October for GARI. This schedule coincided with the period of greatest human recreation on the rivers, and thus greatest potential for pathogen exposure for river users.

SAMPLING PARAMETERS

General

Parameters recorded at each collection site included date, time, precipitation within the previous 48 hours, weather, cloud cover, water clarity, stage level, air and water and temperatures, pH, dissolved oxygen, and conductivity. Weather, cloud cover, water clarity, current velocity, and stage (discharge) level were subjective appraisals of the sample collector based on knowledge of long term conditions at each site. Codes for these observations are provided in Appendix 4.

For some sites, stage level and discharge were also based on gage measurements (Ward *et al.* 2000). Discharge values for mainstem Bluestone River sites were provided by the U. S. Geological Survey (USGS) gaging station Bluestone River near Pipestem (03179000, referred to hereafter in this report as "Pipestem gage"). This gage includes a watershed of 395 square miles (Mathes *et al.* 1982). Stage and discharge for New River sites in the NERI south district (except for site N08; New River at Prince) were based on information from COE on Bluestone Dam releases, and from the USGS New River at Hinton gage (03184500, referred to hereafter in this report as "Hinton gage"). This gage, serving a drainage area of 6,256 square miles, is on river right 0.2 miles upstream from Madam Creek and 1.5 miles downstream from the confluence of the Greenbrier River. Stage and discharge for New River sites in the NERI north district (and for site N08; New River at Prince) were based on information provided by the USGS New River at Thurmond gage (03185400, referred to hereafter in this report as "Thurmond gage"). This gage, serving a drainage area of 6,687 square miles, is on river right 0.1 miles upstream from Dunloup Creek. Stage and discharge information for Gauley River sites was based on information provided by COE on releases from Summersville Dam, and from the USGS Gauley River below Summersville Dam gage (03189600, referred to hereafter in this report as "Summersville Dam gage"). Stage and discharge information for the Meadow River was based on information provided by the USGS Meadow River near Mount Lookout gage (03190400, referred to hereafter in this report as "Meadow River gage"). Sources of river level information for the three parks are provided in Appendix 5.

In addition to the continuous recording gages noted above, the USGS also maintains several stage-height staff gages on tributary streams in New River Gorge National River. Occasional stream discharge measurements are made in these streams to relate stage height to discharge, and this information is used to develop rating curves. Staff gages are present at Lick Creek, Meadow Creek, Laurel Creek, Piney Creek, Dunloup Creek, Arbuckle Creek, Wolf Creek and Marr Branch.

Precipitation in the 48 hours prior to 0800 on the sampling date ("48-hour precipitation") was determined from the closest rain gage. For NERI sites from Glade Creek north, this gage is located at the National Park Service headquarters in Glen Jean. For BLUE sites and NERI sites from Meadow Creek south this gage is maintained by COE at Bluestone Dam. For GARI sites this gage is maintained by COE at Summersville Dam. The two COE gages were read every day. The Glen Jean gage was not read on weekends or federal holidays. This led to recording of some "48-hour" precipitation amounts that actually occurred over 72-120 hours. These are mentioned in the "Comments" column of the Appendices, and noted in the text where these dates are discussed.

Dissolved oxygen (DO) was determined with a YSI model 51B dissolved oxygen meter. Water temperature and field conductivity were determined with a YSI model 33 S-C-T meter. Air temperature was measured with an alcohol thermometer. A Fisher Accumet portable temperature compensating pH meter provided pH data. A Hach model 16800 Portalab Turbidmeter was used to measure turbidity for dates before 9 September 1998, after which this meter was replaced with a Hach model 2100P. The DO and pH meters were calibrated according to their respective operating manuals on each day of sample collection. The turbidity meter was calibrated quarterly.

Fecal Coliform Bacteria

Sampling and analysis for fecal coliform bacteria followed standard methods (American Public Health Association 1992). All procedures followed sterile techniques.

Samples were collected below the surface in pre-washed and sterilized 250ml and 500ml Nalgene screw-cap bottles. A small amount of air space was left in the bottles. Sodium thiosulfate was added to sample bottles before sterilization to remove chlorine from sample water. Most samples were collected from shore. Site N08 (New River at Prince) was sampled by lowering a stainless steel bucket from the West Virginia Route 41 bridge. The bucket was rinsed with river water before actual sample collection. After sample collection, bottles were placed on ice for transport to the laboratory.

Samples were analyzed for fecal coliform bacteria using the membrane filter technique within six hours of sample collection. Following laboratory determination of turbidity, all or part of the sample was filtered. Volume filtered depended upon expected bacterial densities for each sample. This determination was based on our experience with fecal coliform-turbidity relationships at each of the sites, or from similar sites. Ideally the volume chosen would provide between 20 and 60 fecal coliform colonies on the filter. To help assure that the ideal range of colonies was counted, two different volumes were filtered for each sample. Filtered volumes less than 20ml had approximately 10ml of sterile dilution water added to allow uniform dispersion of bacteria over the filter surface.

Samples were filtered under partial vacuum through sterile 47mm Millipore nitrocellulose, white grid membrane filters with a 0.45-micrometer pore size. After filtration, filters were placed into culture dishes containing absorbent pads saturated with m-FC media containing rosalic acid.

Sample blanks consisting of filtered sterile dilution water were used to check the effectiveness of sterilization. Two blanks were prepared before ("pres"), and two after ("posts"), each day's set of samples were processed. Once all filtrations were completed, culture dishes containing filtered samples were inverted and placed into plastic pouches and heat-sealed. Sealed pouches were placed in a 44.5 +/- 0.2 ˚C water bath incubator for 22 to 24 hours.

Following incubation, fecal coliform colonies were counted under 15X magnification, and the counts converted to densities (U. S. Environmental Protection Agency 1978). When one or both filters contained between 20 and 60 colonies, fecal coliform density was recorded (App. 1-3) as an exact number. If both filters contained colonies outside the 20-60 range, density was reported as an estimate.

When fecal coliform colonies on both filters exhibited confluent growth with coliforms (CGWC), were indistinct, or when counts exceeded 200, results were listed as "too numerous to count" (TNTC). In such cases, fecal coliform density was estimated as if the filter with the weaker dilution contained 60 colonies. Results were then recorded as "greater than" (>) the value obtained. For graphical purposes in this report, these values were rounded up to the next whole number (e.g. a value reported as >2,000 FC/100ml is presented as 2,001 FC/100ml).

A similar procedure was followed if neither filter contained colonies. In these cases, density was estimated as if the filter with the stronger dilution contained one colony. Results were then recorded as "less than" (<) the value obtained. For graphical purposes, some of these values are presented as 0 FC/100ml.

RESULTS AND DISCUSSION

Data interpretation focuses primarily on values that exceeded the West Virginia Water Resources Board standard for primary contact recreation. That standard is 200 fecal coliform bacteria per 100 milliliters of sample water (200 FC/100 ml). Unless noted, references in this section to a "standard" refer to this standard. This standard is based on the geometric mean of 5 samples per month for a given site. Since we usually collected no more than two samples per site per month, the standard cannot be legally applied (e.g. for the purposes of determining violations) to these results. Results that exceeded the standard can only be considered indicative of waters that **may** violate the state standard.

Values for other factors frequently associated with high fecal coliform densities are also noted. These include stream discharge, 48-hour precipitation (precipitation in the 48 hours preceding 8:00 A.M. on the date the sample was collected), and turbidity. High discharge, particularly during the rising limb of a hydrograph, has been correlated with high fecal bacteria counts in a number of studies (Morrison and Fair 1966, Purvis and Wilson 1999). Two factors are probably responsible for this increase. Increased runoff from rainfall washes bacteria into streams, and high discharge may cause bypasses or overflows at sewage treatment plants (STPs). This is especially true if the STPs are at or near capacity. Leaking STP collection systems are usually considered to have infiltration and inflow (I&I) problems. These problems exacerbate hydraulic overloads of STPs. Increased discharge, particularly in smaller streams, is usually related to recent storm events. Turbidity, a measure of the amount of particles suspended in water, may serve as a rough estimator of certain types of pollution, including bacterial. We use turbidity, along with our monitoring history, to determine the proportion of a sample to analyze.

Discussion of the data is arranged in a downstream order. Therefore Bluestone National Scenic River is presented first, followed by New River Gorge National River, and then Gauley River National Recreation Area. Within the discussion for each park, mainstem sites are discussed first (also in downstream order) followed by tributary streams. The terms "river (or stream) right or left" refer to the view of a person facing downstream.

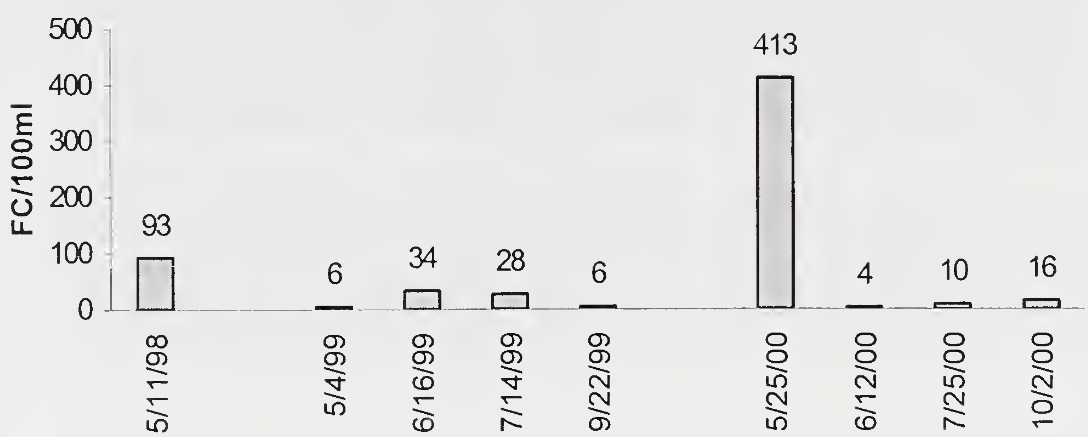
B04, Bluestone River at Pipestem

The sampling site is on river left, upstream of Mountain Creek Lodge at Pipestem State Park. The site is about 0.5 miles upstream of the Pipestem gage. Mountain Creek (0.7 miles) and an intermittent stream (0.4 miles) enter the Bluestone River upstream from the site.

Vehicle access is limited to authorized persons using a gated service road. Most visitors reach the area by the Pipestem State Park tramway. Some visitors hike in along the Bluestone Turnpike Trail (also called the River Trail), mostly from downstream. Typical visitors include lodge visitors, hikers, picnickers, and anglers.

One of the nine samples collected between 1998 and 2000 exceeded the state standard (Fig. 4). Parameter values ranged as follows (App. 1): bacteria density 4 - 413 FC/100 ml (mean 68, median 16), turbidity 0.63 - 14.20 NTU (mean 4.25, median 1.85), 48-hour precipitation 0.00 - 0.96 in (mean 0.22, median 0.11), discharge 19 - 813 cfs (mean 214, median 65).

Figure 4. Bluestone River at Pipestem



The highest bacteria density (413 FC/100 ml on 5/25/00) coincided with the highest turbidity (14.2 NTU), but 48-hour precipitation (0.28 in) and discharge (122 cfs) were moderate. The highest discharge (813 cfs on 5/11/98) coincided with the second highest bacteria density (93 FC/100 ml) and turbidity (9.0 NTU), while 48-hour precipitation was moderate (0.22 in). The second highest discharge (500 cfs on 5/4/99) coincided with low bacteria density (6 FC/100 ml), no precipitation (0.00 in) and moderate turbidity (5.29 NTU). The greatest 48-hour precipitation (0.96 in on 7/25/00) coincided with high discharge (244 cfs), but low bacteria density (10 FC/100 ml) and turbidity (2.86 NTU).

Bacteria density and turbidity were elevated at this site and Mountain Creek (site B05, see below) on 5/11/98 and 5/25/00. Mountain Creek exceeded the standard on both dates.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1991, 6 of 67 samples (8.9%) have exceeded 200 FC/100 ml.

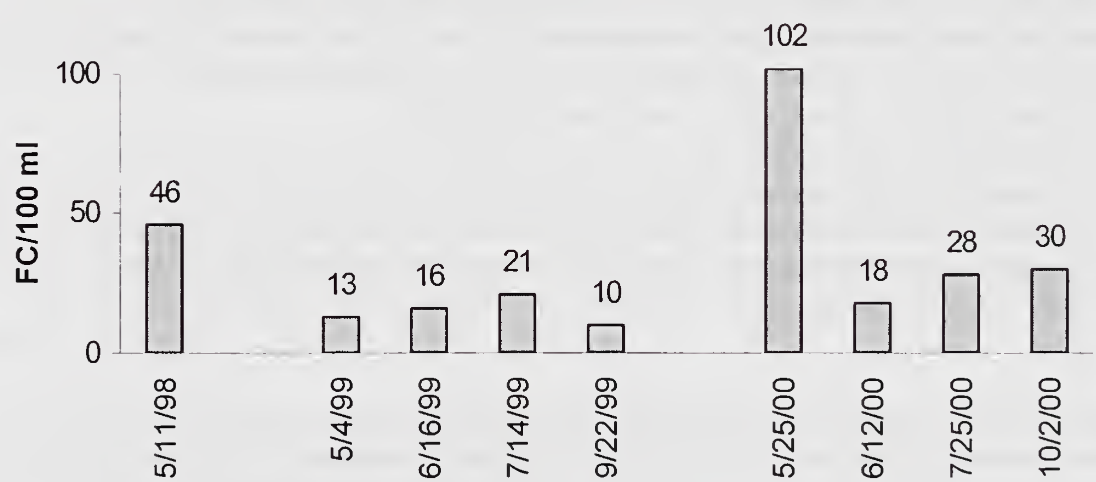
B03, Bluestone River above Confluence

The site is on river left upstream from the confluence of the Bluestone and Little Bluestone Rivers. The site is about 5.4 miles downstream of the Pipestem gage. Twelve tributaries (2 perennial and 10 intermittent) enter the Bluestone River between the Pipestem gage and this site.

Vehicle access is by an unpaved road off County Road 27 (Ellison Ridge Road). Visitors reach the site by vehicle or the Bluestone Turnpike Trail. Typical visitors include hikers, cyclists, anglers and picnickers.

None of the nine samples collected between 1998 and 2000 exceeded the state standard (Fig. 5). Parameter values ranged as follows (App. 1): bacteria density 10 - 102 FC/100 ml (mean 32, median 21), turbidity 2.78 - 6.90 NTU (mean 4.97, median 5.66), 48-hour precipitation 0.00 - 0.96 in (mean 0.22, median 0.11), discharge 19 - 813 cfs (mean 214, median 65).

Figure 5. Bluestone River above Confluence



Little correlation between the major parameters was noted at this site. The highest bacteria density (102 FC/100 ml on 5/25/00) coincided with the second lowest turbidity (2.81 NTU), the fourth highest discharge (122 cfs), and moderate 48-hour precipitation (0.28 in). The highest turbidity (6.9 NTU on 5/11/98) coincided with the highest discharge (813 cfs), and the second highest bacteria density (46 FC/100 ml), while 48-hour precipitation (0.22 in) was moderate. The second highest discharge (500 cfs on

5/4/99) coincided with zero 48-hour precipitation (0.00 in), the lowest bacteria density (13 FC/100 ml), and the fourth highest turbidity (5.91 NTU). The greatest 48-hour precipitation (0.96 in on 7/25/00) coincided with the third highest discharge (244 cfs), the fifth highest turbidity (5.66 NTU) and the fourth highest bacteria density (28 FC/100 ml).

The fecal coliform standard was exceeded at the two upstream sites (413 FC/100 ml for Bluestone River at Pipestem and 1,580 FC/100 ml for Mountain Creek) on the same date (5/25/00) as the highest bacteria density noted at this site (102 FC/100 ml). This site is sampled before the two upstream sites, and the much lower bacteria density at this site could be due to a pulse of contaminated water not having reached this site at sampling time. It is also possible that die-off of fecal coliform bacteria may have occurred between the two upstream sites and this site.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1991, 6 of 71 samples (8.4%) have exceeded 200 FC/100 ml. One of these was between 1991 and 1993 (Hebner 1991a, Sullivan 1993a,c), and the other five between 1994 and 1997 (Wilson and Purvis 2000).

B01, Bluestone River near Bluestone State Park

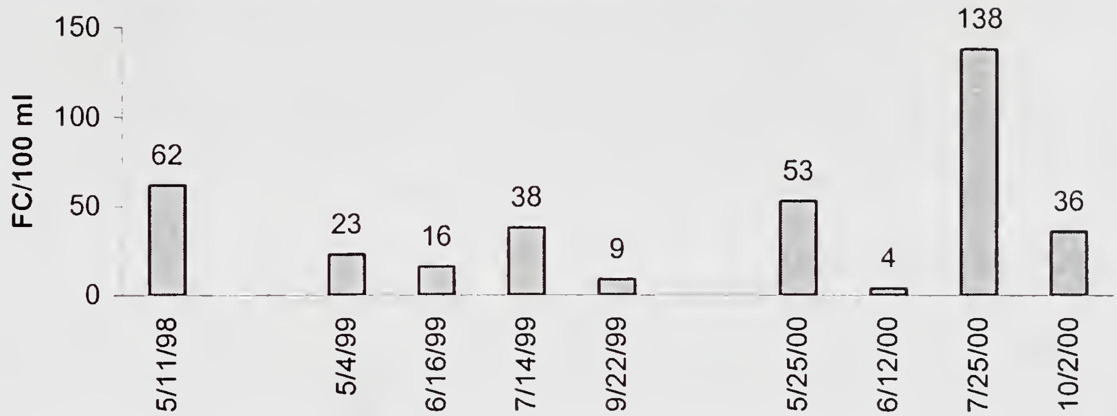
The site is upstream of Bluestone State Park on river left off the Bluestone Turnpike Trail. The site is about 7.5 miles downstream of the Pipestem gage. Twenty tributaries (3 perennial and 17 intermittent) enter the Bluestone River between the Pipestem gage and this site. The largest of these tributaries is the Little Bluestone River.

Visitors are attracted to this area due to the close proximity of Bluestone State Park, Bluestone Lake and Bluestone Wildlife Management Area. Visitors access the area by the Bluestone Turnpike Trail that connects Bluestone and Pipestem State Parks. Typical visitors include hikers, cyclists, anglers and those on horseback.

None of the nine samples collected between 1998 to 2000 exceeded the state standard (Fig. 6). Parameter values ranged as follows (App 1): bacteria density 4 - 138 FC/100 ml (mean 42, median 36), turbidity 0.81 - 7.58 NTU (mean 3.19, median 1.69), 48-hour precipitation 0.00 - 0.96 in (mean 0.22, median 0.11), discharge 19 - 813 cfs (mean 214, median 65).

The highest bacteria density (138 FC/100 ml on 7/25/00) coincided with the greatest 48-hour precipitation (0.96 in) and turbidity (7.58 NTU), and discharge (244 cfs) was slightly elevated. The highest discharge (813 cfs on 5/11/98) coincided with the second highest bacteria density (62 FC/100 ml) and turbidity (7.50 NTU), while 48-hour precipitation was moderate (0.22 in). On 5/11/98, turbidity at this site was identical to that recorded for the Little Bluestone River (site B02, see below).

Figure 6. Bluestone River near Bluestone State Park



Bacteria densities for the 5/11/98 and 5/25/00 samples were not elevated similar to the values noted at upstream sites Bluestone River at Pipestem (B04) and Mountain Creek (B05). As noted for the previous site, this could be due to sample collection occurring at this site before that for the other sites. Again, it is also possible that bacteria die-off occurred between the upstream sites and this location.

Similar conditions occurred at this site and in the upstream tributary Little Bluestone River (site B02, see below) on 7/25/00. On that date the Little Bluestone River had the third highest bacteria density and the highest turbidity and 48-hour precipitation noted for that site during the monitoring period. Bacteria density at the Little Bluestone River site (80 FC/100 ml) was less than for this site (138 FC/100 ml).

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1991, 9 of 72 samples (12.5%) exceeded 200 FC/100 ml. Three of these samples were collected in 1991 (Hebner 1991a), none between 1992 and 1993 (Sullivan 1993a,c), and six between 1994 and 1997 (Wilson and Purvis 2000).

B05, Mountain Creek

Mountain Creek rises south of Flat Top and Jumping Branch and drains about 22.5 square miles of mostly agricultural land (Mathes *et al.* 1982). Mountain Creek enters the Bluestone River 1.2 miles upstream of the Pipestem gage.

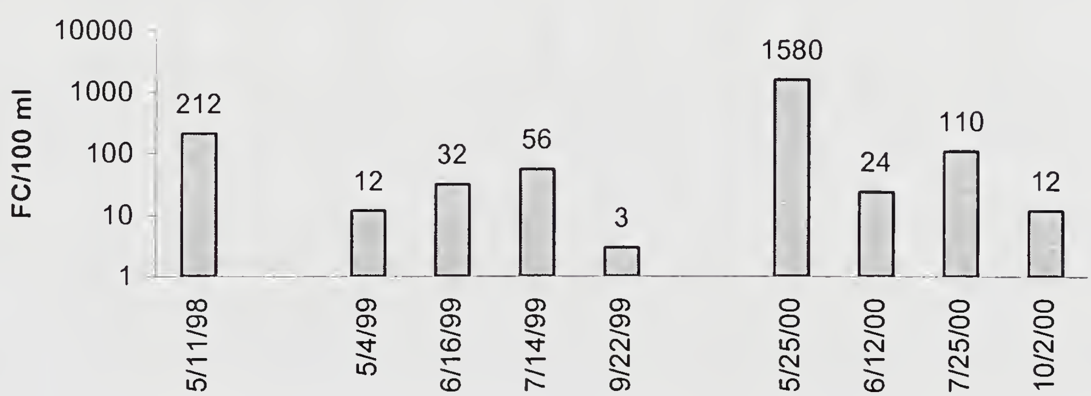
The site is on stream left, near the mouth of the creek in Pipestem State Park. The site is about 0.7 miles upstream of site B04.

Vehicle access is limited to authorized persons using a gated service road. Visitors reach this area via the Pipestem State Park tramway to Mountain Creek Lodge or by the

Bluestone Turnpike Trail that connects Bluestone and Pipestem state parks. Typical visitors include hikers, cyclists, picnickers and anglers.

Two of the nine samples collected between 1998 to 2000 exceeded the state standard (Fig. 7). Parameter values ranged as follows (App. 1): bacteria density 3 – 1,580 FC/100 ml (mean 227, median 32), turbidity 0.74 - 47.60 NTU (mean 8.36, median 3.26), 48-hour precipitation 0.00 - 0.96 in (mean 0.22, median 0.11), discharge (visual) "low" - "high."

Figure 7. Mountain Creek



The highest bacteria density (1,580 FC/100 ml on 5/25/00) coincided with the highest turbidity (47.6 NTU) and "high" discharge, while 48-hour precipitation was moderate (0.28 in). The second highest bacteria density (212 FC/100 ml on 5/11/98) coincided with the second highest turbidity (10.2 NTU) and the other "high" discharge, while 48-hour precipitation (0.22 in) was again moderate.

There was little correlation between discharge and 48-hour precipitation for this site. The two "high" discharges (noted above) coincided with relatively moderate 48-hour precipitation. It is possible that localized precipitation events occurred within the Mountain Creek watershed, and did not extend to the Bluestone Dam rain gage. The highest 48-hour precipitation (0.96 in on 7/25/00) coincided with the third highest bacteria density (110 FC/100 ml) and the fourth highest turbidity (4.17 NTU), and "normal" discharge. It is possible that this precipitation event was localized near the rain gage, and did not extend into the Mountain Creek watershed.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1992, 7 of 58 samples (12.1%) have exceeded 200 FC/100 ml. In addition to the two dates between 1998 and 2000, these include two samples in 1992 (Sullivan 1993a,c) and three samples between 1994 and 1997 (Wilson and Purvis 2000). This site was not monitored in 1991.

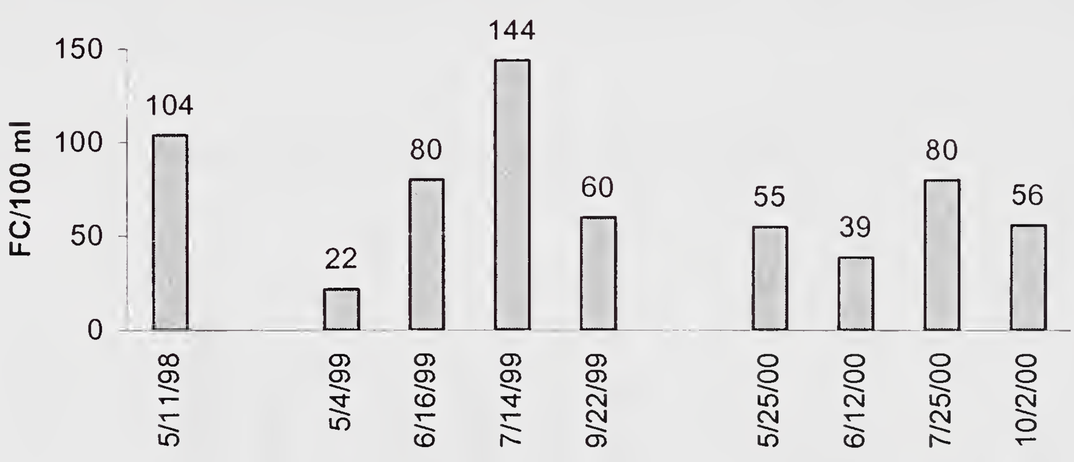
B02, Little Bluestone River

The Little Bluestone River rises east of Flat Top in western Summers County and drains 34.9 square miles, including the communities of Streeter, Jumping Branch, Nimitz and White Oak. The Little Bluestone River enters the Bluestone River about 5.4 miles downstream of the Pipestem gage and 2.1 miles upstream of the Bluestone River at Bluestone State Park site (B01). The Little Bluestone River is the third largest tributary to the Bluestone River, and the largest within the Bluestone National Scenic River boundary.

The site is on river right near the mouth of the stream. Vehicle access site is by an unpaved road off County Road 27 (Ellison Ridge Road). Visitors reach this area by vehicle or the Bluestone Turnpike Trail. Typical visitors include hikers, cyclists and anglers.

None of the nine samples collected between 1998 to 2000 exceeded the state standard (Fig. 8). Parameter values ranged as follows (App. 1): bacteria density 22 - 144 FC/100 ml (mean 71, median 60), turbidity 1.35 - 15.10 NTU (mean 4.20, median 1.99), 48-hour precipitation 0.00 - 0.96 in (mean 0.22, median 0.11), discharge (visual) "low" - "high."

Figure 8. Little Bluestone River



This site produced some anomalous correlations between the major parameters. The highest fecal coliform density (144 FC/100 ml on 7/14/99) coincided with the lowest turbidity (1.35 NTU) and "low" discharge, but the second highest 48-hour precipitation (0.45 in). The second highest bacteria density (104 FC/100 ml on 5/11/98) coincided with the second highest turbidity (7.50 NTU), "high" discharge, and moderate 48-hour precipitation (0.22 in).

The highest turbidity (15.10 NTU on 7/25/2000) coincided with the highest 48-hour precipitation (0.96 in), "high" discharge, and the third highest fecal coliform density (80 FC/100 ml). The third highest turbidity (4.44 NTU on 5/4/99) coincided with "high" discharge, but the lowest bacteria density (22 FC/100 ml) and 48-hour precipitation (0.00 in).

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for water contact recreation. Since 1991, 10 of 72 samples (13.9%) have exceeded 200 FC/100 ml. These include three samples before 1994 (Hebner 1991a, Sullivan 1993a,c) and seven samples between 1994 and 1997 (Wilson and Purvis 2000).

NEW RIVER GORGE NATIONAL RIVER

NEW RIVER MAINSTEM

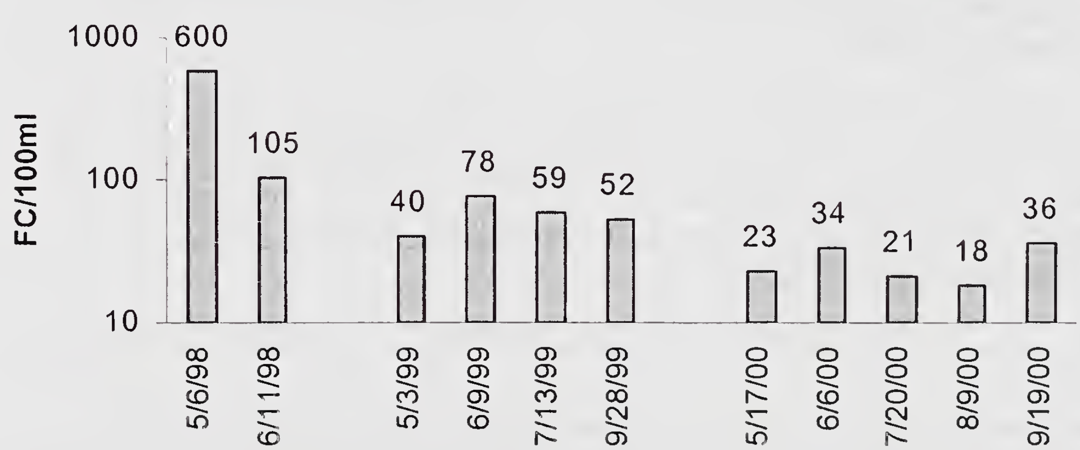
N01, New River at Hinton Visitor Center

This site is on river left behind the National Park Service Hinton Visitor Center on State Route 20, about 1.3 miles below Bluestone Dam. Anglers and sightseers are typical visitors to the site.

The site is about 0.8 miles upstream of the Hinton gage and 37.2 miles upstream of the Thurmond gage. Five tributaries (2 perennial and 3 intermittent), including the Greenbrier River, enter the New River between Bluestone Dam and the Hinton gage. The Greenbrier River enters New River on river right about 0.6 miles upstream from this site, and 1.4 miles upstream of the Hinton gage. For about the first mile and a quarter of their confluence, the Greenbrier and New River are separated by a series of islands that allow little mixing between the two rivers. Therefore this site is usually representative of water being discharged from Bluestone Dam.

One of eleven samples collected between 1998 and 2000 exceeded the state standard (Fig. 9). Parameter values ranged as follows (App. 2): bacteria density 18 - 600 FC/100 ml (mean 96.9, median 40), turbidity 1.65 - 23.3 NTU (mean 5.28, median 3.18), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge 1,540 - 27,900 cfs (mean 6,095.5, median 3,010).

Figure 9. New River at Hinton Visitor Center



High bacteria density at this site generally coincided with high turbidity and discharge. The highest bacteria density (600 FC/100 ml on 5/6/98) coincided with the highest turbidity (23.2 NTU) and discharge (27,900 cfs), and the third highest 48-hour precipitation (0.69 in). The two nearest downstream sites (N04 and N21, both at Sandstone Falls) also exceeded the fecal coliform standard on 5/6/98. The second highest bacteria density (105 FC/100 ml) coincided with the second highest turbidity (6.85 NTU) and discharge (10,000 cfs), while 48-hour precipitation was low (0.02 in). The third highest turbidity (5.59 NTU on 5/3/99) coincided with the third highest discharge (7,600 cfs), but bacteria density was low (40 FC/100 ml) and 48-hour precipitation was nil (0.00 in).

The greatest 48-hour precipitation (0.91 in for 9/28/99) coincided with a moderate bacteria density (52 FC/100 ml), a relatively low turbidity (2.32 NTU) and the lowest discharge (1,540 cfs). Four sample dates had 48-hour precipitation greater than 0.50 in, yet only one of these dates (5/6/98) exceeded the fecal coliform standard **and** had elevated turbidity and discharge.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but may become impaired during periods of high turbidity and discharge. Since 1990, 7 of 96 samples (7.3%) have exceeded the fecal coliform standard. Waterfowl frequent this area and may be additional sources of fecal bacteria.

N04, New River at Sandstone Falls Parking Lot

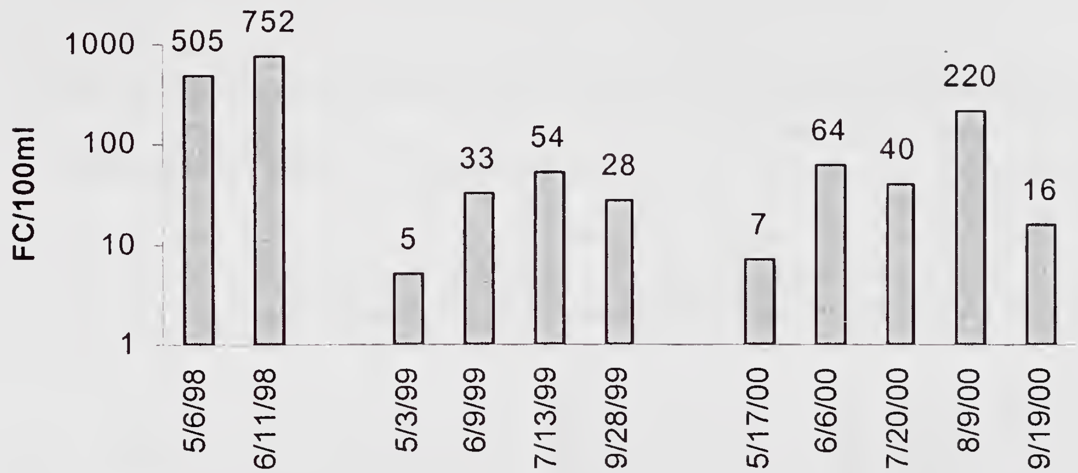
This site is on river left upstream of the parking lot at the National Park Service Sandstone Falls parking lot next to State Route 26 (River Road). Anglers, swimmers, sightseers and picnickers are typical visitors to this site.

The site is about 7.9 miles downstream from the Hinton gage and 28.5 miles upstream of the Thurmond gage. There are 24 tributaries (11 perennial and 13 intermittent) between the Hinton gage and this site. This site is about 8.7 miles downstream from the New River at Hinton Visitor Center site (N01) and 7.7 miles downstream from the Madam Creek tributary site (N02).

Three of eleven samples collected between 1998 and 2000 exceeded the state standard (Fig. 10). Parameter values ranged as follows (App. 2): bacteria density 5 - 752 FC/100 ml (mean 156.7, median 40), turbidity 1.37 - 22.5 NTU (mean 5.71, median 3.36), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge 1,540 - 27,900 cfs (mean 6,095.5, median 3,010).

The highest bacteria density (752 FC/100 ml on 6/11/98) coincided with the second highest discharge (10,000 cfs) and the third highest turbidity (7.4 NTU), but minimal 48-hour precipitation (0.02 in). The second highest bacteria density (505 FC/100 ml on 5/6/98) coincided with the highest turbidity (22.5 NTU) and discharge (27,900 cfs), and the third highest 48-hour precipitation (0.69 in). The third highest bacteria density (220 FC/100 ml on 8/9/00) coincided with the second highest turbidity (12.7 NTU), and moderate 48-hour precipitation (0.45 in). Discharge (3,700 cfs) was also moderate on this date, but was the highest noted for a 2000 sampling date.

Figure 10. New River at Sandstone Falls Parking Lot



The greatest 48-hour precipitation (0.91 in for 9/28/99) coincided with low values for bacteria density (28 FC/100 ml), turbidity (1.60 NTU) and discharge (1,540 cfs). Three other sample dates had 48-hour precipitation greater than 0.50 in, yet only one of these dates (5/6/98) exceeded the fecal coliform standard **and** had elevated turbidity and discharge.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but can become impaired during periods of high turbidity and discharge. Since 1990, 10 of 95 samples (10.5%) have exceeded the fecal coliform standard. Madam Creek (see site N02, below) is one of the most likely sources of fecal contamination. Other potential sources include untreated waste from residences along River Road, the Greenbrier River, and non-migratory geese residing above this site.

N21, New River at Sandstone Falls Boardwalk

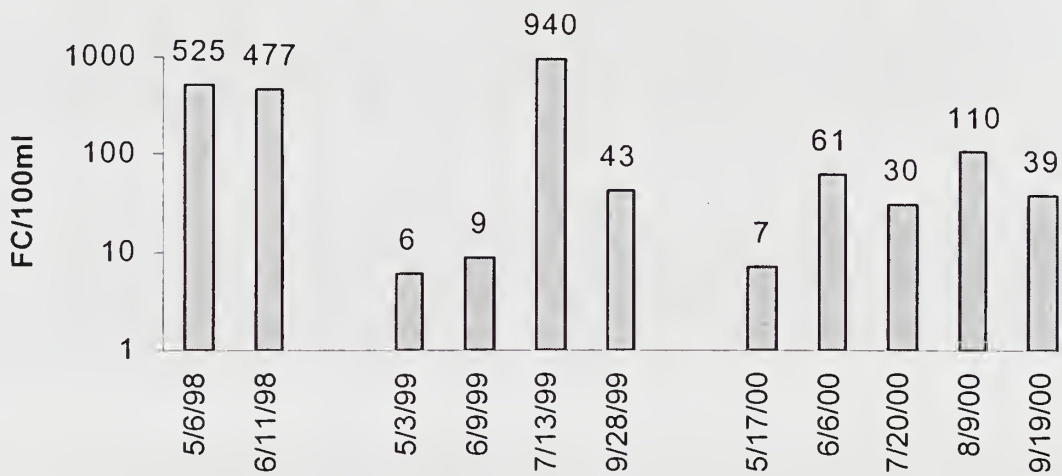
This site is on river left below the main falls at the end of the boardwalk at the National Park Service Sandstone Falls day-use area off State Route 26 (River Road). The site provides a spectacular view of the falls and is frequented by sightseers, anglers and picnickers.

The site is about 8.0 miles downstream from the Hinton gage and 28.4 miles upstream of the Thurmond gage. There are 25 tributaries (11 perennial and 14 intermittent) between the Hinton gage and this site. Sites New River at Hinton Visitor Center (N01), Madam Creek (N02) and New River at Sandstone Falls Parking Lot (N04) are about 8.8, 7.8, 0.1 miles, respectively, upstream of this site.

This site was added to the monitoring program in 1993 because of concerns that the previous site (N04) might not be representative of overall river water quality in the Sandstone Falls area. Considerable mixing occurs as water flows over the falls. This likely incorporates constituents from Madam Creek and the Greenbrier River into samples collected at this site, whereas the site above the falls may not be so well mixed.

Three of eleven samples collected between 1998 and 2000 exceeded 200 FC/100 ml (Fig. 11). Parameter values ranged as follows (App. 2): bacteria density 6 - 940 FC/100 ml (mean 204.3, median 48), turbidity 1.33 - 22.0 NTU (mean 5.84, median 4.25), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge 1,540 - 27,900 cfs (mean 6,095.5, median 3,010).

Figure 11. New River at Sandstone Falls Boardwalk



Sample dates with high fecal coliform density also generally had elevated turbidity and discharge. The highest bacteria density (940 FC/100 ml on 7/13/99) coincided with the fifth highest turbidity (4.89 NTU), the fourth highest discharge (3,900 cfs), and the fifth highest 48-hour precipitation (0.45 in). The values for discharge and turbidity, even though relatively moderate, were the highest for 1999 sampling dates. The second highest bacteria density (525 FC/100 ml on 5/6/98) coincided with the highest turbidity (22.0 NTU) and discharge (27,900 cfs), and the third highest 48-hour precipitation (0.69 in). The third highest bacteria density (477 FC/100 ml on 6/11/98) coincided with the third highest turbidity (8.30 NTU) and the second highest discharge (10,000 cfs), but 48-hour precipitation was minimal (0.02 in).

The greatest 48-hour precipitation (0.91 in for 9/28/99) coincided with low values for bacteria density (43 FC/100 ml), turbidity (1.33 NTU) and discharge (1,540 cfs). As with the upstream sites N01 and N04, three other sample dates had 48-hour precipitation greater than 0.50 in, but only on 5/6/98 did bacteria density exceed the state standard.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but can become impaired during periods of high turbidity and discharge. Since 1993, 8 of 57 samples (14%) have exceeded 200 FC/100 ml. Potential sources of fecal bacteria at this site include Madam Creek, a malfunction or bypass of the Hinton STP, untreated sewage entering the New River directly from businesses and residences along the river below Hinton, and the Greenbrier River. Resident, non-migratory geese that inhabit this section of the New River are also a potential source.

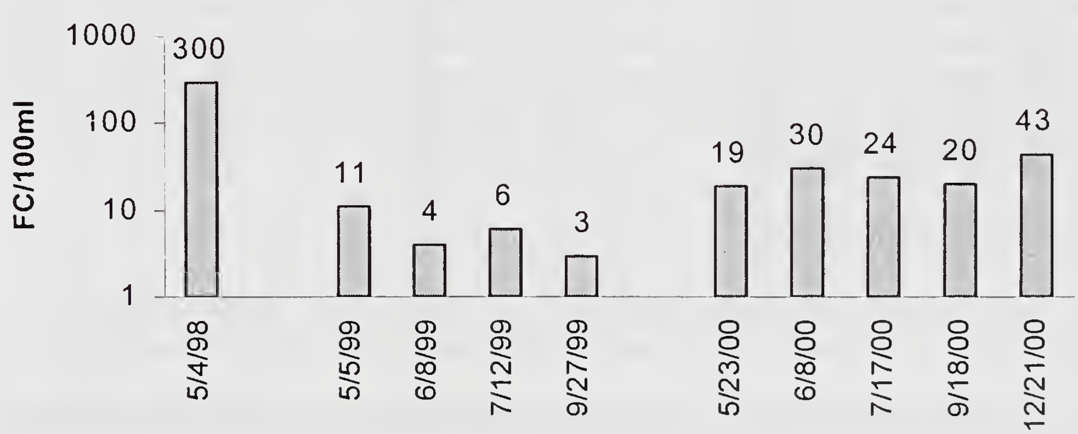
N08, New River at Prince

This is the only river site where a mid-channel sample was collected. Samples were collected by dropping a stainless steel bucket into the river from the mid-point of the State Route 41 bridge below Prince. Anglers, boaters and campers frequent this section of the river.

This site is about 22.9 miles downstream from the Hinton gage and 13.4 miles upstream from the Thurmond gage. Fifty tributaries (24 perennial and 26 intermittent) enter the New River between the Hinton gage and this site. Twenty tributaries (10 perennial and 10 intermittent) enter the New River between this site and the Thurmond gage. The large tributaries Glade Creek (N22) and Laurel Creek (N07) are closely upstream of this site.

One of ten samples collected between 1998 and 2000 exceeded 200 FC/100 ml (Fig. 12). Parameter values ranged as follows (App. 2): bacteria density 3 - 300 FC/100 ml (mean 46, median 19.5), turbidity 1.85 - 25.0 NTU (mean 5.99, median 3.33), 48-hour precipitation 0.00 - 1.44 in (mean 0.33, median 0.075), discharge 1,118 - 19,484 cfs (mean 5,424.8, median 3,472).

Figure 12. New River at Prince



The highest bacteria density (300 FC/100 ml on 5/4/98) coincided with the greatest turbidity (25.0 NTU), discharge (19,484 cfs), and 48-hour precipitation (1.44 in). The upstream tributaries Glade Creek (site N22; 236 FC/100 ml) and Laurel Creek (site N07; 230 FC/100 ml) also exceeded the fecal coliform standard on 5/4/98. The relatively small amount by which the fecal coliform standard was exceeded was surprising considering the relatively great values for the other parameters. High discharges in the lower New River, like that of 5/4/98, are more likely to come from large frontal storms that rain over a large portion of the watershed. These storms increase discharge and turbidity, but because of the large watershed area over which they occur, bacteria density at lower river sites may be relatively low due to die-off during downstream transport. Also, this sample was collected on a Monday, so "48-hour" precipitation occurred over 72 hours. If the majority of this precipitation fell on Friday and Saturday, peak values for bacteria density and turbidity may have occurred before the sample was collected.

Several sample dates had elevated turbidity or discharge, but low bacteria density. The second highest turbidity (7.76 NTU on 7/17/00) coincided with a bacteria density of only 24 FC/100 ml. The third highest turbidity (6.81 NTU on 6/8/00) coincided with the fourth highest discharge (4,933 cfs), but bacteria density was again low (30 FC/100 ml). The third highest discharge (6,868 cfs on 5/5/99) coincided with the fifth highest turbidity (4.35 NTU) and the seventh highest (fourth lowest) bacteria density (11 FC/100 ml). The second highest discharge (6,920 cfs on 12/21/00) coincided with fourth highest turbidity (5.73 NTU), but bacteria density was only moderate (43 FC/100 ml). For all of these dates the 48-hour precipitation was less than 0.50 in. On the only other date that 48-hour precipitation exceeded 0.50 in (0.95 in on 5/23/00), bacteria density (19 FC/100 ml), turbidity (2.31 NTU) and discharge (3,472 cfs) were low to moderate. This sample was collected on a Tuesday following a three-day weekend, so "48-hour" precipitation occurred over 120 hours.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1990, 11 of 98 samples (11.2%) exceeded the fecal coliform standard. Potential sources of fecal contamination between the previous site and this site are limited, and include the riverside communities of Sandstone and Meadow Creek, dispersed residences along the New River, and agricultural activities in the area between Sandstone Falls and the I-64 bridge. Monitored tributaries that enter the New River between Sandstone Falls and the Prince Bridge (Lick Creek, Meadow Creek, Glade Creek, and Laurel Creek), generally have good water quality, and are not likely to often be sources of fecal contamination.

N12, New River at Thurmond

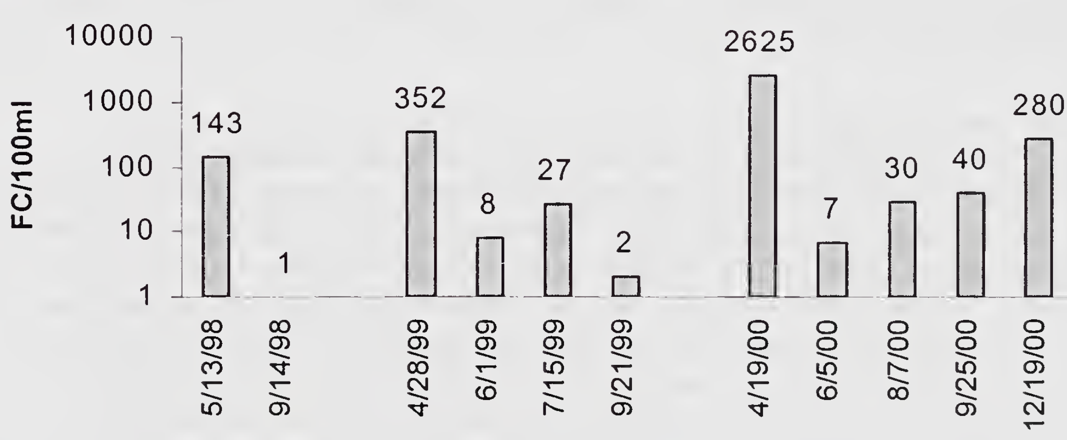
This site is on river right, downstream from the town of Thurmond. Vehicle access is by County Road 25 to Thurmond. Boaters and anglers frequent this section of the river.

The site is about 0.5 miles downstream of the Thurmond gage and 36.9 miles downstream of the Hinton gage. There are 71 tributaries (35 perennial and 36 intermittent) between the Hinton gage and this site. Only one stream, Dunloup Creek, enters the New River between the Thurmond gage and this site. Piney Creek (N09) and Dunloup Creek (N11) are major tributaries entering the New River above this site.

Three of eleven samples collected between 1998 and 2000 exceeded the state standard (Fig. 13). Parameter values ranges as follows (App. 2): bacteria density 1 - 2,625 FC/100 ml (mean 319.6, median 30), turbidity 1.20 - 50.3 NTU (mean 12.69, median 4.5), 48-hour precipitation 0.00 - 0.97 in (mean 0.30, median 0.11), discharge 1,162 - 38,900 cfs (mean 9,151.6, median 3,750).

Turbidity, discharge, and 48-hour precipitation were high on each of the dates that bacteria density exceeded the state standard. The highest bacteria density (2,625 FC/100 ml on 4/19/00) coincided with the greatest turbidity (50.3 NTU) and discharge (38,900 cfs), and the third highest 48-hour precipitation (0.82 in). The second highest bacteria density (325 FC/100 ml on 4/28/99) coincided with the fifth highest turbidity (6.89 NTU) and discharge (5,160 cfs) and the second highest 48-hour precipitation (0.92 in). The third highest bacteria density (280 FC/100 ml on 12/19/00) coincided with the second highest turbidity (44.9 NTU), the third highest discharge (10,600 cfs), and highest 48-hour precipitation (0.97 in). This sample was collected on Tuesday following a three-day weekend, so "48-hour" precipitation occurred over 120 hours. Precipitation on Monday, 12/18/00 (recorded at 0800 on Tuesday, 12/19/00) was 0.05 in. The second highest discharge (24,600 cfs on 5/13/98) coincided with the third highest turbidity (14.0 NTU) and the fourth highest bacteria density (143 FC/100 ml) were elevated, while 48-hour precipitation was nil (0.00 in).

Figure 13. New River at Thurmond



Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but may become impaired during periods of high turbidity, discharge, and 48-hour precipitation. Since 1990, 11 of 98 samples (11.2%) have exceeded the fecal coliform standard.

Dunloup Creek (N11) and Piney Creek (N09) are potential sources of fecal bacteria collected at this site. Untreated or improperly treated wastes impair both of these upstream tributaries. On several dates, both Dunloup Creek and the New River and Thurmond were sampled. High bacteria density at one site generally co-occurred with high density at the other site. On 4/28/99 bacteria density at Thurmond was 352 FC/100 ml. Two samples were collected 1 hour and 55 minutes apart (before and after the Thurmond sample) from Dunloup Creek on this date. Bacteria density of the first Dunloup Creek sample was 1,262 FC/100 ml, and for the second sample it was 575 FC/100 ml. On 4/19/00 bacteria density in the New River at Thurmond was 2,625 FC/100 ml, while in Dunloup Creek it was 395 FC/100 ml.

N20, New River at Cunard

This site is on river left downstream of the National Park Service public access at Cunard. Vehicle access from Fayetteville is by State Route 16 to County Road 9 to the community of Cunard, then by a gravel road to the site. Rafters and anglers are typical visitors to this site.

The site is about 7.2 miles downstream from the Thurmond gage and 43.6 miles downstream of the Hinton gage. There are 9 tributaries (6 perennial and 3 intermittent) between the Thurmond gage and this site, and 79 tributaries (40 perennial and 39 intermittent) between the Hinton gage and this site. Dunloup Creek (N11) and Arbuckle Creek (N13) are the closest monitored upstream tributaries.

Two of ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 14). Parameter values ranged as follows (App. 2): bacteria density 2 - 353 FC/100 ml (mean 94.2, median 17.5), turbidity 1.10 - 52.1 NTU (mean 9.17, median 3.44), 48-hour precipitation 0.00 - 2.01 in (mean 0.42, median 0.09), discharge 1,322 - 26,260 cfs (mean 6,962, median 4,448).

The highest bacteria density (353 FC/100 ml on 8/3/00) coincided with the highest turbidity (52.1 NTU) and second highest discharge (11,700 cfs), although 48-hour precipitation was minimal (0.02 in). The second highest bacteria density (320 FC/100 ml on 9/27/00) coincided with the third highest turbidity (9.56 NTU) and discharge (8,690 cfs), and the highest 48-hour precipitation (2.01 in). Two days earlier, Arbuckle Creek had a bacteria density of 250,000 FC/100 ml and a turbidity of 626 NTU, and Dunloup Creek had a bacteria density of 490 FC/100 ml and a turbidity of 10.8 NTU. These large tributaries, particularly Arbuckle Creek, could be the source of high bacteria density recorded from Cunard on 9/27/00. The highest discharge (26,620 cfs on 5/12/98) coincided with the second highest 48-hour precipitation (0.93 in) and turbidity (12.0 NTU), although bacteria density was low (73 FC/100 ml). This sample was collected on a Tuesday following a three-day weekend, so “48-hour” precipitation actually occurred over 120 hours.

Figure 14. New River at Cunard

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but may become impaired during periods of high turbidity and discharge. Since 1992, 8 of 78 samples (10.2%) have exceeded the fecal coliform standard. Arbuckle Creek is probably the major source of contamination between the previous site (New River at Thurmond, N12) and this one. Dunloup Creek may also be a contributor, as its water may not mix completely with those of the New River before reaching the Thurmond site.

N17, New River at Fayette Station

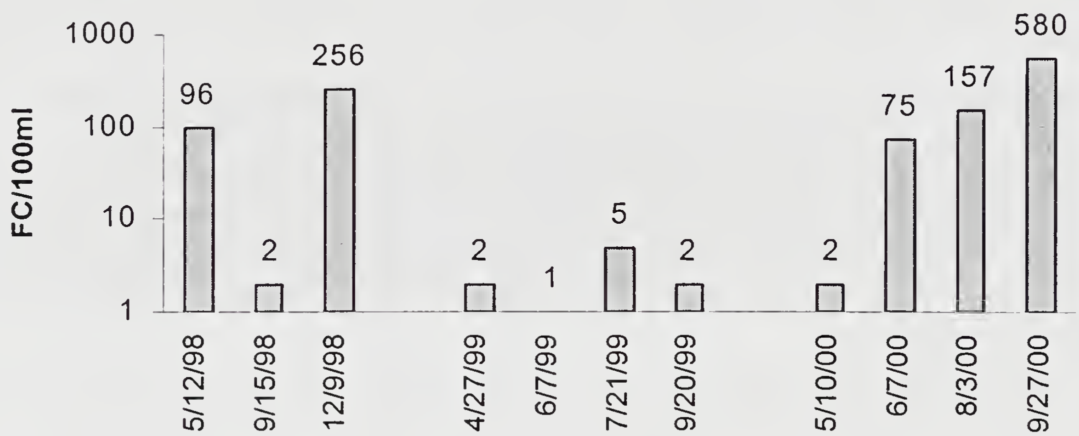
This site is on river left upstream of the mouth of Wolf Creek. Vehicle access is by State Route 82 (Fayette Station Road). Anglers, rafters and swimmers are common visitors to this site.

The site is about 13.6 miles downstream from the Thurmond gage, and 50.0 miles downstream of the Hinton gage. There are 18 tributaries (13 perennial and 5 intermittent) between the Thurmond gage and this site, and 97 tributaries (53 perennial and 44 intermittent) between the Hinton gage and this site. Coal Run (N15) and Keeney Creek (N16) are the two of the closest upstream tributaries monitored by the National Park Service. Wolf Creek (N18) and Marr Branch (N19) enter closely below this site.

Two of eleven samples collected between 1998 and 2000 exceeded the state standard (Fig. 15). Parameter values ranged as follows (App. 2): bacteria density 1 - 580 FC/100 ml (mean 107.1, median 5), turbidity 1.10 - 44.2 NTU (mean 8.88, median 3.15), 48-hour precipitation 0.00 - 2.01 in (mean 0.53, median 0.16), discharge 1,322 - 26,620 cfs (mean 6,571.5, median 3,471).

High bacteria density generally corresponded to high turbidity, discharge, or 48-hour precipitation. The highest bacteria density (580 FC/100 ml on 9/27/00) coincided with the highest 48-hour precipitation (2.01 in) and the third highest discharge (8,690 cfs), although turbidity (6.75 NTU) was only slightly elevated. The second highest bacteria density (256 FC/100 ml on 12/9/98) coincided with the second highest turbidity (16.0 NTU) and 48-hour precipitation (1.69 in), but a normal discharge (2,667 cfs). The highest turbidity (44.2 NTU on 8/3/00) coincided with the third highest bacteria density (157 FC/100 ml) and the second highest discharge (11,700 cfs), while 48-hour precipitation was minimal (0.02 in). The highest discharge (26,620 cfs on 5/12/98) coincided with the third highest 48-hour precipitation (0.93 in) and turbidity (13.0 NTU), and the fourth highest bacteria density (96 FC/100 ml). This sample was collected on a Tuesday following a three-day weekend, so "48-hour" precipitation actually occurred over 120 hours.

Figure 15. New River at Fayette Station



The upstream sites New River at Cunard (N20), Coal Run (N15), and Keeney Creek (N16) all exceeded the state standard on 8/3/00, while bacteria density at Fayette Station remained below 200 FC/100 ml. Bacteria density was 353 FC/100 ml in the New River at Cunard, 241 FC/100 ml in Coal Run, and 3,250 FC/100 ml in Keeney Creek. The potential explanations for this phenomenon involve relative discharge, time of sample collection, and travel time of suspended material. Keeney Creek was sampled at 1149, Fayette Station at 1221, Cunard at 1335, and Coal Run at 1350. The Keeney Creek site is well above its confluence with the New River, and considerable travel time is required for Keeney Creek water to reach the New River, especially at the "normal" discharge noted for Keeney Creek on this date (App. 2). Even though the New River was high (11,700 cfs), and therefore swift (Appel 1983), it is likely that more than the 32 minutes between samples would have been required for a bacteria pulse at the Keeney Creek site to reach Fayette Station. Keeney Creek is chronically polluted (see below), and a bacteria density of 3,250 FC/100 ml is not unusual, and probably represented a relatively steady state condition rather than a pulse. Even so, the proportional contribution of Keeney Creek discharge to New River discharge on this date was relatively small, so any input from Keeney Creek would be diluted by the much greater volume of discharge in the New

River. The discharge of Coal Run under the "normal" conditions noted for this date would have been even smaller than that of Keeney Creek, so dilution of the Coal Run input would have been even greater. Also, the Coal Run sample, as well as that for Cunard, were collected after that for Fayette Station. Even if the Cunard sample represented what would have been contributed to the Fayette Station sample, the distance between the two sites allows for considerable settling of suspended particles like bacteria. The lower turbidity at Fayette Station (44.2 NTU) as compared to that at Cunard (52.1 NTU) supports both this latter argument, and the possibility that the most contaminated water had not reached Fayette Station at the time of sampling. The turbidity data also supports another possibility, that of bacterial die-off between Cunard and Fayette Station.

The highest bacteria density at this site (580 FC/100 ml on 9/27/00) coincided with similarly high values for the three upstream sites. On this date the bacteria density at all four sites exceeded the state standard. Bacteria density was 320 FC/100 ml at Cunard, 1,930 FC/100 ml in Coal Run, and 5,850 FC/100 ml in Keeney Creek. Discharge in Coal Run was "high" on this date, but "normal" in Keeney Creek. On other dates that bacteria density in Coal Run and Keeney Creek exceeded the state standard, the density at Fayette Station was less than 200 FC/100 ml.

Wolf Creek (N18) is just downstream of this site. Bacteria density of Wolf Creek on 9/27/00 was 2,620 FC/100 ml. The confluence of Wolf Creek and the New River creates a large eddy in the New River downstream of the Fayette Station sample site. This eddy may extend into the river sample site, especially during periods of high precipitation producing abundant runoff, and may contribute to high bacteria densities recorded at the Fayette Station site.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but can become impaired during periods of high turbidity, 48-hour precipitation and discharge. Since 1990, 14 of 99 samples (14.1%) have exceeded the fecal coliform standard.

NEW RIVER TRIBUTARIES

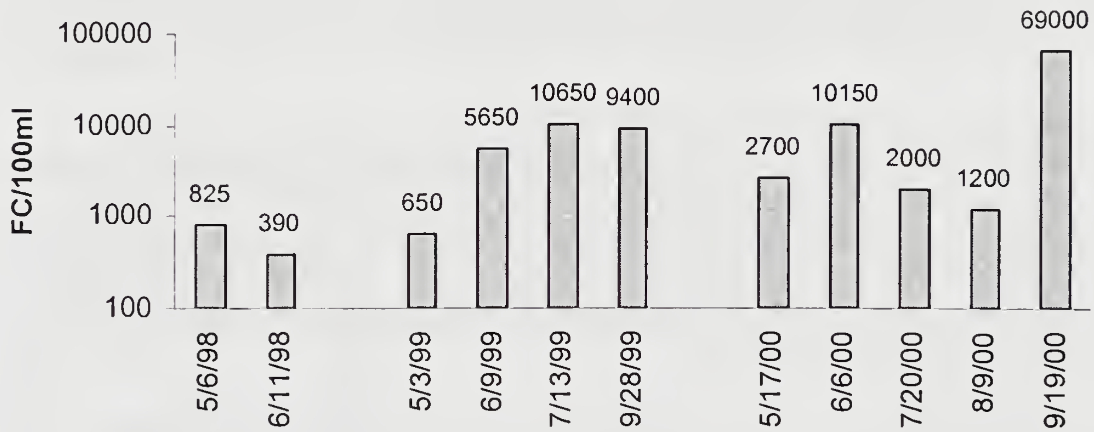
N02, Madam Creek

This site is on stream left near the mouth of the creek, just downstream of the State Route 26 bridge across the creek. Some anglers occasionally fish in the New River near the mouth of Madam Creek.

Madam Creek is 6.1 miles long and drains 12.3 square miles (West Virginia Department of Natural Resources 1983). Madam Creek enters the New River approximately 0.2 miles downstream of the Hinton gage and 36.2 miles upstream of the Thurmond gage.

All eleven samples collected between 1998 and 2000 exceeded the state standard (Fig. 16). Parameter values ranged as follows (App. 2): bacteria density 390 - 69,000 FC/100 ml (mean 10,238, median 2,700), turbidity 2.1 - 64.7 NTU (mean 19.9, median 12.0), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge (visual) "low" to "high."

Figure 16. Madam Creek



Fecal coliform bacteria density in Madam Creek was always high, but showed little consistent relationship with turbidity, discharge, or 48-hour precipitation. The highest bacteria density (69,000 FC/100 ml on 9/19/00) coincided with the highest turbidity (64.7 NTU), the fourth highest 48-hour precipitation (0.52 in) and "normal" discharge. The second highest bacteria density (10,650 FC/100 ml on 7/13/99) coincided with the second lowest turbidity (2.13 NTU), "low" discharge, and moderate 48-hour precipitation (0.45 in). The third highest bacteria density (10,150 FC/100 ml on 6/6/00) coincided with the second highest turbidity (47.2 NTU), "high" discharge and moderate 48-hour precipitation (0.38 in). The greatest 48-hour precipitation (0.91 in on 9/28/99) coincided with "low" discharge, the fourth highest bacteria density (9,400 FC/100 ml), and the fifth highest turbidity (18.2 NTU).

"High" discharge was noted on four sample dates. On these dates, bacteria density ranged from 650 to 10,150 FC/100 ml, turbidity ranged from 7.89 to 47.2 NTU, and 48-hour precipitation varied from 0.00 to 0.69 in.

Water quality at this site in terms of fecal coliform bacteria is unsatisfactory for contact recreation. Madam Creek has consistently high bacteria densities as a result of raw sewage entering the stream from residential straight pipes or inadequate septic systems. Since 1990, 88 of 97 samples (90.7%) have exceeded 200 FC/100 ml.

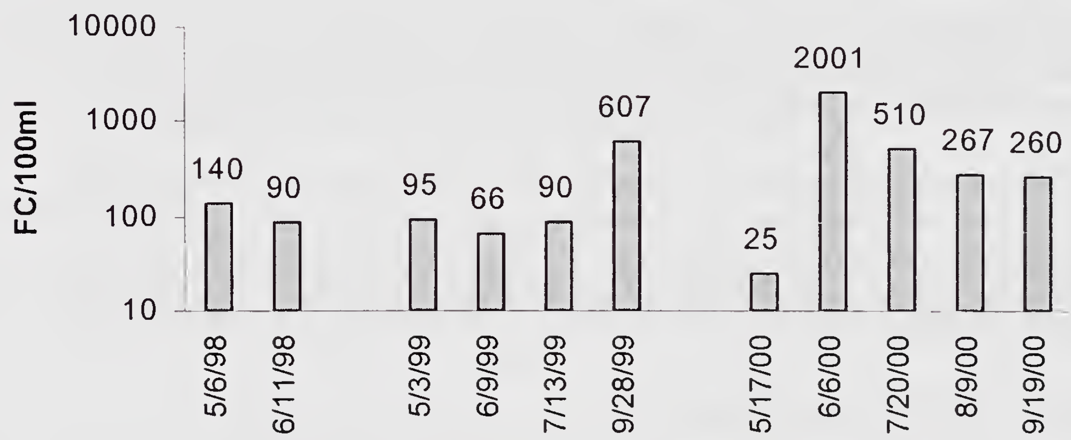
N05, Lick Creek

This site is on stream right near the mouth of the stream, just downstream of a CSX railroad bridge. Vehicle access from State Route 20 is by an unimproved road that follows the creek. Anglers and campers are commonly seen in this area.

Lick Creek is 11.2 miles long and drains 39.1 square miles (West Virginia Department of Natural Resources 1983). Lick Creek enters the New River about 9.4 miles downstream of the Hinton gage and 27.0 miles upstream of the Thurmond gage.

Five of eleven samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 17). Parameter values ranged as follows (App. 2): bacteria density 25 - 2,001 FC/100 ml (mean 377, median 140), turbidity 0.78 - 55.4 NTU (mean 10.6, median 2.4), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge 1.1 - 175.4 cfs (mean 26.1, median 8.4). The bacteria density reported for 6/6/00 was actually >2,000 FC/100 ml (App. 2), but for graphical purposes is presented as 2,001 FC/100 ml.

Figure 17. Lick Creek



The greatest bacteria density (2001 FC/100 ml on 6/6/00) coincided with the highest turbidity (55.4 NTU), the third highest discharge (25.88 cfs), but only the seventh highest 48-hour precipitation (0.38 in). The second highest bacteria density (607 FC/100 ml on 9/28/99) coincided with the greatest 48-hour precipitation (0.91 in), but the lowest turbidity (0.78 NTU) and discharge (1.1 cfs). The third highest bacteria density (510 FC/100 ml on 7/20/00) coincided with the second highest 48-hour precipitation (0.76 in), the fourth highest turbidity (6.0 NTU), and the fifth highest discharge (9.46 cfs). The second highest turbidity (28.1 NTU on 8/9/00) coincided with the fourth highest bacteria density (267 FC/100 ml) and discharge (20.56 cfs) and the fifth highest 48-hour precipitation (0.45 in).

The highest discharge (175.4 cfs on 5/6/98) coincided with the third highest turbidity (13.5 NTU) and 48-hour precipitation (0.69 in), and the sixth highest bacteria density (140 FC/100 ml). The second highest discharge (36.09 cfs on 5/3/99) coincided with the fifth highest turbidity (5.04 NTU), the seventh highest bacteria density (95 FC/100 ml), and no 48-hour precipitation (0.00 in).

Water quality of Lick Creek in terms of fecal coliform bacteria is limited for contact recreation. Since 1990, 15 of 97 samples (15.5%) have exceeded the fecal coliform standard. It is not known whether the occurrence of all values exceeding the standard between 1998 and 2000 being in the latter part of this period is a trend in degrading water quality or the result of random influences on a relatively small sample size. Although general trends were noted between high bacteria densities and high values for turbidity, discharge, and 48-hour precipitation, there was a lot of variability in this relationship. Farms, pasturelands and inadequate and/or failing residential septic systems are thought to be sources of bacteria found in this stream (Wilson and Purvis 2000).

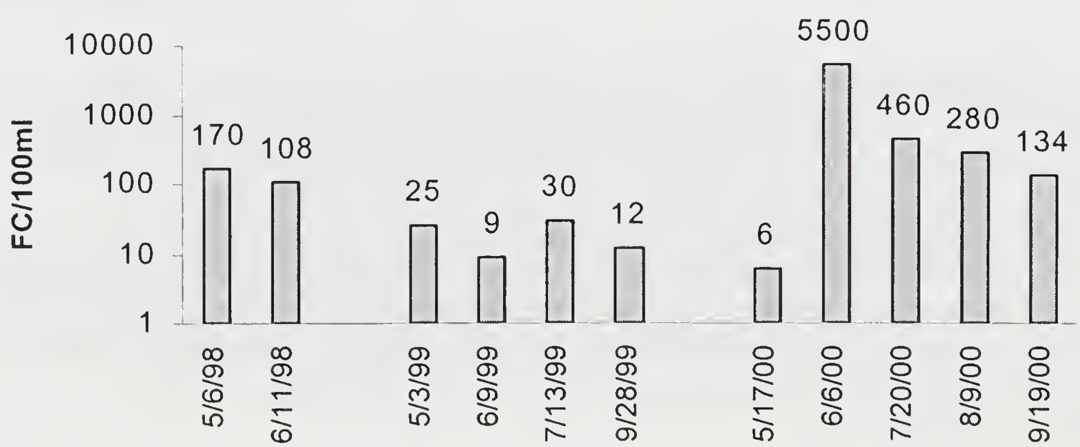
N06, Meadow Creek

This site is near the mouth of the stream on stream left, beneath the County Road 7 bridge just north of the community of Meadow Creek. Local residents commonly visit the site.

Meadow Creek is 8.9 miles long and drains 28.8 square miles (West Virginia Department of Natural Resources 1983). Meadow Creek enters the New River about 12.5 miles downstream of the Hinton gage and 23.9 miles upstream of the Thurmond gage.

Three of eleven samples exceeded the fecal coliform standard between 1998 and 2000 (Fig. 18). Parameter values ranged as follows (App. 2): bacteria density 6 - 5,500 FC/100 ml (mean 612.2, median 108), turbidity 1.2 - 111.0 NTU (mean 15.79, median 3.08), 48-hour precipitation 0.00 - 0.91 in (mean 0.38, median 0.45), discharge 0.77 - 100.2 cfs (mean 24.09, median 10.56).

Figure 18. Meadow Creek



All samples exceeding the fecal coliform standard had high turbidity. The highest bacteria density (5,500 FC/100 ml on 6/6/00) coincided with the highest turbidity (111.0 NTU) and the third highest discharge (36 cfs), but only the seventh highest 48-hour precipitation (0.38 in). The second highest bacteria density (460 FC/100 ml on 7/20/00) coincided with the second highest turbidity (18.10 NTU) and 48-hour precipitation (0.76 in) and the fifth highest discharge (24 cfs). The third highest bacteria density (280 FC/100 ml on 8/9/00) coincided with the third highest turbidity (15.60 NTU), the fourth highest discharge (35 cfs) and the fifth highest 48-hour precipitation (0.45 in).

The greatest 48-hour precipitation (0.91 in on 9/28/99) coincided with the third lowest bacteria density (12 FC/100 ml) and the lowest turbidity (1.20 NTU) and discharge (0.77 cfs). The second highest 48-hour precipitation (0.76 in on 7/20/00) coincided with the second highest bacteria density (460 FC/100 ml) and turbidity (18.10 NTU) and the fifth highest discharge (24 cfs). The greatest discharge (100.2 cfs on 5/6/98) coincided with the third highest 48-hour precipitation (0.69 in), and the fourth highest turbidity (10.0 NTU) and bacteria density (170 FC/100 ml).

Meadow Creek water quality in terms of fecal coliform bacteria is generally satisfactory for contact recreation, but occasionally may become impaired. High turbidity appears to be a reliable indicator of high fecal coliform density in this stream. Since 1990, 20 of 96 samples (20.8%) have exceeded the fecal coliform standard. Runoff from agricultural land in the mostly rural watershed may contribute fecal contaminants. Also, the Meadow Bridge Wastewater Treatment Plant may be a source of fecal bacteria if the plant is susceptible to hydraulic overflows following precipitation events.

N22, Glade Creek

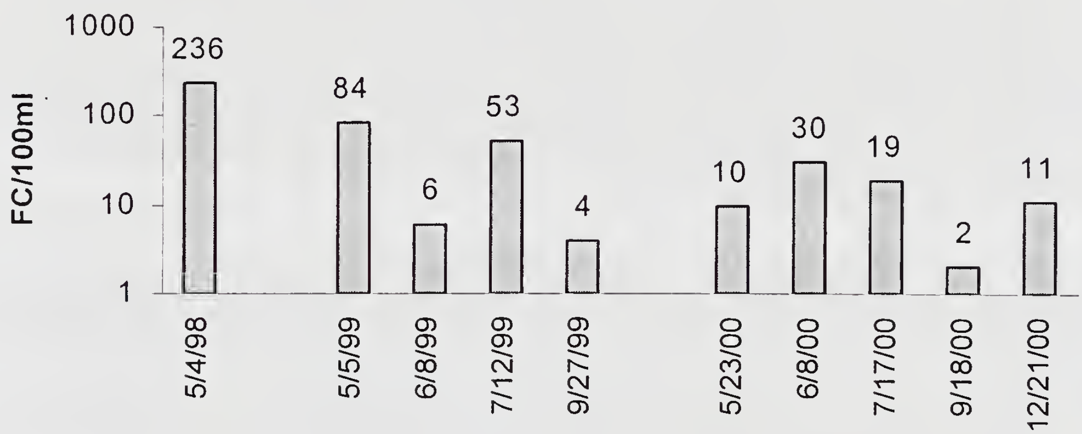
This site is on stream left near the mouth of the creek, and adjacent to the National Park Service Glade Creek Trail Head. Vehicle access is by Glade Creek Road off State Route 41. Anglers, hikers and picnickers are commonly seen at this site.

Glade Creek is 19 miles long and drains 63.3 square miles (West Virginia Department of Natural Resources 1983). Glade Creek enters the New River about 17.6 miles downstream of the Hinton gage and 18.8 miles upstream from the Thurmond gage.

One of ten samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 19). Parameter values ranged as follows (App. 2): bacteria density 2 - 236 FC/100 ml (mean 45.5, median 15), turbidity 0.29 - 8.2 NTU (mean 1.85, median 1.07), 48-hour precipitation 0.00 - 1.44 in (mean 0.33, median 0.075), discharge (visual) "low" - "high."

The highest bacteria density (236 FC/100 ml on 5/4/98) coincided with the highest turbidity (8.2 NTU) and 48-hour precipitation (1.44 in) and "high" discharge. Except for the 5/4/98 sample, turbidity was consistently low. The second highest turbidity (3.24 NTU on 7/17/00) coincided with the third highest 48-hour precipitation (0.44 in), the fifth highest bacteria density (19 FC/100 ml) and "normal" discharge. The second highest 48-hour precipitation (0.95 in on 5/23/00) coincided with low bacteria density (10 FC/100 ml) and turbidity (1.19 NTU), while discharge was "normal." It should be noted that "48-hour" precipitation for 5/4/98 and 7/17/00 occurred over 72 hours, and that for 5/23/00 occurred over 120 hours. The fourth highest "48-hour" precipitation (0.34 in on 7/12/99) also occurred over 48 hours, and coincided with the third highest bacteria density (53 FC/100 ml) but low turbidity (0.76 NTU) and discharge ("low").

Figure 19. Glade Creek



Glade Creek water quality in terms of fecal coliform bacteria is generally satisfactory for water contact recreation. Since 1995, 4 of 34 samples (12%) have exceeded the state standard. Low bacteria densities in Glade Creek may be due in part to the lack of development within the watershed (Wood 1990a). Additional development has occurred within the Glade Creek watershed since the earlier report, but water quality remains good.

N07, Laurel Creek at Quinnimont

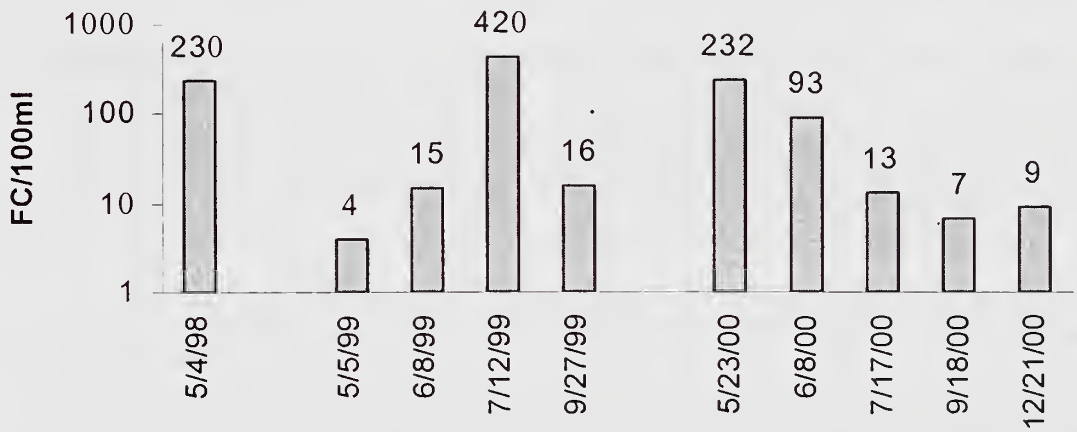
This site is near the mouth on stream right just downstream of a railroad bridge adjacent to the CSX Quinnimont railroad yard. Access is by State Route 41 to the railroad yard. Railroad personnel are the only people commonly seen in this area.

Laurel Creek is 11 miles long and drains 27.6 square miles (West Virginia Department of Natural Resources 1983). Laurel Creek enters the New River about 22.2 miles downstream from the Hinton gage and 14.2 miles upstream from the Thurmond gage.

Three of ten samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 20). Between 1998 and 2000 parameter values were as follows (App. 2): bacteria density 4 - 420 FC/100 ml (mean 103.9, median 15.5), turbidity 0.82 - 7.2 NTU (mean 2.63, median 1.91), 48-hour precipitation 0.00 - 1.44 in (mean 0.33, median

0.075), discharge 0.30 - 66.76 cfs (mean 29.94, median 18.5). Stream gage readings were not available for some dates, so visual characterizations of discharge were made.

Figure 20. Laurel Creek at Quinnimont



Bacteria density was generally elevated when 48-hour precipitation exceeded a third of an inch. The highest bacteria density (420 FC/100 ml on 7/12/99) coincided with the fourth highest 48-hour precipitation (0.34 in), although turbidity (1.36 NTU) and discharge were "low." The second highest bacteria density (232 FC/100 ml on 5/23/00) coincided with the second highest 48-hour precipitation (0.95 in), the fifth highest turbidity (2.33 NTU), and "normal" discharge. The third highest bacteria density (230 FC/100 ml on 5/4/98) coincided with the highest turbidity (7.2 NTU), discharge (66.76 cfs), and 48-hour precipitation (1.44 in). The "48-hour" precipitation for 5/23/00 occurred over 120 hours, and that for 5/4/98 occurred over 72 hours.

The second highest turbidity (4.79 NTU on 6/8/00) coincided with the fourth highest bacteria density (93 FC/100 ml), the third highest measured discharge (45 cfs), and minimal 48-hour precipitation (0.04 in). The second highest discharge (59.9 cfs on 12/21/00) coincided with low 48-hour precipitation (0.11 in), turbidity (1.49 NTU) and bacteria density (9 FC/100 ml). Ice was noted in the creek during sample collection on that date.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1990, 8 of 98 samples (8.2%) have exceeded the fecal coliform standard. Elevated 48-hour precipitation may be a good indicator of occasionally impaired water quality. Two of the three samples collected between 1998 and 2000 that exceeded 200 FC/100 ml coincided with substantial 48-hour precipitation, while 48-hour precipitation for the third occasion was more moderate.

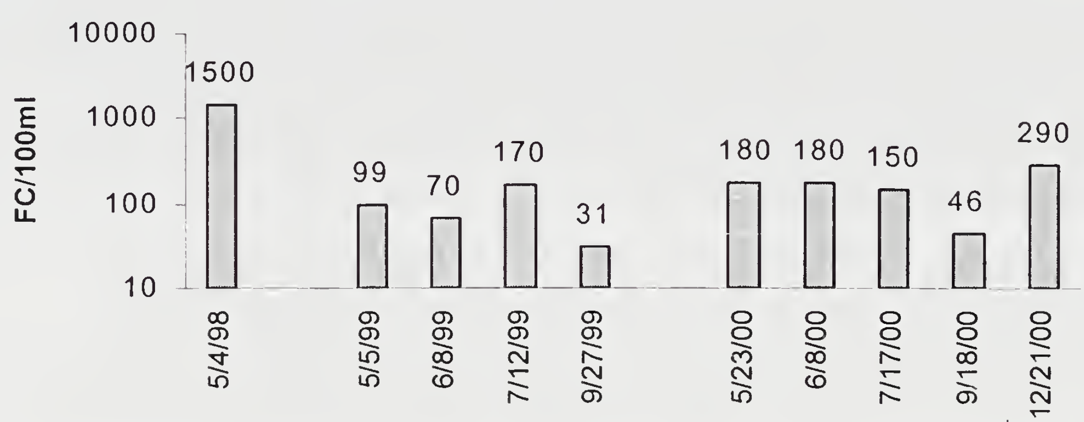
N09, Piney Creek at McCreery

This site is on stream left near the mouth of Piney Creek, about 200 meters upstream of the State Route 41 bridge. Piney Creek enters the New River on river left just downstream of a National Park Service public access. Rafters, including commercial outfitters launching from this access, and anglers are commonly seen near the mouth of Piney Creek.

Piney Creek is the largest tributary to the New River within New River Gorge National River. The stream is 33.5 miles long and drains 135.9 square miles (West Virginia Department of Natural Resources 1983). Piney Creek enters the New River about 25.0 miles downstream from the Hinton gage and 11.4 miles upstream from the Thurmond gage.

Two of ten samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 21). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 31 - 1,500 FC/100 ml (mean 271.6, median 160), turbidity 0.93 - 22.5 NTU (mean 6.98, median 4.05), 48-hour precipitation 0.00 - 1.44 in (mean 0.33, median 0.075), discharge 19.2 - 159.7 cfs (mean 62.4, median 46.3). A gage reading was not available for one sampling date, so discharge was categorized visually.

Figure 21. Piney Creek at McCreery



The highest bacteria density (1,500 FC/100 ml on 5/4/98) coincided with the highest turbidity (22.5 NTU), 48-hour precipitation (1.44 in), and discharge. Discharge was so high on this date that the gage could not be reached to be read. The "48-hour" precipitation for this date occurred over 72 hours. The second highest bacteria density (290 FC/100 ml on 12/21/00) coincided with the third lowest turbidity (3.02 NTU), the fourth highest discharge (69 cfs, third highest measured), and minimal 48-hour precipitation (0.11 in). As with Laurel Creek, ice was noted in the stream on this date.

The second highest turbidity (12.20 NTU on 7/17/00) coincided with the third highest discharge (120 cfs, second highest measured), the third highest 48-hour precipitation (0.44 in), and relatively moderate bacteria density (150 FC/100 ml). The second highest 48-hour precipitation (0.95 in on 5/23/00) coincided with the third highest bacteria density (180 FC/100 ml), and moderate turbidity (4.04 NTU) and discharge (46.3 cfs). The second highest discharge (159.7 cfs on 5/5/99, highest measured) coincided with moderate bacteria density (99 FC/100 ml) and turbidity (3.79 NTU) and low 48-hour precipitation (0.00 in). The "48-hour" precipitation for 7/17/00 occurred over 72 hours, and that for 5/23/00 occurred over 120 hours.

Piney Creek water quality in terms of fecal coliform bacteria is limited for contact recreation. Since 1990, 33 of 97 samples (34%) have exceeded the fecal coliform standard. Substantial 48-hour precipitation may precede runoff events that increase discharge, turbidity and fecal coliform bacteria density.

N26, Dowdy Creek

This site is 0.2 miles upstream from the mouth on stream right, just upstream of the McKendree Road (County Route 25) bridge crossing the creek. Rafters and anglers are commonly seen near the mouth of Dowdy Creek.

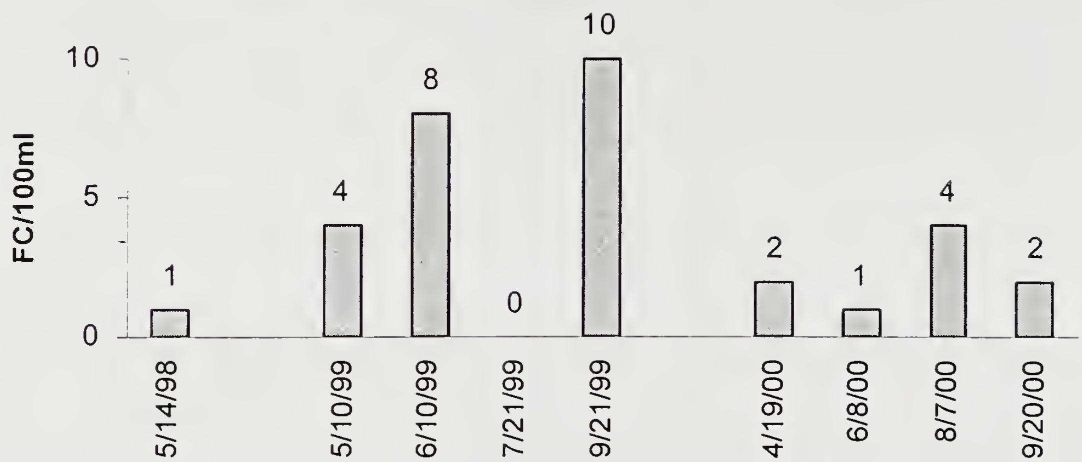
Dowdy Creek rises on the western slope of Highland Mountain and is about 3.1 miles long. It enters the New River about 29.1 miles downstream of the Hinton gage and 7.3 miles upstream of the Thurmond gage.

None of the nine samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 22). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 0 - 10 FC/100 ml (mean 3.55, median 2), turbidity 0.34 - 2.83 NTU (mean 0.93, median 0.52), 48-hour precipitation 0.00 - 0.82 in (mean 0.22, median 0.11), discharge "low" to "high." Four of the fecal coliform bacteria densities provided in Figure 22 have been rounded to the nearest whole number.

Bacteria density in Dowdy Creek was low regardless of turbidity, 48-hour precipitation or discharge. The greatest bacteria density (10 FC/100 ml on 9/21/99) coincided with a turbidity of 0.34 NTU, 48-hour precipitation of 0.11 in, and a "low" discharge.

The highest turbidity (2.83 NTU on 6/8/00) coincided with minimal bacteria density (1 FC/100 ml) and 48-hour precipitation (0.04 in), while discharge was "normal." The highest 48-hour precipitation (0.82 in on 4/19/00) also coincided with a minimal bacteria density (2 FC/100 ml) and turbidity (0.75 NTU), while discharge was "high." The second highest 48-hour precipitation (0.56 in on 7/21/99) coincided with minimal bacteria density (0 FC/100 ml) and "low" discharge, but the second highest turbidity (1.99 NTU). In addition to 4/19/00, discharge was also "high" on 5/14/98. On this date the values for the other major parameters were low. Bacteria density was 1 FC/100 ml, turbidity was 0.7 NTU and 48-hour precipitation was 0.00 in.

Figure 22. Dowdy Creek



Dowdy Creek water quality in terms of fecal coliform bacteria is satisfactory for contact recreation. Although a minimal number of samples (1 in 1997, 9 from 1998 to 2000) have been collected from the site, none have exceeded the fecal coliform standard. Dowdy Creek drains a fairly rural, undeveloped area with few potential sources of fecal contamination.

N25, Slater Creek

This site is about 0.53 miles upstream of the mouth on stream right just upstream of the McKendree Road (County Route 25) bridge across the creek. Rafters, anglers, and picnickers commonly use the National Park Service Day-Use area near the mouth of Slater Creek.

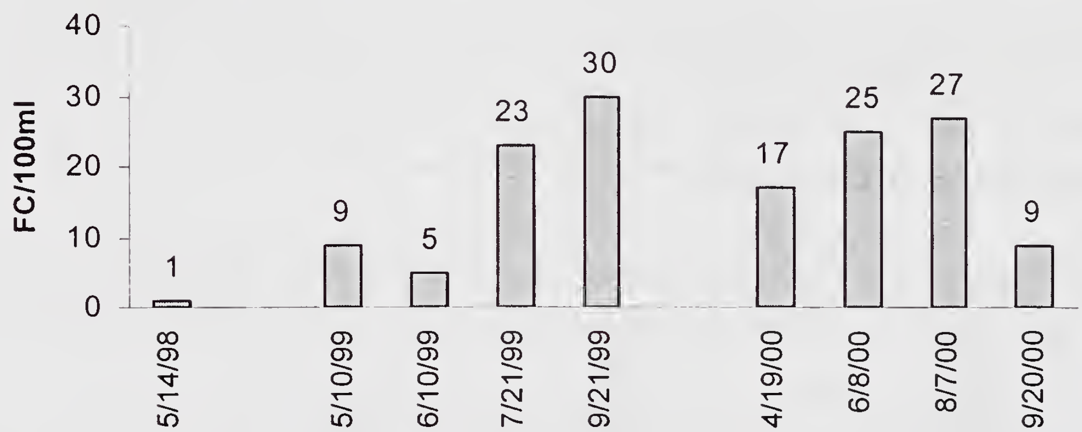
Slater Creek rises on the western slope of Mann Mountain, just south of Chestnut Knob, and flows about 4.8 miles to its mouth in the community of Thayer. Slater Creek enters the New River about 31.8 miles downstream of the Hinton gage and 4.6 miles upstream of the Thurmond gage.

None of the nine samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 23). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 1 - 30 FC/100 ml (mean 16.22, median 17), turbidity 2.36 - 11.20 NTU (mean 5.58, median 4.43), 48-hour precipitation 0.00 - 0.82 in (mean 0.22, median 0.11), discharge "low" - "high". Some fecal coliform densities provided in Figure 23 have been rounded to the nearest whole number.

Similar to Dowdy Creek, bacteria density in Slater Creek remained low, regardless of turbidity, 48-hour precipitation or discharge. The greatest bacteria density (30 FC/100 ml on 9/21/99) coincided with moderate turbidity (4.24 NTU), low 48 hour precipitation (0.11 in) and "low" discharge. The second highest bacteria density (27 FC/100 ml on

8/7/00) coincided with moderate turbidity (4.43 NTU), higher 48-hour precipitation (0.27 in) and "normal" discharge. The "48-hour" precipitation for 8/7/00 occurred over 72 hours.

Figure 23. Slater Creek



The highest turbidity (11.20 NTU on 6/8/00) coincided with the third highest bacteria density (25 FC/100 ml), "normal" discharge, and minimal 48-hour precipitation (0.04 in). The second highest turbidity (8.87 NTU on 4/19/00) coincided with the highest 48-hour precipitation (0.82 in), "high" discharge, and the fifth highest bacteria density (17 FC/100 ml). The second highest 48-hour precipitation (0.56 in on 7/21/99) coincided with the fourth highest bacteria density (23 FC/100 ml) and turbidity (5.00 NTU), but "low" discharge. In addition to 4/19/00, "high" discharge also occurred on 5/14/98. This date had the lowest bacteria density (1 FC/100 ml), third highest turbidity (6.9 NTU), and no 48-hour precipitation (0.00 in).

Water quality of Slater Creek in terms of fecal coliform bacteria is satisfactory for contact recreation. Although a minimal number of samples (1 in 1997, 9 from 1998 to 2000) have been collected from the site, none have exceeded the fecal coliform standard. Slater Creek drains a fairly undeveloped area. An inactive strip mine is located near its headwaters.

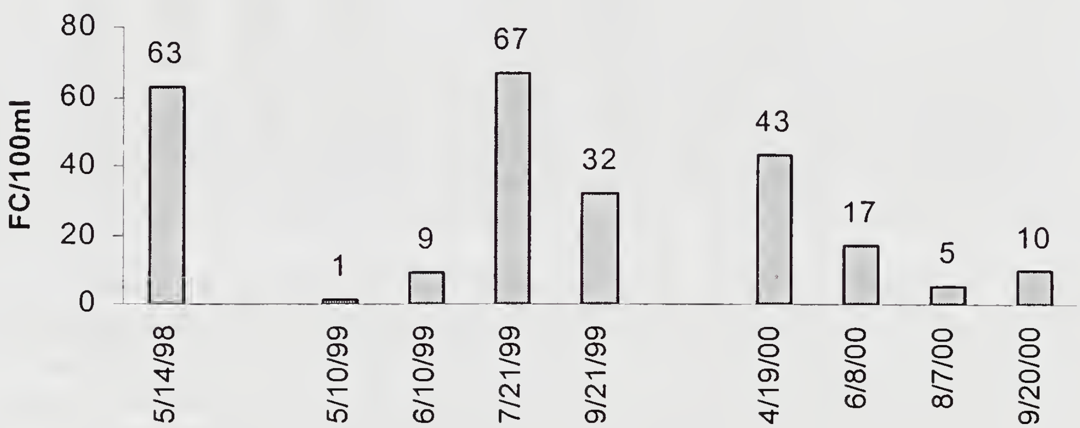
N24, Buffalo Creek

This site is on stream right just downstream of the McKendree Road (County Route 25) bridge across the creek. Buffalo Creek is designated a "Fly Fishing Only" stream by the West Virginia Department of Natural Resources. Anglers and hikers visit the site. Rafters and anglers visit the mouth of the creek where it enters the New River.

Buffalo Creek rises northwest of Chestnut Knob and east of Beury Mountain, and runs about 4 miles to its mouth. It enters the New River about 32.6 miles downstream of the Hinton gage and 3.8 miles upstream of the Thurmond gage.

None of the nine samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 24). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 1 - 67 FC/100 ml (mean 27.44, median 17), turbidity 1.31 - 5.25 NTU (mean 2.73, median 1.94), 48-hour precipitation 0.00 - 0.82 in (mean 0.22, median 0.11), discharge "low" - "high." Some fecal coliform values presented in Figure 24 have been rounded to the nearest whole number.

Figure 24. Buffalo Creek



Similar to Dowdy and Slater Creeks, bacteria density in Buffalo Creek remained low in 1998 - 2000. The greatest bacteria density (67 FC/100 ml on 7/21/99) coincided with the second highest 48-hour precipitation (0.56 in), low turbidity (1.66 NTU) and "low" discharge. The second highest bacteria density (63 FC/100 ml on 5/14/98) coincided with higher turbidity (2.90 NTU) and discharge was "high" discharge, but 48-hour precipitation was nil (0.00 in).

The highest turbidity (5.25 NTU on 4/19/00) coincided with the highest 48-hour precipitation (0.82 in), the third highest bacteria density (43 FC/100 ml) and "high" discharge. The second highest turbidity (5.14 NTU on 6/8/00) coincided with a low 48-hour precipitation (0.04 in), moderate bacteria density (17 FC/100 ml) and "normal" discharge.

Buffalo Creek water quality in terms of fecal coliform bacteria is satisfactory for contact recreation. Although a minimal number of samples (1 in 1997, 9 from 1998 to 2000) have been collected, none have exceeded the fecal coliform standard. Throughout 1998 to 2000 bacteria densities remained low regardless of values for turbidity, 48-hour precipitation and discharge.

N27, Claremont Mine Spring

The water at this site originates in a poorly reclaimed coal gob pile, and exits the pile through a metal pipe next to a ditch along McKendree Road (County Route 25). This water eventually enters the New River via culverts. Samples were collected from the discharge of the metal pipe.

It is unknown how many people use this water, or for what purpose(s) it is used. The amount of water discharged through the pipe is unknown, and it is also not known if water leaves the gob pile in other ways. The site is approximately 34.5 miles downstream of the Hinton gage and 1.9 miles upstream of the Thurmond gage.

Samples were analyzed for fecal coliform bacteria densities and turbidity in the laboratory. Forty-eight hour precipitation was noted for each sample date, but field measurements of pH, dissolved oxygen, conductivity and temperature were not made.

None of the nine samples collected between 1998 and 2000 exceeded the contact recreation standard (Fig. 25). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 0 - 0.7 FC/100 ml (mean 0.22, median 0), turbidity 0.34 - 3.18 NTU (mean 1.38, median 1.18), 48-hour precipitation 0.00 - 0.82 in (mean 0.22, median 0.11). In Figure 25 the five samples with no colony growth on either filter are presented as 0 FC/100 ml, while the four samples with bacteria growth on the filters are presented as the estimated numeric value.

Figure 25. Claremont Mine Spring

The highest bacteria density was 0.7 FC/100 ml on 6/8/00. Turbidity was 1.42 NTU and 48-hour precipitation was 0.04 in. The highest turbidity (3.18 NTU on 4/19/00) coincided with the greatest 48-hour precipitation (0.82 in), while bacteria density was 0

FC/100 ml. The second highest turbidity (2.50 NTU on 5/14/98) coincided with a 48-hour precipitation of 0.00 in, while bacteria density was 0 FC/100 ml.

Water quality of the Claremont Mine Spring in terms of fecal coliform bacteria is satisfactory for contact recreation. Although minimal samples have been collected (1 in 1996, 9 from 1998 to 2000), none have exceeded 1 FC/100 ml. Fecal coliforms were detected on four sample dates (not including the 1996 sample), indicating that this water is unsuitable for human consumption without appropriate treatment. The source(s) of the fecal coliform bacteria is (are) unknown, but could be wildlife, humans, or domestic animals such as dogs. The bacteria associated with fecal material likely enter the water via cracks and crevices in the ground surface and/or the discharge pipe.

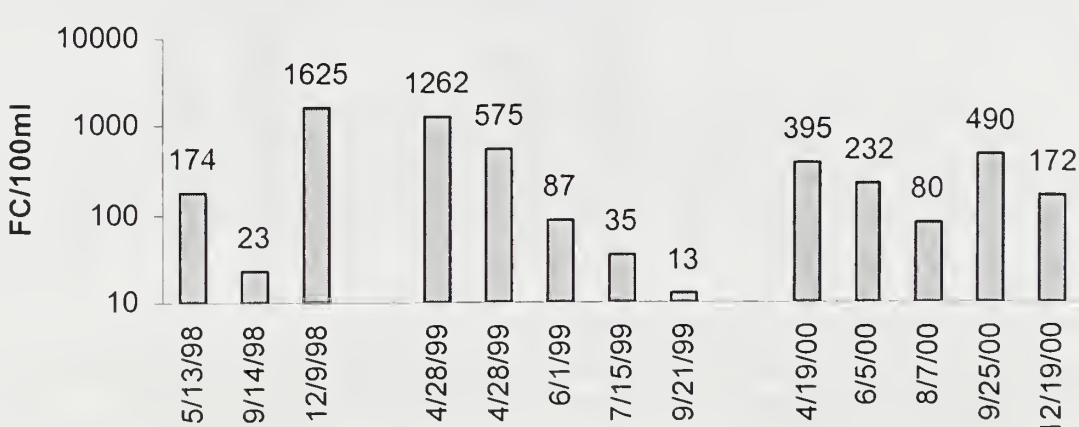
N11, Dunloup Creek

This site is on stream left, just downstream of the County Route 25 bridge near the National Park Service Thurmond-Minden Trailhead parking area. Anglers frequently use this stream. Dunloup Creek is stocked with trout by the West Virginia Department of Natural Resources and a local chapter of Trout Unlimited to maintain a put-and-take fishery. Hikers, cyclists and other visitors also visit this area.

Dunloup Creek drains 48.5 square miles along its 14.9-mile length (West Virginia Department of Natural Resources 1983). It enters the New River about 36.5 miles downstream of the Hinton gage and 0.1 miles downstream from the Thurmond gage.

Six of thirteen samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 26). Between 1998 and 2000 parameter values ranged as follows (App 2): bacteria density 13 - 1,625 FC/100 ml (mean 397.1, median 174), turbidity 1.10 - 57.3 NTU (mean 15.56, median 6.62), 48-hour precipitation 0.00 - 1.69 in (mean 0.46, median 0.20), discharge 8.1 - 149.9 cfs (mean 62.5, median 37.1).

Figure 26. Dunloup Creek



High bacteria density generally coincided with high turbidity, 48-hour precipitation or discharge. The highest bacteria density (1,625 FC/100 ml on 12/9/98) coincided with the greatest 48-hour precipitation (1.69 in), the third highest turbidity (37.0 NTU) and moderate discharge (59.7 cfs). The Mt. Hope sewage treatment plant lift station bypassed partially treated wastewater to Dunloup Creek from 12/8/98 to 12/9/98. Precipitation events such as the 1.69 in noted for the 12/9/98 sample often lead to overflows at the lift station due to I&I problems associated with the collection system.

The second highest bacteria density (1,262 FC/100 ml) occurred in the first of two samples collected on 4/28/99. Forty-eight-hour precipitation for this date was 0.92 in. The first sample, collected at 9:00 AM, also had the second highest turbidity (49.2 NTU), and the third highest discharge (131.9 cfs). The second sample, taken at 10:55 AM, had the third highest bacteria density (575 FC/100 ml), the highest turbidity (57.3 NTU), and the second highest discharge of (140.7 cfs). The highest discharge (149.9 cfs on 5/13/98) coincided with relatively moderate bacteria density (174 FC/100 ml), and turbidity (4.5 NTU) and no 48-hour precipitation (0.00 in).

The second highest 48-hour precipitation (0.97 in on 12/19/00) coincided with relatively moderate bacteria density (172 FC/100 ml), turbidity (6.11 NTU) and discharge (41.2 cfs). A possible reason for these lower values is that the "48-hour" precipitation for this date occurred over 120 hours. Three other samples with high 48-hour precipitation (0.92 in for the two 4/28/99 samples and 0.82 in for 4/19/00) all had bacteria densities exceeding 200 FC/100 ml. Bacteria density on 9/25/00 was high (490 FC/100 ml), even though 48-hour precipitation (0.20 in), discharge (24.4 cfs) and turbidity (10.8 NTU) were low.

Dunloup Creek water quality in terms of fecal coliform bacteria is generally limited for contact recreation. Since 1990, 148 of 324 samples (45.7%) have exceeded the fecal coliform standard.

N13, Arbuckle Creek

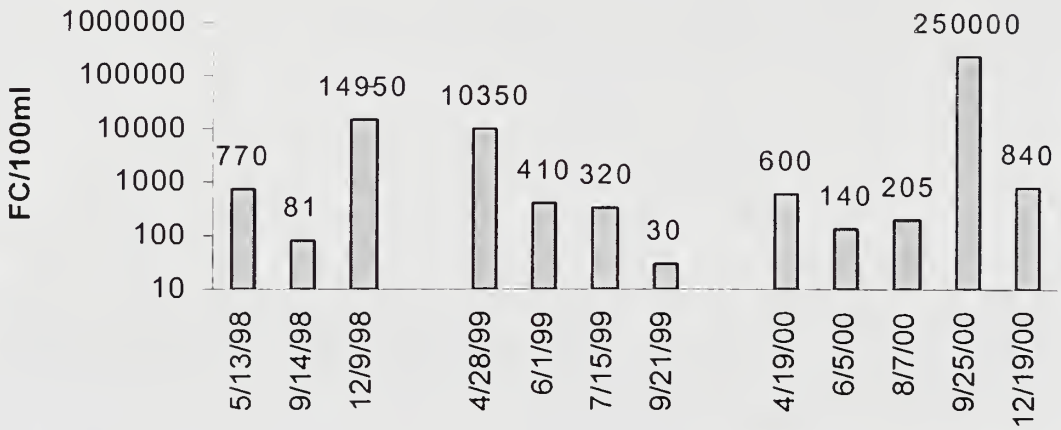
This site is on stream right underneath the Thurmond-Minden Trail bridge that crosses the creek near its mouth. Anglers, hikers and mountain bikers commonly visit this area.

Arbuckle Creek drains 8.7 square miles along its 6.2-mile length (West Virginia Department of Natural Resources 1983). Arbuckle Creek enters the New River approximately 37.2 miles downstream of the Hinton gage and 0.8 miles downstream of the Thurmond gage.

Nine of 12 samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 27). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 30 - 250,000 FC/100 ml (mean 23,224, median 505), turbidity 2.4 - 626

NTU (mean 63.27, median 5.71), 48-hour precipitation 0.00 - 1.69 in (mean 0.42, median 0.16), discharge 2.1 - 100 cfs (mean 29.69, median 19.8).

Figure 27. Arbuckle Creek



The highest bacteria density (250,000 FC/100 ml on 9/25/00) coincided with the highest turbidity (626.0 NTU) and discharge (100 cfs), while 48-hour precipitation was relatively low (0.20 in). The second highest bacteria density (14,950 FC/100 ml on 12/9/98) coincided with the highest 48-hour precipitation (1.69 in), while turbidity (30 NTU) and discharge (19.8 cfs) were somewhat less. The Oak Hill sewage treatment plant bypassed wastewater to Arbuckle Creek on 12/8/98. The third highest bacteria density (10,350 FC/100 ml on 4/28/99) coincided with the second highest turbidity (59.4 NTU) and discharge (43.2 cfs), and the third highest 48-hour precipitation (0.92 in). The second highest 48-hour precipitation (0.97 in on 12/19/00) coincided with the fourth highest bacteria density (840 FC/100 ml), while turbidity 5.61 NTU and discharge (8.8 cfs) were relatively low. Discharge and turbidity may have been low on 12/19/00 because "48-hour" precipitation for this date actually occurred over 120 hours.

It is unknown why bacteria density, turbidity and discharge were so elevated on 9/25/00 when 48-hour precipitation was only 0.20 in. Rain gage records showed no significant precipitation even 96 hours prior to sample collection on 9/25/00. Possible explanations include a localized precipitation event, treatment plant bypass, and treatment plant or collection system failure.

Arbuckle Creek water quality in terms of fecal coliform bacteria is unsatisfactory for contact recreation. Since 1990, 60 of 98 samples (61.2%) have exceeded the fecal coliform standard. Historically, Arbuckle Creek has been severely polluted by wastewater originating from the Oak Hill and Arbuckle Public Service District wastewater treatment plants, both of which discharge into Arbuckle Creek. Both facilities frequently bypass untreated or partially treated wastewater into Arbuckle Creek due to hydraulic overloading and I&I problems with their collection systems. Lift stations along the collection systems sometimes overflow, even during relatively dry periods (Wilson and Purvis 2000).

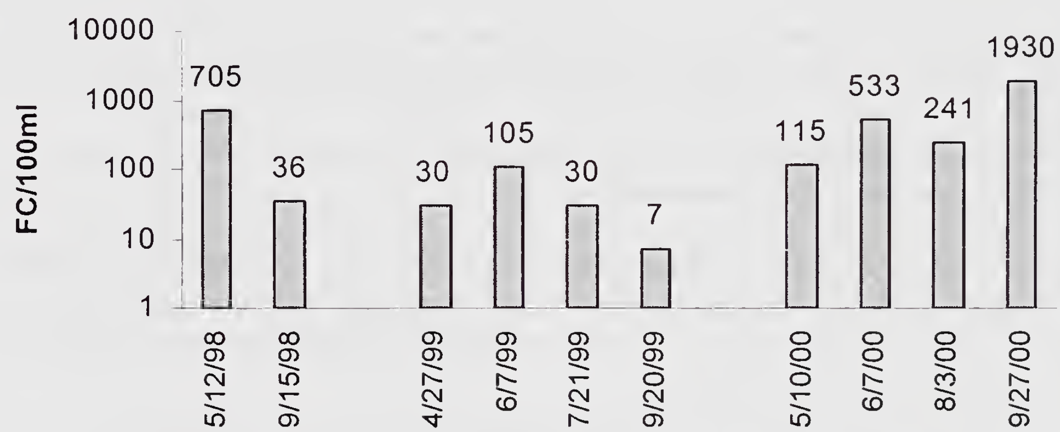
N15, Coal Run

This site is on stream left underneath an old railroad trestle across Coal Run near its mouth, just off the Cunard to Kaymoor Trail. Anglers and hikers are commonly seen in this area.

Coal Run is about 5.8 miles long, and drains areas once mined for coal and the communities of Gatewood, Brooklyn and Cunard. Coal Run enters the New River about 44.0 miles downstream of the Hinton gage and 7.6 miles downstream of the Thurmond gage.

Four of ten samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 28). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 7 - 1,930 FC/100 ml (mean 373.2, median 110), turbidity 3.26 - 14.10 NTU (mean 7.52, median 7.47), 48-hour precipitation 0.00 - 2.01 in (mean 0.42, median 0.09), discharge "low" - "high."

Figure 28. Coal Run



The 8/3/00 sample produced colonies "too numerous to count" (TNTC) on both filters. This resulted in a reported bacteria density of >240 FC/100 ml. This is presented as 241 FC/100 ml in the Figure 28. The actual bacteria density on this date may have been considerably greater.

The two highest bacteria densities coincided with the two highest 48-hour precipitation amounts. The highest bacteria density (1,930 FC/100 ml on 9/27/00) coincided with the highest 48-hour precipitation (2.01 in), "high" discharge, and the third highest turbidity (8.94 NTU). The second highest bacteria density (705 FC/100 ml on 5/12/98) coincided with the second highest 48-hour precipitation (0.93 in), "high" discharge, and more moderate turbidity (5.8 NTU). These were the only two sample dates with "high" discharge. The "48-hour" precipitation for 5/12/98 occurred over 120 hours.

High bacteria density also occurred during "normal" discharge. For example, "normal" discharge on 6/7/00 coincided with the third highest bacteria density (533 FC/100 ml) and the fourth highest turbidity (8.75 NTU) and 48-hour precipitation (0.49 in).

High turbidity was not necessarily associated with high fecal coliform density. The highest turbidity (14.10 NTU on 8/3/00) coincided with a high bacteria density (>240 FC/100 ml, see note above), while 48-hour precipitation was low (0.02 in) and discharge was "normal". The second highest turbidity (10.0 NTU on 6/7/99) coincided with a more moderate bacteria density (105 FC/100 ml), low 48-hour precipitation (0.00 in), and "low" discharge.

Coal Run water quality in terms of fecal coliform bacteria is limited for contact recreation. Since 1990, 39 of 97 samples (40.2%) have exceeded the fecal coliform standard. During 1998-2000 the highest bacteria densities coincided with high values for 48-hour precipitation. Turbidity was elevated on nine of the ten sample dates, with the highest turbidities coinciding with minimal 48-hour precipitation. This phenomenon may be related to logging and other land disturbing activities within the drainage.

N16, Keeney Creek

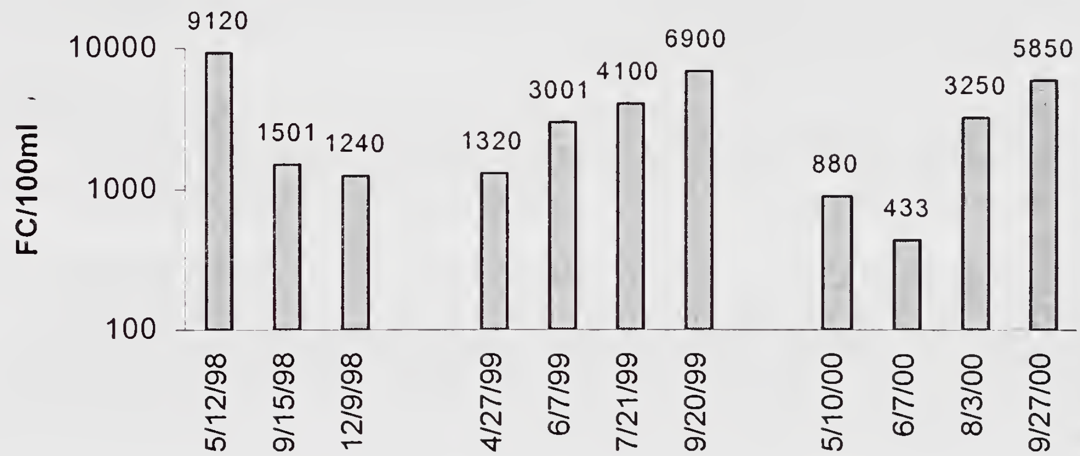
This site is on stream left, just downstream of a bridge across the creek in the lower end of the community of Winona. Vehicle access is by Lansing-Edmond Road (County Route 82) to Winona, and then right onto Keeney Creek Road (County Route 85). Nearby residents are often seen near the creek, and minnow traps and toys are commonly seen in and near the creek at the sampling site.

Keeney Creek rises west of the community of Divide and drains 8.9 square miles along its 6.9-mile length (West Virginia Department of Natural Resources 1983). Keeney Creek enters the New River approximately 46.1 miles downstream of the Hinton gage and 9.7 miles downstream of the Thurmond gage.

All eleven samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 29). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 433 - 9,120 FC/100 ml (mean 3,418, median 3,001), turbidity 0.65 - 6.33 NTU (mean 2.68, median 2.9), 48-hour precipitation 0.00 - 2.01 in (mean 0.53, median 0.16), discharge "low" - "high".

Samples from 9/15/98 and 6/7/99 both produced colonies "too numerous to count" (TNTC) on both filters. This resulted in reported bacteria densities of >1,500 FC/100 ml on 9/15/98 and >3,000 FC/100 ml on 6/7/99. These are presented as 1,501 FC/100 ml and 3,001 FC/100 ml, respectively, in Figure 29. Actual bacteria density on these dates may have been considerably greater.

Figure 29. Keeney Creek



Fecal coliform bacteria density was high regardless of turbidity, 48-hour precipitation or discharge. The highest bacteria density (9,120 FC/100 ml on 5/12/98) coincided with "high" discharge, and the third highest 48-hour precipitation (0.93 in) and turbidity (3.40 NTU). The "48-hour" precipitation for this date occurred over 120 hours. The second highest bacteria density (6,900 FC/100 ml on 9/20/99) coincided with "low" discharge and precipitation (0.00 in) and moderate turbidity (2.26 NTU).

Turbidity was not greatly elevated on any sample date, even when 48-hour precipitation exceeded one inch (12/9/98 and 9/27/00). The highest turbidity (6.33 NTU on 8/3/00) coincided with high bacteria density (3,250 FC/100 ml), while 48-hour precipitation was low (0.02 in) and discharge was "normal.". The highest 48-hour precipitation (2.01 in on 9/27/00) coincided with the third highest bacteria density (5,850 FC/100 ml), moderate turbidity (3.07 NTU) and "normal" discharge.

Discharge was "high" on two sample dates. Data for 5/12/98 are noted above. For 6/7/00, turbidity was second highest (5.47 NTU), while bacteria density was the lowest (433 FC/100 ml), and 48-hour precipitation was moderate (0.49 in).

Keeney Creek water quality in terms of fecal coliform bacteria is unsatisfactory for contact recreation. Since 1990, 95 of 99 samples collected (95.9%) have exceeded the fecal coliform standard. Monitoring of Keeney Creek water quality indicates a substantial and continuous source, or sources, of fecal material entering the stream. Residences in the communities of Winona, Lookout and Divide, all without a centralized wastewater treatment facility, are likely sources of this chronic contamination. General apathy towards the stream is indicated by the amount of solid waste, mostly household trash, regularly noted at the monitoring site. Keeney Creek should be considered a definite health risk to those coming into contact with its waters.

N18, Wolf Creek

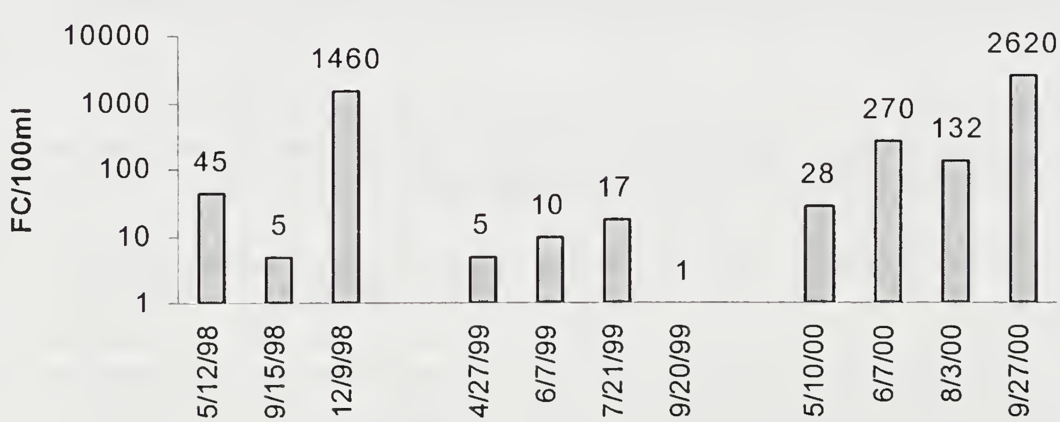
This site is on stream right at the mouth of Wolf Creek near the Fayette Station river access parking area off of Fayette Station Road (County Route 82). Anglers, rafters, hikers and sightseers commonly visit this area.

Wolf Creek drains 17.4 square miles along its 5.2 mile length (West Virginia Department of Natural Resources 1983). Wolf Creek enters the New River about 50.05 miles downstream of the Hinton gage and 13.65 miles downstream of the Thurmond gage.

Three of eleven samples collected between 1998 and 2000 exceeded the fecal coliform standard (Fig. 30). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 1 - 2,620 FC/100 ml (mean 417.5, median 28), turbidity 1.30 - 27.0 NTU (mean 6.98, median 3.50), 48-hour precipitation 0.00 - 2.01 in (mean 0.53, median 0.16), discharge 1.55 - 49.63 cfs (mean 12.36, median 5.53).

The three samples that exceeded the fecal coliform standard generally coincided with elevated turbidity, discharge, and 48-hour precipitation. The highest bacteria density (2,620 FC/100 ml on 9/27/00) coincided with the greatest discharge (49.63 cfs) and 48-hour precipitation (2.01 in), and the second highest turbidity (14.6 NTU). The second highest bacteria density (1,460 FC/100 ml on 12/9/98) coincided with the greatest turbidity (27.0 NTU), the second highest 48-hour precipitation (1.69 in), and the third highest discharge (36.2 cfs). The third highest bacteria density (270 FC/100 ml on 6/7/00) coincided with the fourth highest turbidity (7.37 NTU) and discharge (10.53 cfs), and the fifth highest 48-hour precipitation (0.49 in).

Figure 30. Wolf Creek



Water quality of Wolf Creek in terms of fecal coliform bacteria is limited for contact recreation. Since 1990, 28 of 97 samples (28.9%) have exceeded the fecal coliform standard. Bacteria densities for this site during this study often exceeded the fecal coliform standard following significant 48-hour precipitation events. Similar results were noted earlier (e.g. Wilson and Purvis 2000). Residences without sewer or a septic system, inadequate septic systems, a malfunctioning sewer collection system, pastureland and an overloaded sewer system lift station on House Branch are potential sources of bacterial contaminants found in Wolf Creek. An abandoned coal gob pile near the headwaters contributes acid drainage to Wolf Creek. Negative impacts on the pH have not been noted at the mouth. The amount of acid drainage into Wolf Creek is unknown, and it may be neutralized before reaching the mouth.

N28, Ajax Mine Spring

This site is on Fayette Station Road (County Route 82), north of the New River. The site is approximately 50.2 miles downstream of the Hinton gage and 13.8 miles downstream of the Thurmond gage.

The water originates from the former Ajax Mine. Discharge of this water source is not known. A sizable, but unknown, number of area residents collect water from this site for household use. During dry periods this may be the only water reliably available to area residents that normally depend on wells and cisterns. Water flows continuously from a large hose into a ditch along Fayette Station Road, and eventually to the New River.

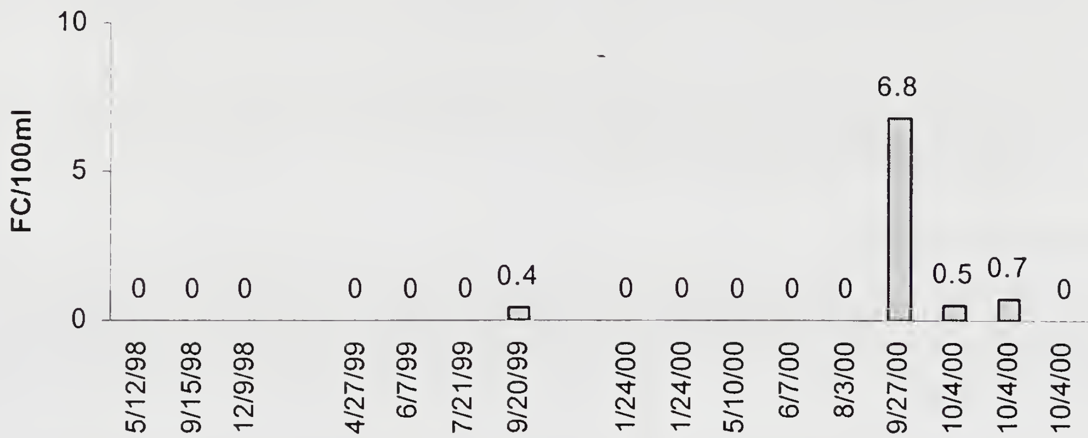
Water can be collected three small (faucet-sized) spigots, and one large spigot with an attached hose about 3 inches in diameter. Samples were usually taken from the large hose, but were taken from one of the smaller spigots if the hose was being used at the time of collection. The exact source of the sample was noted at the time of collection. Field measurements of pH, dissolved oxygen, conductivity and temperature were not made, but 48-hour precipitation was noted and turbidity was measured in the laboratory.

None of the sixteen samples collected between 1998 and 2000 exceeded the contact recreation standard (Fig. 31). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 0 - 6.8 FC/100 ml (mean 0.52, median 0), turbidity 0.11 - 1.91 NTU (mean 0.52, median 0.25), 48-hour precipitation 0.00 - 2.01 in (mean 0.45, median 0.04).

Twelve of the values presented in Figure 31 were originally reported with a "<" symbol next to the numeric value (App. 2). These values are presented as zero in Figure 31. Three samples produced one colony, and they are presented as the estimated value. The 9/27/00 sample produced 17 colonies, so the estimated numeric value is presented.

Multiple samples were collected on 1/24/00 (two samples) and 10/4/00 (three samples). The 1/24/00 samples were collected sequentially from the same hose. The first sample was collected before the hose was flushed, and the second sample was collected after the hose was flushed. Samples on 10/4/00 were taken from three outlets: the pump house spring box, large green hose, and as a composite of the small spigots. These samples were taken to check variability between outlets.

Figure 31. Ajax Mine Spring



Fecal coliforms were noted only from four samples taken on three dates: 9/20/99, 9/27/00, and 10/4/00 (2 samples). Fecal coliforms in these samples indicates that this water is unsuitable for human consumption without treatment. The highest bacteria density (6.8 FC/100 ml on 9/27/00) coincided with the highest turbidity (1.91 NTU) and 48-hour precipitation (2.01 in). The second highest turbidity (1.70 NTU on 12/9/98) coincided with the second highest 48-hour precipitation (1.69 in), but bacteria density was 0 FC/100 ml. The third highest 48-hour precipitation (0.93 in on 5/12/98) also coincided with low bacteria density (0 FC/100 ml) and turbidity (0.20 NTU). The "48-hour" precipitation for this date occurred over 120 hours.

A likely source of fecal coliform bacteria in this water is the ground on which the hose was often found laying. Also, fecal-contaminated surface water may enter cracks and crevices that lead to the mine voids that produce this water. This may be especially true during significant precipitation events.

Ajax Mine Spring water quality in terms of fecal coliform bacteria is satisfactory for contact recreation. None of the 35 samples collected since 1995 (7 in 1995, 10 in 1996, 2 in 1997, 16 from 1998 to 2000; App. 2) have exceeded the state standard. However, the presence of fecal coliform bacteria in some samples indicates that this water is not suitable for human consumption unless it is treated or disinfected.

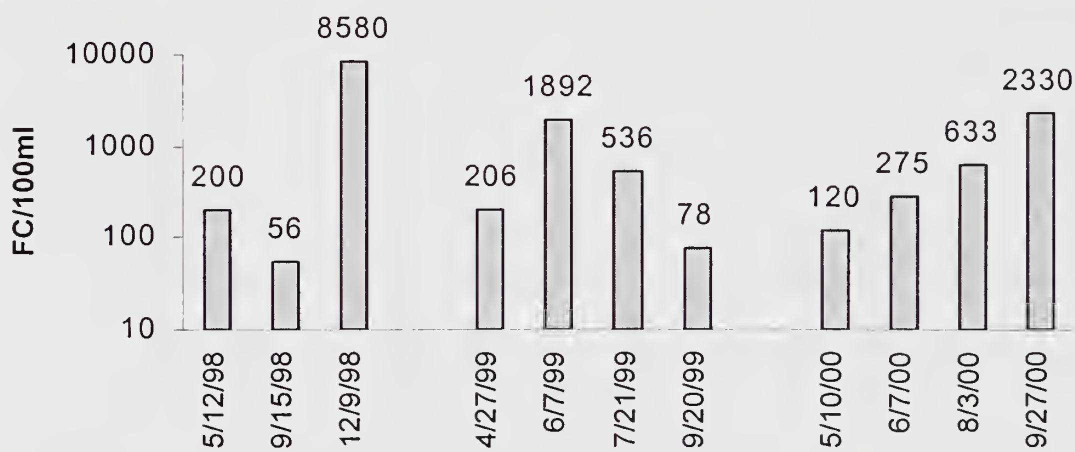
N19, Marr Branch

This site is on stream right just off Fayette Station Road (County Route 82) below the Rivers Inc. complex. Guests of Rivers Inc. are sometimes seen at the site. Anglers and rafters are common near the confluence of Marr Branch with the New River.

Marr Branch, about 2.75 miles long, rises west of the community of Oak Ridge and just north of Fayetteville. The Fayetteville Wastewater Treatment Plant discharges into an unnamed tributary of Marr Branch upstream of the monitoring site. Marr Branch enters the New River about 50.9 miles downstream of the Hinton gage and 14.5 miles downstream of the Thurmond gage.

Seven of the eleven samples collected between 1998 and 2000 exceeded, and one sample equaled, the fecal coliform standard (Fig. 32). Between 1998 and 2000 parameter values ranged as follows (App. 2): bacteria density 56 - 8,580 FC/100 ml (mean 1,355, median 275), turbidity 1.97 - 22.0 NTU (mean 5.47, median 3.18), 48-hour precipitation 0.00 - 2.01 in (mean 0.53, median 0.16), discharge 0.25 - 24.5 cfs (mean 4.25, median 0.72).

Figure 32. Marr Branch



The highest bacteria density (8,580 FC/100 ml on 12/9/98) coincided with the highest turbidity (22.0 NTU) and discharge (24.5 cfs), and the second highest 48-hour precipitation (1.69 in). The Fayetteville sewage treatment plant discharged wastewater to a tributary of Marr Branch from 12/8/98 to 12/9/98.

The second highest bacteria density (2,330 FC/100 ml on 9/27/00) coincided with the highest 48-hour precipitation (2.01 in) and the second highest turbidity (9.31). A staff gage reading was unavailable for 9/27/00, but discharge was categorized visually as "normal". The third highest bacteria density (1,892 FC/100 ml on 6/7/99) coincided with low turbidity (1.97 NTU), 48-hour precipitation (0.00 in), and discharge (0.25 cfs). All other dates that Marr Branch exceeded the fecal coliform standard coincided with the other monitored parameters being at minimal to moderate levels.

The three highest turbidity values coincided with significant 48-hour precipitation. Data for 12/9/98 and 9/27/00 are noted above. The third highest turbidity (5.1 NTU on 5/12/98) coincided with the third highest 48-hour precipitation (0.93 in) and the second highest discharge (7.8 cfs), while bacteria density was 200 FC/100 ml. The "48-hour" precipitation for this date occurred over 120 hours.

Marr Branch water quality is unsatisfactory with regard to contact recreation standards. Since 1991, 72 of 97 (74.2%) samples have exceeded the fecal coliform standard. Marr Branch historically has been impacted by sewage originating primarily from the Fayetteville sewage treatment plant. This was especially true prior to 1994. A new treatment facility became operational in December of 1994. This reduced, but not eliminated, bacterial contamination of Marr Branch (Wilson and Purvis 2000). One reason for continued fecal contamination is likely I&I problems with the collection system for this facility.

GAULEY RIVER NATIONAL RECREATION AREA

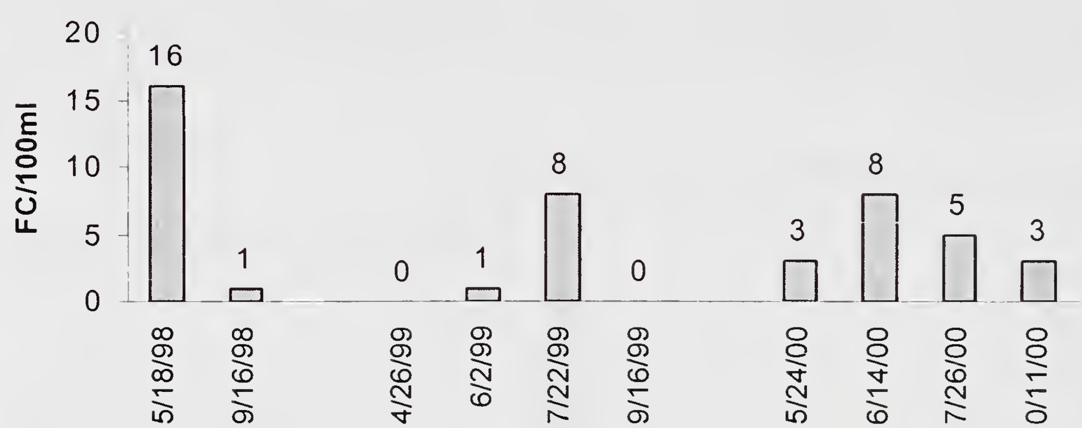
G01, Summersville Dam

This site is on river right of the Gauley River below Summersville Dam. Vehicle access is by the tailwaters access road off State Route 129. Typical visitors include boaters, anglers, campers and sightseers.

The site is about 600 feet upstream of the Summersville Dam gage. No streams enter the Gauley River between the sampling site and the gage.

None of the ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 33). Parameter values ranged as follows (App. 3): bacteria density 0 - 16 FC/100 ml (mean 4.5, median 3), turbidity 1.69 - 4.28 NTU (mean 2.59, median 2.33), 48-hour precipitation 0.00 - 0.38 in (mean 0.07, median 0.005), discharge 100 - 1,739 cfs (mean 576, median 452).

Figure 33. Summersville Dam



Bacteria densities for all samples were well below the fecal coliform standard. The highest bacteria density (16 FC/100 ml on 5/18/98) coincided with moderate turbidity (3.5 NTU), nil 48-hour precipitation (0.00 in), and discharge (705 cfs) within the normal range for the season.

The highest turbidity (4.28 NTU on 4/26/99), visually characterized as "clear," coincided with very low fecal coliform (<1 FC/100 ml), nil 48-hour precipitation (0.00 in) and the second lowest discharge (200 cfs). The greatest 48-hour precipitation (0.38 in on 5/24/00) coincided with the highest discharge (1,739 cfs), but bacteria density (3 FC/100 ml) and turbidity (1.99 NTU) were low.

Water quality in terms of fecal coliform bacteria at this site is satisfactory for contact recreation. Since 1991, only 2 of 88 samples (2.3%) have exceeded the fecal coliform standard. Both of these samples were collected in 1996. The high fecal coliform densities were attributed to runoff from a stormwater drain above the sampling site, and were not typical of water released from Summersville Dam (Wilson and Purvis 2000). Summersville Lake serves as a catch basin for sediments and other materials originating upstream, and the retention time behind the dam probably allowed for die-off of fecal coliform bacteria (Hebner 1991a, and Sullivan 1993a,c).

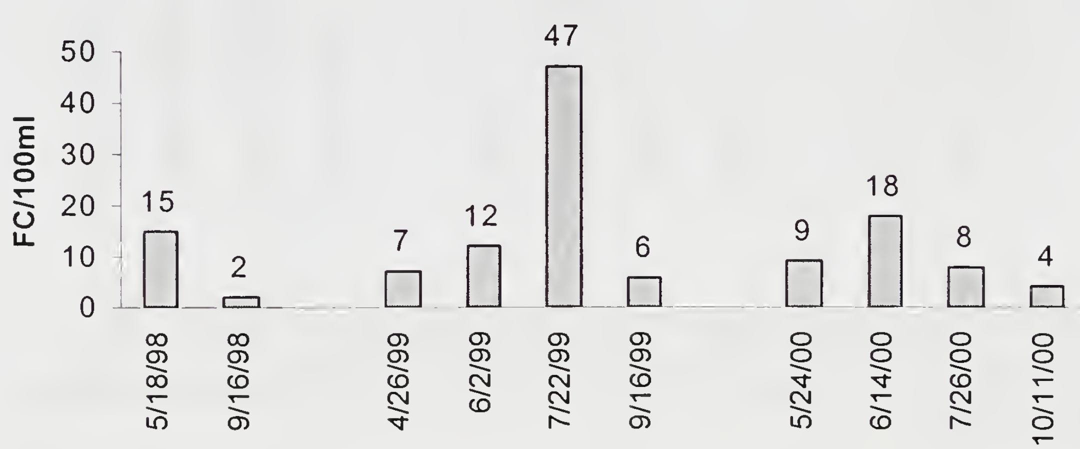
G06, Gauley River at Mason Branch

This site is on river right upstream of the river access at Mason Branch, just above Driftwood Beach. Vehicle access is by Panther Mountain Road (County Road 22) off State Route 129. Typical visitors to this site are boaters, anglers and campers.

This site is about 8.6 miles downstream of the Summersville Dam gage. Ten tributaries (six perennial and four intermittent) enter the Gauley River between the gage and the site.

None of the ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 34). Parameter values ranged as follows (App. 3): bacteria density 2 - 47 FC/100 ml (mean 12.8, median 8.5), turbidity 0.91 - 6.37 NTU (mean 2.34, median 1.70), 48-hour precipitation 0.00 - 0.38 in (mean 0.67, median 0.005), discharge 100 - 1,739 cfs (mean 576, median 452).

Figure 34. Gauley River at Mason Branch



Bacteria density for all samples was well below the state standard. The highest bacteria density (47 FC/100 ml on 7/22/99) coincided with the lowest discharge (100 cfs), minimal 48-hour precipitation (0.06 in), and the second lowest turbidity (1.47 NTU). The highest turbidity (6.37 NTU on 4/26/99) coincided with the second lowest discharge (200 cfs), low bacteria density (7 FC/100 ml), and nil 48-hour precipitation (0.00 in). The highest 48-hour precipitation (0.38 in on 5/24/00) coincided with the highest discharge (1,739 cfs) and the third highest turbidity (2.64 NTU), but bacteria density was low (9 FC/100 ml).

Water quality at this site in terms of fecal coliform bacteria is satisfactory for contact recreation. Since 1996, only 1 of 24 samples (4.2%) has exceeded the fecal coliform standard. This site replaced a previous site, mid-Gauley, in 1996. Between 1991 and 1995, 1 of 51 (2%) mid-Gauley samples exceeded the standard.

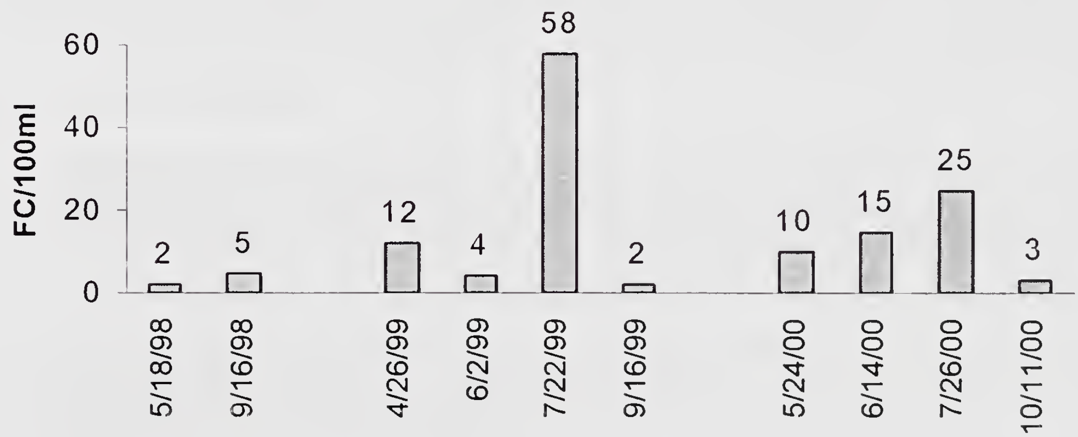
G04, South Side Swiss

This site is on river right of the Gauley River, upstream of the community of Swiss and just upstream of the mouth of Laurel Creek. Vehicle access is by County Road 19-25 off State Route 39. The area is popular for swimming, angling, and camping.

The site is about 14.1 miles downstream from the Summersville Dam gage. There are 44 tributaries (17 perennial and 27 intermittent) between the gage and the site.

None of the ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 35). Parameter values ranged as follows (app. 3): bacteria density 2 - 58 FC/100 ml (mean 13.6, median 7.5), turbidity 0.86 - 6.18 NTU (mean 2.30, median 1.78), 48-hour precipitation 0.00 - 0.38 in (mean 0.07, median 0.005), discharge 100 - 1,739 cfs (mean 575.5, median 452).

Figure 35. South Side Swiss



Similar to the other Gauley River mainstem sites, bacteria density at this site were well below the state standard. The highest bacteria density (58 FC/100 ml on 7/22/99) coincided with the highest turbidity (6.18 NTU), but 48-hour precipitation (0.06 in) and discharge (100 cfs) were within normal ranges. This was the same date that the most adjacent upstream site, Gauley River at Mason Branch site, had its highest bacteria density (47 FC/100 ml), although turbidity at that site was lower (1.47 NTU).

Dates with higher values for 48-hour precipitation or discharge did not have increased bacteria densities or turbidity. For example, the highest discharge (1,739 cfs on 5/24/00) coincided with the highest 48-hour precipitation (still only moderate at 0.38 in), but bacteria density (10 FC/100 ml) and turbidity (1.75 NTU) were low to moderate.

Like the other mainstem sites, water quality at this site in terms of fecal coliform bacteria is satisfactory for contact recreation. Since 1991, 5 of 86 samples (5.8%) have exceeded the fecal coliform standard.

G05, Meadow River

The sampling site is on river right upstream of the mouth of Anglins Creek and the Wilderness Public Service District (PSD) water treatment plant, outside of the Gauley River National Recreation Area boundary. Vehicle access is by Mount Lookout Road (County Road 24) to State Route 41. Anglers are the primary visitors to this site.

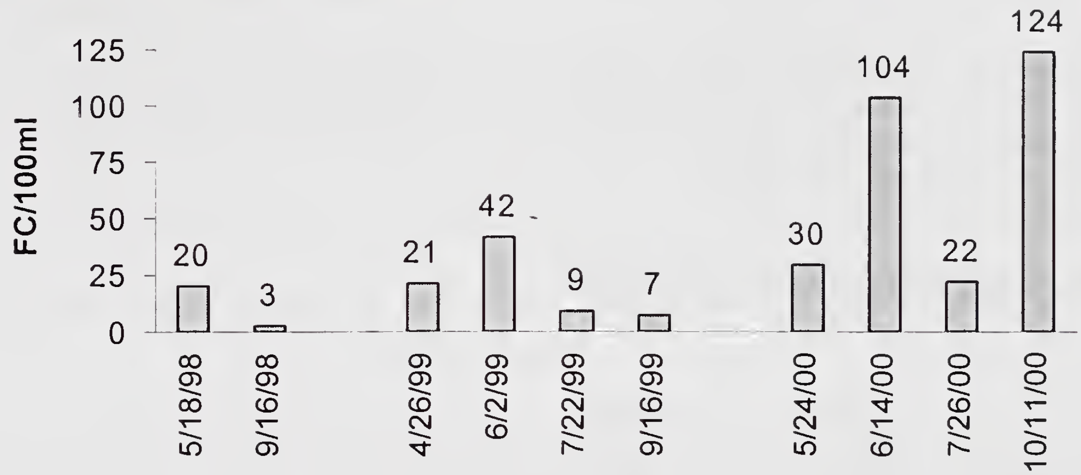
The site is about 8.9 miles upstream of the Meadow River gage. Fourteen tributaries (11 perennial and 3 intermittent) enter the Meadow River between the sampling site and the gage. The Meadow River enters the Gauley River about 4.9 miles downstream from the Summersville Dam gage.

None of the ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 36). Parameter values ranged as follows (App 3.): bacteria density 3 - 124 FC/100 ml (mean 38.2, median 21.5), turbidity 0.55 - 6.11 NTU (mean 2.23, median 1.77), 48-hour precipitation 0.00 - 0.38 in (mean 0.07, median 0.005), discharge 19 - 648 cfs (mean 231.6, median 135). The 9/16/98 sample had no colony growth on either filter. The result of the density calculation was rounded down to the nearest whole number for Figure 36. Actual value is noted in the "Comments" column of Appendix 3.

The highest bacteria density (124 FC/100 ml on 10/11/00) coincided with low turbidity (1.35 NTU), discharge (99 cfs), and 48-hour precipitation (0.02 in). The second highest bacteria density (104 FC/100 ml on 6/14/00) also coincided with low turbidity (1.63 NTU), discharge (135 cfs), and 48-hour precipitation (0.00 in).

The highest turbidity (6.11 NTU on 4/26/99) coincided with the highest discharge (648 cfs), but 48-hour precipitation was nil (0.00 in) and bacteria density (21 FC/100 ml) was low. The second highest turbidity (3.10 NTU on 5/18/98) coincided with the second highest discharge (368 cfs), but again, bacteria density was low (20 FC/100 ml), and 48-hour precipitation was nil (0.00 in).

Figure 36. Meadow River



Given the relatively large size of the Meadow River watershed, it is entirely possible that a precipitation event not recorded by the rain gage at Summersville Dam may have occurred in the upper watershed, and contributed to large discharges occurring following little rainfall. Since these samples occurred early in the year, it is also possible that snowmelt runoff may account for the high discharge. Also, the extensive wetlands in the Meadow River watershed may provide a mechanism for retaining sizeable amounts of water from precipitation events, and releasing this water to the stream channel for a considerable time after the precipitation event has ended.

Water quality at this site in terms of fecal coliform bacteria is generally satisfactory for contact recreation. Since 1993, 3 of 62 samples (4.8%) have exceeded the fecal coliform standard.

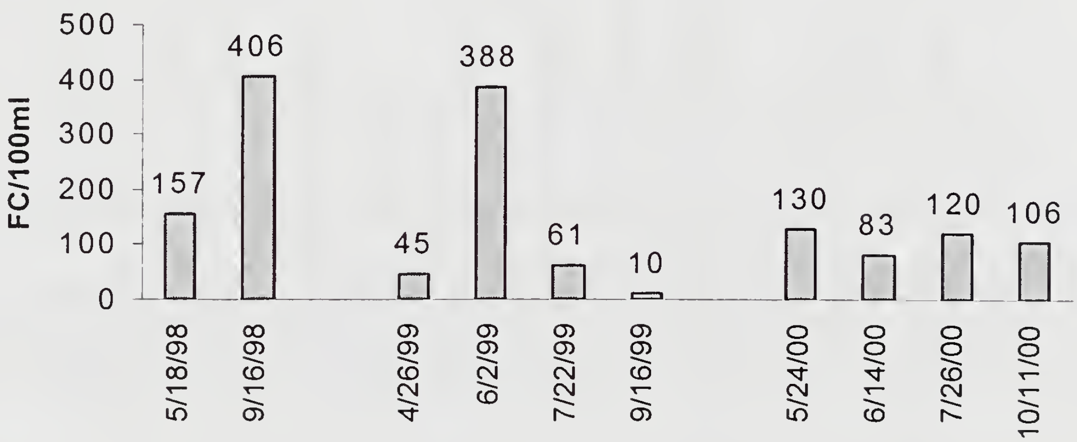
G07, Peters Creek at Ford

Peters Creek is the second largest tributary to the Gauley River within Gauley River National Recreation Area. It rises north of Summersville, flows westward to Lockwood, and turns south to its confluence with the Gauley River near Peters Junction. Peters Creek is 17.5 miles long and drains about 51.9 square miles of rural land. (West Virginia Department of Natural Resources 1984). Coal mining and transportation, timbering and natural gas production occur within the watershed. A coal preparation plant is located along the stream near Lockwood. Peters Creek enters the Gauley River about 6.5 miles downstream from the Summersville Dam gage.

This site is on stream left about 1.5 miles upstream from the mouth of the creek. The site is just above the second ford of Peters Creek on a gas well right-of-way that is reached from State Route 39 and County Road 22. Four wheel drive enthusiasts are typical visitors to the sample site, while anglers, campers and boaters are the main visitors at the mouth of Peters Creek.

Two of ten samples collected between 1998 and 2000 exceeded the state standard (Fig. 37). Parameter values ranged as follows (App. 3): bacteria density 10 - 406 FC/100 ml (mean 150.6, median 113), turbidity 1.18 - 4.37 NTU (mean 2.34, median 2.04), 48-hour precipitation 0.00 - 0.38 in (mean 0.07, median 0.005), discharge (visual) "low" to "normal." A discharge measurement is available for 5/19/98 because an inactive USGS gage (Peters Creek near Lockwood; 03191500) was active between October 1996 and September 1998 (Ward *et al.* 1999).

Figure 37. Peters Creek at Ford



The highest bacteria density (406 FC/100 ml on 9/16/98) coincided with low turbidity (2.0 NTU), discharge ("low"), and 48-hour precipitation (0.00 in). The second highest density (388 FC/100 ml on 6/2/99) also coincided with low turbidity (2.07 NTU), 48-hour precipitation (0.01 in), and low discharge. The lowest bacteria density (10 FC/100 ml on 9/16/99) coincided with the highest turbidity (4.37 NTU), nil 48-hour precipitation (0.00 in) and "low" discharge. The second highest turbidity (3.59 NTU on 6/14/00), also coincided with a relatively low bacteria density (83 FC/100 ml) nil 48-hour precipitation (0.00 in), but "normal" discharge. The greatest 48-hour precipitation (0.38 in on 5/24/00) coincided with moderate bacteria density (130 FC/100 ml), low turbidity (1.71 NTU) and "normal" discharge.

Peters Creek water quality in terms of fecal coliform bacteria is limited for contact recreation. Since 1996, 7 of 24 samples (29.2%) have exceeded 200 FC/100 ml. Due to access problems, this site replaced a previous site closer to the mouth, Peters Creek, in 1996. Between 1991 and 1995, 12 of 51 (23.5%) Peters Creek samples exceeded the standard. Residences, pasture, and a coal preparation plant are located a mile or so upstream of the sampling site, and are possible sources of bacterial contamination and sediment. Stream sedimentation remains a concern due to the numerous land-disturbing activities occurring with the watershed.

GENERAL DISCUSSION

Bluestone National Scenic River

Water quality of the Bluestone River within Bluestone National Scenic River in terms of fecal coliform bacteria is generally satisfactory for water contact recreation. Earlier reports (Hebner 1991a, Sullivan 1993a,c) suggested a relationship between fecal coliform bacteria density and elevated discharge. Higher fecal coliform density generally coincided with higher discharge, especially during the spring. Fecal coliform density was generally low during the low-discharge summer months. Human health risks are most likely to exist during the high discharge periods or events, but such risks are probably minimal.

Between 1998 and 2000, water quality for each site generally fit the above pattern. Bluestone River exhibited higher fecal coliform levels early in the year during higher spring discharges, and also following appreciable precipitation events. Few mainstem values exceeded the state standard during normal discharges. Yearly differences in the number of samples exceeding the state standard can be attributed to variations in discharge and precipitation, as well as the number of samples collected. The occasional high fecal coliform densities recorded at Bluestone River sites do not fit the pattern of a continual source of fecal contamination. Rather, seasonal and meteorological factors seem to influence the occurrence of elevated bacteria densities at these sites.

Water quality of Little Bluestone River and Mountain Creek is very similar to that of the Bluestone River. Both streams rarely exceeded the standard during normal discharge and precipitation. Elevated bacteria density resulted from storm events producing high, turbid discharges. The earlier reports also linked elevated fecal coliform density in these streams to high discharge, precipitation, and turbidity. Water quality of these streams does not appear to be impacted on a continual basis.

Sample results from Bluestone National Scenic River produced some anomalous results. Comparing all five sites across several of the nine sampling dates (Tables 1-2) helps to clarify factors that may be influencing these results.

Fecal coliform density and turbidity was high at all sites on 5/11/98, although 48-hour precipitation at Bluestone Dam was only moderate (0.22 in). Earlier precipitation data is not available for this site, but data from another site is illustrative. At Glen Jean, 96-hour precipitation was 0.93 in, and an additional 1.69 in was recorded since 5/1/98. This indicates that soils were saturated and any rain that fell should exert a quick, strong influence on stream discharge. Discharge as measured at the Pipestem gage for 5/11/98 (813 cfs) was the greatest for any sampling date during the monitoring period.

For 7/14/99, fecal coliform bacteria density and turbidity were moderate to low at all sites except for bacteria density in Little Bluestone River. Forty eight-hour precipitation at Bluestone Dam was relatively high (0.45 in). At Glen Jean, 48-hour precipitation was minimal (0.01 in), and precipitation since 7/1/99 was low (0.35 in). This indicates dry soil conditions, and a localized rainfall event, probably scattered thundershowers given the time of year. This would not likely have a quick, strong influence on stream discharge, as much of the rainfall would soak into the soil, with very little reaching stream channels. Indeed, discharge at the Pipestem gage for this date (53 cfs) was only the seventh highest (third lowest), and discharge in Little Bluestone River and Mountain Creek were categorized as "low." The high fecal coliform density in Little Bluestone River on 7/14/99 is probably due to a localized rainfall event. This may have caused runoff from the few small communities and farms, including their livestock, in the watershed.

Table 1. Relative rank (1 is highest) of fecal coliform bacteria density for each site on selected sampling dates in Bluestone National Scenic River. Sites are arranged in downstream order.

Site \ Date	5/11/98	7/14/99	5/25/00	7/25/00
Mountain Creek	2	4	1	3
Bluestone River at Pipestem	2	4	1	6
Bluestone River at confluence	2	5	1	4
Little Bluestone River	2	1	7	3*
Bluestone River at Bluestone SP	2	4	3	1

*Rank for Little Bluestone River on 7/25/00 is a tie with another date (6/16/99).

Table 2. Relative rank (1 is highest) of turbidity for each site on selected sampling dates in Bluestone National Scenic River. Sites are arranged in downstream order.

Site \ Date	5/11/98	7/14/99	5/25/00	7/25/00
Mountain Creek	2	3	1	4
Bluestone River at Pipestem	2	7	1	4
Bluestone River at confluence	1	7	8	5
Little Bluestone River	2	9	5	1
Bluestone River at Bluestone SP	2	6	8	1

For 5/25/00, fecal coliform bacteria density and turbidity were elevated at the upstream sites, but low to moderate at the downstream sites. Forty eight-hour precipitation at Bluestone Dam (0.28 in) and Glen Jean (0.53 in) were moderate. Additional rainfall (0.38 in) fell at Glen Jean in the previous 24 hours. This latest rainfall event probably increased bacteria density and turbidity. Since sites within Bluestone National Scenic River were sampled in an upstream direction, it is likely that the lower sites were sampled before the increased turbidity and bacteria density reached them, while the upper sites were sampled after this occurred.

For 7/25/00, fecal coliform bacteria density and turbidity were higher at the lowest mainstem site and the two tributaries, particularly Little Bluestone River. Forty eight-hour precipitation for this date (0.96 in) was the highest for sampling dates during the monitoring period for Bluestone National Scenic River. Bluestone Dam is closer to the lowest site, and at about the same latitude as the Little Bluestone River watershed. It is likely that the storm that produced this rainfall was concentrated in the lowest part of the Bluestone River watershed, including the Little Bluestone River sub-watershed.

All sites within Bluestone National Scenic River in terms of fecal coliform bacteria have satisfactory water quality for water contact recreation. No site produced bacteria levels indicative of continual contamination. No single source of fecal coliform bacteria in these waters has been identified. Some stream-borne bacteria may originate from agricultural (e.g. livestock pasture) and natural (e.g. wildlife) sources. The developed area around Bluefield and Princeton, which lies within the Bluestone River watershed, is another likely source of fecal material. However, travel time between these developed areas and Bluestone National Scenic River is probably sufficient to allow many fecal bacteria to die before they reach the park. Whether pathogenic materials also associated with human fecal material is present in these waters is unknown. Because fecal coliform bacteria density only infrequently exceeded the contact recreation standard, health risks to river users are probably low. This risk probably increases during high, turbid discharges following storm events and snowmelt runoff.

New River Gorge National River

Water quality of the New River between 1998 and 2000, in terms of fecal coliform bacteria, was generally satisfactory for water contact recreation, especially during base-flow conditions. Most sample sites experienced high bacteria densities during high discharges. These events typically occurred during spring runoff and following prolonged or intense precipitation. Increase turbidity during these events indicates that sediment and contaminants were being washed or flushed into the river. For most sites that exceeded the fecal coliform standard for primary contact water recreation, the amount by which the standard was exceeded usually was not very great. During these high, turbid discharges there is some health concern for individuals coming into contact with these waters.

Some New River sites may present health risks at the confluence of polluted tributary streams. These streams consistently exceed the state standard for fecal coliform bacteria. Bacterial contamination in these streams originates from municipal wastewater collection and treatment systems, inadequate residential sewage systems, and direct waste lines to the streams. These streams probably contribute most of the fecal bacteria contamination that is found in New River within New River Gorge National River.

Fecal bacteria originate from municipal wastewater collection and treatment systems in Meadow Creek, Piney Creek, Dunloup Creek, Arbuckle Creek, Wolf Creek, and Marr Branch. Many facilities discharging into these streams become overloaded during storm events. This is primarily due to the facilities being fed by combined storm and sanitary sewers, and by inflow and infiltration (I&I) problems existing in collection systems. When facility capacity is exceeded by incoming discharges, inadequately treated sewage may be bypassed by the affected facility and discharged into the receiving stream. Bypassed sewage is generally chlorinated to kill microorganisms, and then dechlorinated so that stream biota is not affected. Some sewage is treated by ultraviolet (UV) radiation before being bypassed. Improvements or upgrades have been made to some of these facilities, and other work is in progress. However storm water runoff continues to be a problem for all of these systems. Madam Creek, Coal Run, and Keeney Creek have direct waste lines discharging into the streams, as well as faulty residential sewage systems.

Of the tributaries with municipal discharges, Meadow Creek appears to be least impacted by these discharges. The Meadow Bridge STP is located near the top of the watershed, and serves a relatively small, sparsely populated, rural area. Earlier reports noted the plant's collection system suffered from I&I problems and operational deficiencies that resulted in the discharge of partially treated waste into Meadow Creek during storm events (West Virginia Department of Natural Resources 1989, Schmidt and Hebner 1991, Sullivan 1993b,c). Livestock pastured in the upper watershed may be another potential source of fecal contamination. Between 1994 through 1997, 10 of 46 (22%) of samples exceeded the fecal coliform standard. Between 1998 and 2000, 3 of 11 (27%) samples exceeded the standard, with all three samples that exceeded the standard being collected in 2000. The earlier reports noted that fecal coliform bacteria density increased during or following precipitation events that produced runoff. This was less evident during the monitoring period for this report, perhaps in part due to the relatively low number of samples collected. Meadow Creek does not seem to be continuously impacted by fecal coliform bacteria. However, bacteria pulses can occur in conjunction with precipitation events. During such pulses, conditions are not satisfactory for human contact recreation. The number of people coming into contact with the waters of Meadow Creek is probably small. A river access for non-commercial users of the New River is just upstream of the mouth of the stream in the community of Meadow Creek. This access is used primarily by private boaters, mostly those using canoes and other craft suitable for the relatively calm waters found on the New River in this area, and anglers. Trout fishing in Meadow Creek is a popular activity, and local children have been observed playing in the stream.

Piney Creek is the largest tributary to New River within New River Gorge National River. There are several wastewater treatment facilities in the watershed, and each is a potential contributor of untreated or partially treated waste to Piney Creek. Also, many residential areas with faulty or failing septic systems discharge into the stream. Between 1994 and 1997, 18 of 46 samples (39%) exceeded the fecal coliform standard. There was some indication that the frequency and severity of contamination was less between 1998 and 2000 than had been indicated by earlier monitoring, and that this improvement was due to STP upgrades. Between 1998 and 2000, 2 of 10 (20%) of samples exceeded the state standard. This might seem to indicate that Piney Creek water quality is improving. However, the relative sparseness of samples, and some high-bacteria density storm event samples that will be presented in another report, causes us to withhold judgment on any trend in Piney Creek water quality. The City of Beckley is set to begin replacement of six miles of sewer interceptor line on the south side of their service area. When this project is completed this should significantly reduce I&I problems in that area, and should also reduce hydraulic overloading of their recently upgraded STP that discharges to Piney Creek. With the mouth of Piney Creek near a heavily used river access, the continued occurrence of high fecal coliform bacteria densities indicates that this stream remains a potential health hazard.

In 1997 - 1998 the Environmental Enforcement Branch of the West Virginia Division (now Department) of Environmental Protection (DEP) sampled the Piney Creek watershed to document major sources of fecal coliform bacteria and to document trends in fecal coliform density (Robertson 1998). The study focused on major STPs discharging to Piney Creek or its' tributaries, and strategic points along the watershed. This effort documented numerous problem areas and provided information on actions aimed at improving compliance of permitted sewage treatment facilities. Also, an association was noted between higher fecal coliform counts and precipitation events. It was suggested that increased bacteria counts resulted from hydraulic overloading of STP collection systems. Combined sewage outlets (CSO) and storm water release outlets (SSO) discharge hundreds of millions of gallons of untreated waste into Piney Creek each year. As a result, the DEP Environmental Inspector for Raleigh County issued a request requiring all permitted wastewater treatment facilities to disinfect all wastewater discharges to Piney Creek. Further, the report outlined actions designed to reduce bacterial contamination of Piney Creek by STPs. This led to upgrades and modifications for 16 treatment facilities that were scheduled for completion by 2000. Continued monitoring will reveal the effectiveness of these improvements to Piney Creek water quality.

Fecal coliform bacteria in Dunloup Creek originate from two wastewater treatment plants (Mt. Hope and White Oak) and individual residences along the stream. Both the Mt. Hope and White Oak systems suffer from I&I problems and become overloaded during storm events. Between 1994 and 1997, 23 of 47 samples (49%) samples exceeded the fecal coliform standard. Between 1998 and 2000, 6 of 13 (46%) exceeded the standard. This indicates a continual source of bacteria entering the stream. Consequently, Dunloup Creek remains a health risk to individuals coming into contact with its waters. The stream is easily accessed at many points, particularly along State Route 25 between Glen Jean and Thurmond, and is one of the more heavily fished streams in the park, especially after stockings of catchable trout. Several commercial rafting companies put into New River just upstream from the mouth of Dunloup Creek. Hikers, cyclists, and swimmers frequently visit Dunloup Creek.

Dunloup Creek has a long history of contamination from fecal coliform bacteria. The town of Mt. Hope and several communities (Oswald, Kilsythe, Glen Jean, Harvey and Red Star) are within the drainage. The Mt. Hope sewage treatment plant lift station and the White Oak Public Service District wastewater treatment plant are major point sources of fecal contaminants, especially during high rainfall/high flow events. Collection systems for both plants have I&I and CSO problems. Storm events often overload these facilities, resulting in partially treated wastewater being discharge into the stream. Other sources of fecal contamination include failing, inadequate, and non-existent residential septic systems located along and near the creek.

The Dunloup Creek samples presented and analyzed in this report do not include a large number of samples that were taken during storm events. Those samples, began in 1998, were collected in an effort to follow the pattern of fecal coliform bacteria density during the course of runoff events. Such samples collected in 1998 were reported and analyzed separately (Purvis and Wilson 1999).

Arbuckle Creek is similar to Dunloup Creek in having two STPs in its watershed. Both facilities have I&I problems and are frequently overloaded. These inadequacies are reflected by Arbuckle Creek consistently exceeding the fecal coliform standard. Between 1994 and 1997, 31 of 47 samples (66%) exceeded the standard. Between 1998 and 2000, 9 of 12 samples (75%) exceeded the standard, with three samples exceeding 10,000 FC/100ml, including one that produced 250,000 FC/100ml. High values occurred regardless of discharge or precipitation levels. This stream remains a health risk for individuals coming into contact with its waters. A large commercial outfitter, A.C.E., has its facility on Arbuckle Creek just above the park boundary, and two trails used by hikers and cyclists intersect the stream. These factors increase the potential for human contact with contaminated waters.

Wolf Creek exceeded 200 FC/100ml 10 of 48 times (21%) between 1994 and 1997, and 3 of 11 times (27%) between 1998 and 2000. A lift station on House Branch, a tributary to Wolf Creek, pumps untreated waste to the Fayetteville STP. Earlier reports (e.g. West Virginia Department of Natural Resources 1989) noted that this lift station became overloaded during storm events and discharged untreated waste into House Branch. A sizable number of residences in the Salem-Gatewood Road area that drains into Wolf Creek are not on public sewer. Inadequate, failing, or non-existent septic systems in this area are other potential sources of fecal contamination in Wolf Creek. While high bacteria density in Wolf Creek was not as common as in Marr Branch, the potential remains for densities in the thousands (e.g. 2,620 FC/100ml on 9/27/00). Since Wolf Creek enters the New River near a heavily used take-out area for private and commercial whitewater boaters, hundreds of park visitors run the risk of having contact with the contaminated waters of this stream on days when the fecal coliform standard is exceeded.

Before 1994, Marr Branch was severely impacted by untreated sewage coming from the old Fayetteville STP. Following startup of the new STP in late 1994, many parameters showed marked improvement. The stream no longer ran black, dissolved oxygen increased, and conductivity decreased. Although fecal coliform density was lower, many samples continued to exceed the West Virginia standard. Contact with the STP operator revealed that the collection system for the plant experiences hydraulic overloading from I&I and CSO. This overloads the plant during storm events, allowing partially treated wastewater to be bypassed into Marr Branch.

The facility for Rivers, Inc., a commercial whitewater and climbing outfitter, is located on Marr Branch below the Fayetteville STP outfall. A small package plant at the Rivers, Inc. facility treats waste generated on site, and this may be an additional source of fecal material in Marr Branch.

In spite of the new STP, sewage pollution of Marr Branch continues. In 1994 (old STP), 13 of 16 samples (81%) exceeded 200 FC/100ml. Between 1995 and 1997 (new STP), 23 of 32 samples (72%) exceeded 200 FC/100ml. Between 1998 and 2000, 7 of 11 (64%) of the samples exceeded the standard. Overall, 70% of the samples (30 of 43) collected between 1995 and 2000 have had fecal coliform densities that exceeded the West Virginia standard for water contact recreation. While there appears to be some improvement in the frequency of high fecal coliform densities, Marr Branch remains a potential health risk to persons coming into contact with its waters. Marr Branch enters the New River between the two major take-outs for whitewater outfitters, Fayette Station and Teays. Those taking out at Teays may be exposed to waters of Marr Branch.

Madam Creek, Coal Run, and Keeney Creek consistently have high fecal coliform density. None of these streams have public wastewater treatment facilities within their watersheds, and residences along the streams are not connected to any kind of centralized treatment facility. Individual residential septic systems are present at some residences. Many of these are not properly maintained (e.g. pumped on a regular basis), or have structural problems (e.g. cracks) or design faults (e.g. improper soil for adequate percolation) that result in sewage leaking out of the systems. Most residences in these watershed are located on the only relatively level land available, the narrow strip adjacent to water courses. Consequently, leakage from inadequate septic systems only travels a short distance before it enters a stream. In some locations raw sewage is piped directly from residences into streams. The primary sources for bacterial contamination of each creek are the residential areas located within these watersheds.

Between 1994 and 1997, 44 of 46 (96%) Madam Creek samples exceed the fecal coliform standard. Between 1998 and 2000, 11 of 11 (100%) of samples exceeded the standard. This indicates a continual source, or sources, of fecal contamination. Madam Creek should be considered a definite health hazard for any individual coming into contact with its waters.

Coal Run exceeded the fecal coliform standard in 21 of the 48 (44%) samples collected between 1994 and 1997. Between 1998 and 2000, 4 of 10 (40%) samples exceeded the standard. These data, along with chronically elevated turbidity and conductivity in this stream, indicate continual disturbance within the watershed. Logging and mining may account for increased turbidity and conductivity. Increased bacteria levels are probably due to a lack of residential sewage treatment for the communities of Brooklyn and Cunard. Coal Run enters the New River just downstream of a major put-in for commercial whitewater outfitters. Also, this stream intersects the Cunard to Kaymoor trail. Thus a large number of park visitors have the potential to come into contact with the contaminated waters of Coal Run.

Between 1994 and 1997, 47 of 48 (98%) of Keeney Creek samples exceed the fecal coliform standard. Between 1998 and 2000, 11 of 11 (100%) of samples exceeded the standard. This indicates a continual source, or sources, of fecal contamination. Keeney

Creek should be considered a definite health hazard for any individual coming into contact with its waters.

Two tributaries in New River Gorge National River that have been monitored since at least 1994 have shown little sign of fecal contamination. For Lick Creek, 7 of 46 (15%) of samples collected between 1994 and 1997 exceeded the fecal coliform standard. For Laurel Creek, 5 of 46 (11%) of samples exceeded the standard. These numbers rose somewhat in the more recent monitoring period. For Lick Creek, 5 of 11 (45%) samples collected between 1998 and 2000 exceeded the fecal coliform standard. For Laurel Creek, 3 of 10 (30%) of samples exceeded the standard. For each stream, high fecal coliform densities usually coincided with high discharges following significant precipitation events. Watersheds of both streams are sparsely populated and the infrequent high values do not fit the pattern of continual domestic pollution. High coliform densities in these streams are probably due to livestock pastures and natural (wildlife) sources within their watersheds. In general, water quality for each stream can be considered fair, except during high, turbid discharges when it may be questionable.

In recent years, several previously unmonitored tributaries were added to the monitoring program. Most of these streams were thought to be relatively free of contamination from domestic sewage, so an intensive fecal coliform bacteria monitoring program was not warranted. It was later decided that sampling these streams might provide a first level estimate of potential fecal contamination from natural sources (wildlife).

Sampling of Glade Creek began in 1995 (App. 2). Between 1995 and 1997, 3 of 24 (13%) samples exceeded the fecal coliform standard, with a maximum bacteria density of 480 FC/100ml. Between 1998 and 2000, 1 of 10 (10%) samples exceeded the standard. Over half of the samples from this stream have produced fecal coliform bacteria densities of less than 10 FC/100ml. Apparently this stream is relatively free of fecal contamination, except for the occasional pulses that result from major rainfall events. This watershed is relatively undeveloped, except around the divide and in the upper watershed. Most residences in the upper watershed are served either by a municipal STP, or by one of several small "package plants" that exist in the developed areas. These treatment facilities apparently do an effective job of keeping fecal pollution out of Glade Creek, except following sizable runoff events.

Sampling of Dowdy, Slater, and Buffalo Creeks began with one sample from each stream in 1997 (App. 2). Regular sampling began in 1998, and all of the 9 additional samples collected from each of these streams produced fecal coliform densities considerably below the water contact recreation standard. The highest density recorded was 67 FC/100ml from Buffalo Creek. The highest density from Slater Creek was 30 FC/100ml, and the highest density from Dowdy Creek was 10 FC/100ml. All three of these streams drain sparsely populated areas east of New River Gorge National River. Development in these watersheds is largely precluded by their relatively steep, rugged terrain. Some extractive activities, such as mining and logging, have occurred in the past, and logging continues in some of these areas. A small community, Thayer, exists at the mouth of

Slater Creek, and bacteria densities may be greater at this location than at the sampling location just upstream of the community. A National Park Service river access is at the mouth of Slater Creek. Buffalo Creek has been stocked with brook trout (*Salvelinus fontinalis*), and is managed by the West Virginia Department of Natural Resources as a "Fly-Fishing Only" stream. At least one local outfitter brings clients to fish this stream.

The two groundwater sources, Claremont Mine Spring and Ajax Mine Spring, were added to the regular monitoring program in 1998. Prior to this, Claremont Mine Spring was sampled once in 1996, and Ajax Mine Spring was sampled seven times in 1995, ten times in 1996, and twice in 1997 (App. 2). Because of the small nature of these sources, they do not receive any recreational use. The low fecal coliform densities reported for this monitoring period indicate that if these sources did receive such use, there would be little risk to the public. The Ajax site is used as a water source for many residents of northern Fayette County. Since some samples contained fecal coliform bacteria, this water should not be used for human consumption until it is treated to eliminate the bacteria. Although it is possible that the source of bacteria found in these samples could be contamination from leaching septic fields or other sources far removed from the discharge location, it is more likely that the contamination results from events in the immediate vicinity of the faucets. These include domestic dogs (including those accompanying water users), wildlife, and individual humans.

Because four sampling runs are required to complete all of New River Gorge National River, it is not possible to examine a single day throughout the entire length of the park. However, certain sections can be so examined.

Table 3. Fecal coliform bacteria densities (FC/100 ml) for upper sites in the New River Gorge National River south district, 48-hour precipitation (in) as measured at Bluestone Dam, New River discharge (cfs) at the Hinton gage, and visual characterization of discharge in Madam Creek (H=high, N=normal, L=low), for selected dates. Sites are arranged in downstream order.

Site \ Date	5/6/98	6/11/98	7/13/99	6/6/00	8/9/00	9/19/00
New River, Hinton Visitor Center	600	105	59	34	18	36
Madam Creek	825	390	10,650	10,150	1,200	69,000
New River, Sandstone Falls parking lot	505	752	54	64	220	16
New River, Sandstone Falls boardwalk	525	477	940	61	110	39
48-hour precipitation	0.69	0.02	0.45	0.38	0.45	0.52
New River discharge	27,900	10,000	3,900	2,970	3,700	1,780
Madam Creek level	H	N	L	H	H	N

In the south district (Table 3), fecal coliform densities were uniformly high on 5/6/98. Densities for the New River sites were the highest or second highest recorded between 1998 and 2000. Although the Madam Creek density was over four times the state standard for water contact recreation , it was still the third lowest recorded over this period. Forty-eight hour precipitation at Bluestone Dam (0.69 in) was the third highest for the monitoring period. High values for 48-hour precipitation generally correlate well with high fecal coliform densities. This can be seen in the New River samples, but the relatively low bacteria density for Madam Creek requires further explanation. Forty-eight hour precipitation at Glen Jean for this date was 0.19 in, and was 1.76 in for the four previous days. This indicates saturated soils. Such soils produce quick runoff from storm events, especially in smaller watersheds like Madam Creek (Dunne and Leopold 1978). Since fecal coliform bacteria density usually peaks before peak discharge, the peak density in Madam Creek probably occurred one or more days before 5/6/98.

Fecal coliform densities for 6/11/98 were higher at the downstream sites, while Madam Creek had the lowest value recorded between 1998 and 2000 (Table 3). This pattern would seem to indicate input from the Greenbrier River, but this is not supported by stream discharge data (Ward *et al.* 1999). Daily mean discharge for the Greenbrier River at the USGS gage closest to the mouth (0318400 Greenbrier River at Hilldale, WV) was rising between 6/10/98 and 6/12/98, but the New River as measured at the Hinton gage, which includes the flow of the Greenbrier River, was rising by a much greater volume. Obviously more of the increased discharge came from the New River. It is probable that water coming through Bluestone Dam (New River) was lower in fecal coliform density due to bacterial die-off or settling in Bluestone Lake, while bacterial contaminants in the un-regulated Greenbrier River were not so-reduced. These higher effective contributions from the Greenbrier River were then recorded in the New River at Sandstone Falls.

Data for 7/13/99, 6/6/00, 8/9/00, and 9/19/00 show relatively low fecal coliform density in the New River sites, but very high density in Madam Creek (Table 3). Each of these sample dates occurred with significant 48-hour precipitation (0.38-0.52 in) after New River discharge had been either decreasing for several days, or uniformly low for a week or more (Ward *et al.* 2000, 2001). This indicates localized rainfall (e.g. for 9/19/00 the 48-hour rainfall at Bluestone Dam was 0.52 in, while at Glen Jean, about 25 air-miles away, it was only 0.02 in), relatively dry conditions (e.g. for the 7/13/99 sample only 0.35 in was recorded since 6/30/99, and 3.23 in for all of May and June, compared to an average of 3.19 in *per month* for January through April, at Glen Jean), or both. This is typical summer weather for this area, with the New River at Hinton dropping towards its lowest levels, usually reached in September. While localized precipitation will not raise significantly the level of the New River, smaller tributaries can so rise. Runoff from these precipitation events can carry fecal contamination that has been puddled in cesspool-like areas into the channels of small streams such as Madam Creek.

Similar patterns of seemingly anomalous data can be seen in other areas in New River Gorge National River. It is not our intention to delve into all such instances in this report. Although some information is provided below (**General Considerations**) a more in-depth discussion of these issues is planned for a later report. For the present we wish to caution the reader to be careful in interpreting data presented in this report. Fecal coliform bacteria density in streams results from the complex interaction of a number of factors. A partial list of these factors includes source type and intensity, stream discharge, recent precipitation, watershed hydrology and geomorphology, temperature, other water quality variables, and stream channel hydraulics.

Gauley River National Recreation Area

Water quality of the Gauley River in terms of fecal coliform bacteria is generally satisfactory for water contact recreation. Very few samples exceeded the state standard, and such samples usually only exceeded the standard by a small amount. What high values did occur generally coincided with high discharge following snowmelt or runoff-producing storm events. Summersville Dam probably prevents fecal contamination originating from sources upstream of the dam from entering the Gauley River within Gauley River National Recreation Area. Sources below Summersville Dam are limited due to the rugged terrain and lack of development. Most contamination below the dam probably originates from developed areas in the watersheds of the two major tributaries, Meadow River and Peters Creek. Wilson and Purvis (2000) suggested that the lowest mainstem site, South Side Swiss, may receive contamination from Laurel Creek. Also, some earlier contamination of the most upstream site, Summersville Dam, may have been due to contribution from a nearby storm water drainage ditch.

Meadow River water quality is comparable to that of the Gauley River, with only a few samples exceeding the fecal coliform standard, and those samples usually exceeding it by only a small amount. The highest fecal coliform densities occurred when discharge, turbidity or precipitation were also higher. Fecal material in the Meadow River probably originate from human, natural, and agricultural sources in upper reaches of the watershed. Some comments have been made to National Park Service staff that the wastewater treatment facility in the town of Rainelle in the upper watershed may be one source of this contamination. Rainelle is approximately 25 miles upstream of the park boundary, and it is unknown how the distance and time of travel between any potential upstream source and Gauley River National Recreation Area would affect on the level of contamination reaching the park. Other potential domestic sources include the community of Nallen, less than five miles upstream from the park boundary, and several smaller communities scattered along the Meadow River between Nallen and Rainelle.

Peters Creek water quality in terms of fecal coliform bacterial should be considered limited for water contact recreation. This especially true when compared to the other sites within Gauley River National Recreation Area. More samples exceeding the state standard came from Peters Creek than from any other site within Gauley River National Recreation Area. Elevated fecal coliform densities coincided with various levels of discharge and precipitation. The highest densities occurred during high, turbid discharges and followed substantial precipitation events. These bacteria most likely originate from domestic sources outside the park boundary. On most sampling dates the stream had a milky appearance, indicative of the presence of suspended matter in the stream. Although not discussed in this report, conductivity levels were consistently elevated. Increased turbidity and conductivity probably reflect land-disturbing activities (i.e., mining, timbering, other development) occurring within the watershed. Peters Creek should be considered a health risk to recreational users coming into contact with its waters.

General Considerations

Fecal Coliform Sources

Several factors may increase stream fecal coliform bacteria densities. These include population density in the stream's watershed, type of sewage treatment facilities (including collection systems) and their efficacy, proximity of dwellings to stream channels, stream discharge, and the amount, intensity and pattern of recent precipitation.

The number and density of human beings living in a watershed has a direct influence on the amount of fecal material produced in that watershed. The greater the population, the greater the amount of fecal material produced. All of this fecal material has the potential to enter stream channels. Whether or not it does enter depends on the other factors noted above.

In areas without centralized sewage treatment, many residences do not have septic systems. These houses often pipe raw sewage directly into streams, or into ditches that lead to streams. In addition to such "straight pipes", many residences with septic systems do not have an adequate one. Inadequacies include leaking pipes or tanks, tanks not pumped and hence non-functional, and drain fields located in areas where the soil does not percolate properly. These deficiencies also lead to raw or inadequately treated sewage entering streams. Watersheds without centralized sewage treatment generally have chronic fecal contamination.

Examples of chronically polluted streams without centralized sewage treatment include Madam Creek, Coal Run, and Keeney Creek. In many places, local topography in these watersheds limits residences to a relatively narrow strip very near a stream channel. Because of this, contamination from inadequate septic systems enters streams relatively quickly. Watersheds with broader floodplain areas tend to have some residences located farther from stream channels, and may provide some additional percolation, and slow the transport of septic leakage into channels. Such a floodplain area exists in the Brooklyn-Cunard area of the Coal Run watershed. This may be one reason why Coal Run exceeds the state standard less frequently (40%) than Madam (91%) or Keeney Creek (96%), streams that generally lack broad floodplains.

While precipitation is not a source of fecal coliform bacteria in streams, it does influence their occurrence. Runoff from precipitation washes bacteria into stream channels from areas of aseptic standing water. Such water is common around septic systems that have not been properly maintained, especially those that have not been pumped. Rainfall also increases the volume that must be transported by sewage treatment plant collection systems. Some of this increased volume occurs because of I&I problems in the collection systems. In these cases rainfall that infiltrates the ground may leak into the collection system through cracks and bad joints in the pipes. Some collection systems also transport storm drainage. These combined sewers, along with I&I problems, deliver large amounts of sewage to treatment plants during precipitation events. If the volume entering the plant exceeds its treatment capacity, which frequently occurs, the plant bypasses some of the sewage after first treating it with chlorine or ultraviolet radiation to kill the bacteria. The collection systems of such plants are often stressed during rainfall events, and sewage often leaks out of pipes, or the excessive pressure dislodges manhole covers. Both of these results lead to raw sewage entering streams more directly, and this sewage is not subject to treatment.

Indicators of Fecal Coliforms

Suspended solids that increase turbidity provide surface area for attachment and a mode of transport for bacteria (Pipes 1982). The highest bacteria density coincided with the highest turbidity at nearly one half (16 of 34; 47%) of the sample sites. At many other sites the highest bacteria density coincided with the second or third highest turbidity. Although the relationship between turbidity and fecal coliform density varies from site to site, turbidity at a given site provides a good gage to estimate bacteria density. Visual characterization of clarity serves as a useful gage of turbidity. Excluding the two groundwater sites (Claremont Mine Spring, Ajax Mine Spring) and two sites that were always characterized as "clear" (Dowdy Creek and Gauley River below Summersville Dam), the highest turbidity coincided with the least clear visual characterization (in order of decreasing clarity, "clear," "milky," "murky," and "turbid;" App. 4) at nearly all of the sites (26 of 30; 87%). Therefore visual characterization of a site's clarity, based on years of observations, provides a reasonable gage of the bacteria density at that site.

Parameter Magnitude

This report presents a lot of data about several parameters. Since the reader may not know whether a given value is high, moderate, or low, we have included such modifiers in some of the discussion for each sampling site. This may be misleading in a larger context, due to variation between sites (Table 4). The reader is cautioned that for a given parameter, these modifiers are applied only to that parameter, only at the site being discussed, and only for the period covered by this report.

Table 4. Comparison of the relative ranks of similar 48-hour precipitation events in the six sampling runs. Value in parentheses indicates where a similar value would have fallen had it occurred.

Sampling Run	Amount	Rank (highest = 1)	Modifier
BLUE	0.45"	2 of 9	High
NERI south short	0.44"	3 of 10	High
NERI south long	0.45"	6 of 11	Moderate
NERI north short	(0.45")	5 of 12	Moderate
NERI north long	0.49"	5 of 11	Moderate
GARI	0.38	1 of 10	High

Trends

The number and percentage of values exceeding the West Virginia water contact recreation standard is presented for two time periods, the monitoring period covered by this report (1998-2000) and the period covered by the previous report (1994-1997). While this provides some information on water quality trends over time, an in-depth discussion of such trends is beyond the scope of this report. Such a report is planned for the future.

Other Sampling Efforts

This report covers baseline sampling. No attempt was made to specifically sample storm events, dry periods, or other special conditions. Some storm-event sampling occurred in Piney Creek and Dunloup Creek, and some of the Dunloup Creek information was presented in another report (Purvis and Wilson 1999). We have conducted some simultaneous sampling for *E. coli* (the standard suggested by the U. S. Environmental Protection Agency) and fecal coliforms (the standard used by West Virginia). Since we want to assemble more of this kind of data before discussing this relationship, that information is not presented in this report.

Future Directions

Another report covering monitoring for 2001-2002 is already in preparation. That report will cover the floods of 2001, and concentrate on a special sampling program to look at water quality during and after storm events. Several new sites will be added to the monitoring program in 2003 to better define the influence of tributary streams on New River water quality. Some sites will be moved, with both the old and new locations sampled for one or two years to allow correlation between future and historical data. Many sites will be renamed to accurately reflect their location in the drainage network. A continuous water quality data logger will be deployed in one of the tributary streams to complement one already deployed at the Thurmond gage. Another report is planned that will summarize water quality since the beginning of the monitoring program (including information from the continuous data logger). Part of this report, or perhaps a separate report, will provide in-depth analysis of relationships between parameters. This information will be used to model fecal coliform bacteria density dynamics. This modeling may permit forecasting of times when water contact recreation, especially in the heavily used New River, is not advisable due to health concerns associated with high densities of fecal coliform bacteria. The development of a Geographic Information System (GIS) at the park will allow water quality data to be placed in a broader context. Water quality information not already in the U. S. Environmental Protection Agency's **STO**rage and **RET**rieval (STORET) database will be added to that system. Finally, a comprehensive review of the water quality monitoring program is planned. This technical evaluation will included experts from within and outside of the National Park Service, and will help to guide the future directions of the program.

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Appendix 1.
Bluestone River Mainstem and Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-Hour Precipitation (inches)	Fecal Coliform/100 ml	Comments
B04	BLUESTONE RIVER AT PIPESTEM	5/11/1998	12:43	OVC	19.0	14.6	9.7	7.6	119	MR	9.00	813	0.22	93	
B04	BLUESTONE RIVER AT PIPESTEM	5/4/1999	13:03	CLR	26.0	15.0	8.0	8.2	218	MI	5.29	500	0.00	6	
B04	BLUESTONE RIVER AT PIPESTEM	6/16/1999	13:43	OVC	21.0	21.8	8.9	8.7	347	C	1.76	44	0.00	34	
B04	BLUESTONE RIVER AT PIPESTEM	7/14/1999	13:05	BKN	26.0	29.0	6.2	8.8	390	C	1.41	53	0.45	28	
B04	BLUESTONE RIVER AT PIPESTEM	9/22/1999	12:29	SCT	22.0	15.0		9.1	330	C	0.63	19	0.11	6	
B04	BLUESTONE RIVER AT PIPESTEM	5/25/2000	13:12	SCT	22.5	19.1	12.2	8.2	260	MR	14.20	122	0.28	413	
B04	BLUESTONE RIVER AT PIPESTEM	6/12/2000	12:44	SCT	28.0	25.9	10.4	8.5	348	C	1.85	62	0.00	4	
B04	BLUESTONE RIVER AT PIPESTEM	7/25/2000	13:10	OVC	20.0	20.1	5.3	8.2	252	MR	2.86	244	0.96	10	
B04	BLUESTONE RIVER AT PIPESTEM	10/2/2000	12:42	CLR	25.0	16.1	11.3	9.0	284	C	1.30	65	0.00	16	
B03	BLUESTONE RIVER AT CONFLUENCE	5/11/1998	11:18	OVC	19.0	14.5	9.6	7.6	112	MR	6.90	813	0.22	46	
B03	BLUESTONE RIVER AT CONFLUENCE	5/4/1999	11:39	CLR	24.0	14.0	8.0	8.1	171	MI	5.91	500	0.00	13	
B03	BLUESTONE RIVER AT CONFLUENCE	6/16/1999	12:27	OVC	24.0	22.5	5.4	8.5	345	MR	6.73	44	0.00	16	1
B03	BLUESTONE RIVER AT CONFLUENCE	7/14/1999	11:37	OVC	24.0	22.5	6.2	8.4	361	MI	2.97	53	0.45	21	
B03	BLUESTONE RIVER AT CONFLUENCE	9/22/1999	11:23	SCT	19.0	14.0		8.9	320	C	2.78	19	0.11	10	
B03	BLUESTONE RIVER AT CONFLUENCE	5/25/2000	11:45	OVC,-L	18.2	20.0	9.0	7.6	285	C	2.81	122	0.28	102	
B03	BLUESTONE RIVER AT CONFLUENCE	6/12/2000	11:30	SCT	32.0	24.2	7.2	7.7	340	MR	4.92	62	0.00	18	
B03	BLUESTONE RIVER AT CONFLUENCE	7/25/2000	12:11	OVC	22.0	21.0	4.8	8.0	252	MR	5.66	244	0.96	28	
B03	BLUESTONE RIVER AT CONFLUENCE	10/2/2000	11:22	CLR	17.5	15.4	8.2	8.5	277	C	6.06	65	0.00	30	
B01	BLUESTONE RIVER AT ST. PARK	5/11/1998	10:01	OVC	18.9	14.5	9.3	7.1	105	MI	7.50	813	0.22	62	
B01	BLUESTONE RIVER AT ST. PARK	5/4/1999	10:07	CLR	19.0	14.2	8.0	7.8	137	MI	4.50	500	0.00	23	
B01	BLUESTONE RIVER AT ST. PARK	6/16/1999	11:15	OVC	22.0	23.0	8.7	8.5	341	C	1.69	44	0.00	16	
B01	BLUESTONE RIVER AT ST. PARK	7/14/1999	10:01	OVC	22.0	21.0	8.4	8.3	335	C	1.61	53	0.45	38	
B01	BLUESTONE RIVER AT ST. PARK	9/22/1999	9:53	SCT	12.0	15.0		8.6	299	C	0.81	19	0.11	9	
B01	BLUESTONE RIVER AT ST. PARK	5/25/2000	10:25	OVC,-L	19.5	20.0	9.7	7.7	292	C	1.41	122	0.28	53	
B01	BLUESTONE RIVER AT ST. PARK	6/12/2000	10:13	SCT	28.0	24.9	8.5	8.4	350	C	2.14	62	0.00	4	
B01	BLUESTONE RIVER AT ST. PARK	7/25/2000	11:07	OVC	20.0	18.5	8.2	7.9	205	MR	7.58	244	0.96	138	2
B01	BLUESTONE RIVER AT ST. PARK	10/2/2000	10:04	OVC,F	15.5	15.4	9.7	8.8	262	C	1.55	65	0.00	36	
B05	MOUNTAIN CREEK	5/11/1998	12:25	OVC	18.0	11.4	10.5	7.0	48	MI	10.20	H	0.22	212	
B05	MOUNTAIN CREEK	5/4/1999	12:50	CLR	26.0	12.5	8.0	7.4	151	MI	3.26	N	0.00	12	
B05	MOUNTAIN CREEK	6/16/1999	13:24	OVC	21.0	18.0	8.6	7.3	224	C	1.33	L	0.00	32	
B05	MOUNTAIN CREEK	7/14/1999	12:47	OVC	26.0	25.0	5.1	6.8	299	MI	4.70	L	0.45	56	
B05	MOUNTAIN CREEK	9/22/1999	13:07	SCT	16.0	13.0		7.2	380	C	2.07	L	0.11	3	
B05	MOUNTAIN CREEK	5/25/2000	12:52	SCT	20.0	15.5	12.8	6.9	122	MR	47.60	H	0.28	1580	
B05	MOUNTAIN CREEK	6/12/2000	12:27	SCT	26.0	19.2	11.2	7.3	230	C	1.22	L	0.00	24	
B05	MOUNTAIN CREEK	7/25/2000	12:56	OVC	21.0	18.0	5.4	7.6	111	MI	4.17	N	0.96	110	
B05	MOUNTAIN CREEK	10/2/2000	12:20	CLR	20.0	13.0	10.0	7.9	219	C	0.74	L	0.00	12	

Appendix 1.
Bluestone River Mainstem and Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-Hour Precipitation (inches)	Fecal Coliform/100 ml	Comments
B04	BLUESTONE RIVER AT PIPESTEM	5/11/1998	12:43	OVC	19.0	14.6	9.7	7.6	119	MR	9.00	813	0.22	93	
B04	BLUESTONE RIVER AT PIPESTEM	5/4/1999	13:03	CLR	26.0	15.0	8.0	8.2	218	MI	5.29	500	0.00	6	
B04	BLUESTONE RIVER AT PIPESTEM	6/16/1999	13:43	OVC	21.0	21.8	8.9	8.7	347	C	1.76	44	0.00	34	
B04	BLUESTONE RIVER AT PIPESTEM	7/14/1999	13:05	BKN	26.0	29.0	6.2	8.8	390	C	1.41	53	0.45	28	
B04	BLUESTONE RIVER AT PIPESTEM	9/22/1999	12:29	SCT	22.0	15.0		9.1	330	C	0.63	19	0.11	6	
B04	BLUESTONE RIVER AT PIPESTEM	5/25/2000	13:12	SCT	22.5	19.1	12.2	8.2	260	MR	14.20	122	0.28	413	
B04	BLUESTONE RIVER AT PIPESTEM	6/12/2000	12:44	SCT	28.0	25.9	10.4	8.5	348	C	1.85	62	0.00	4	
B04	BLUESTONE RIVER AT PIPESTEM	7/25/2000	13:10	OVC	20.0	20.1	5.3	8.2	252	MR	2.86	244	0.96	10	
B04	BLUESTONE RIVER AT PIPESTEM	10/2/2000	12:42	CLR	25.0	16.1	11.3	9.0	284	C	1.30	65	0.00	16	
B03	BLUESTONE RIVER AT CONFLUENCE	5/11/1998	11:18	OVC	19.0	14.5	9.6	7.6	112	MR	6.90	813	0.22	46	
B03	BLUESTONE RIVER AT CONFLUENCE	5/4/1999	11:39	CLR	24.0	14.0	8.0	8.1	171	MI	5.91	500	0.00	13	
B03	BLUESTONE RIVER AT CONFLUENCE	6/16/1999	12:27	OVC	24.0	22.5	5.4	8.5	345	MR	6.73	44	0.00	16	1
B03	BLUESTONE RIVER AT CONFLUENCE	7/14/1999	11:37	OVC	24.0	22.5	6.2	8.4	361	MI	2.97	53	0.45	21	
B03	BLUESTONE RIVER AT CONFLUENCE	9/22/1999	11:23	SCT	19.0	14.0		8.9	320	C	2.78	19	0.11	10	
B03	BLUESTONE RIVER AT CONFLUENCE	5/25/2000	11:45	OVC,-L	18.2	20.0	9.0	7.6	285	C	2.81	122	0.28	102	
B03	BLUESTONE RIVER AT CONFLUENCE	6/12/2000	11:30	SCT	32.0	24.2	7.2	7.7	340	MR	4.92	62	0.00	18	
B03	BLUESTONE RIVER AT CONFLUENCE	7/25/2000	12:11	OVC	22.0	21.0	4.8	8.0	252	MR	5.66	244	0.96	28	
B03	BLUESTONE RIVER AT CONFLUENCE	10/2/2000	11:22	CLR	17.5	15.4	8.2	8.5	277	C	6.06	65	0.00	30	
B01	BLUESTONE RIVER AT ST. PARK	5/11/1998	10:01	OVC	18.9	14.5	9.3	7.1	105	MI	7.50	813	0.22	62	
B01	BLUESTONE RIVER AT ST. PARK	5/4/1999	10:07	CLR	19.0	14.2	8.0	7.8	137	MI	4.50	500	0.00	23	
B01	BLUESTONE RIVER AT ST. PARK	6/16/1999	11:15	OVC	22.0	23.0	8.7	8.5	341	C	1.69	44	0.00	16	
B01	BLUESTONE RIVER AT ST. PARK	7/14/1999	10:01	OVC	22.0	21.0	8.4	8.3	335	C	1.61	53	0.45	38	
B01	BLUESTONE RIVER AT ST. PARK	9/22/1999	9:53	SCT	12.0	15.0		8.6	299	C	0.81	19	0.11	9	
B01	BLUESTONE RIVER AT ST. PARK	5/25/2000	10:25	OVC,-L	19.5	20.0	9.7	7.7	292	C	1.41	122	0.28	53	
B01	BLUESTONE RIVER AT ST. PARK	6/12/2000	10:13	SCT	28.0	24.9	8.5	8.4	350	C	2.14	62	0.00	4	
B01	BLUESTONE RIVER AT ST. PARK	7/25/2000	11:07	OVC	20.0	18.5	8.2	7.9	205	MR	7.58	244	0.96	138	2
B01	BLUESTONE RIVER AT ST. PARK	10/2/2000	10:04	OVC,F	15.5	15.4	9.7	8.8	262	C	1.55	65	0.00	36	
B05	MOUNTAIN CREEK	5/11/1998	12:25	OVC	18.0	11.4	10.5	7.0	48	MI	10.20	H	0.22	212	
B05	MOUNTAIN CREEK	5/4/1999	12:50	CLR	26.0	12.5	8.0	7.4	151	MI	3.26	N	0.00	12	
B05	MOUNTAIN CREEK	6/16/1999	13:24	OVC	21.0	18.0	8.6	7.3	224	C	1.33	L	0.00	32	
B05	MOUNTAIN CREEK	7/14/1999	12:47	OVC	26.0	25.0	5.1	6.8	299	MI	4.70	L	0.45	56	
B05	MOUNTAIN CREEK	9/22/1999	13:07	SCT	16.0	13.0		7.2	380	C	2.07	L	0.11	3	
B05	MOUNTAIN CREEK	5/25/2000	12:52	SCT	20.0	15.5	12.8	6.9	122	MR	47.60	H	0.28	1580	
B05	MOUNTAIN CREEK	6/12/2000	12:27	SCT	26.0	19.2	11.2	7.3	230	C	1.22	L	0.00	24	
B05	MOUNTAIN CREEK	7/25/2000	12:56	OVC	21.0	18.0	5.4	7.6	111	MI	4.17	N	0.96	110	
B05	MOUNTAIN CREEK	10/2/2000	12:20	CLR	20.0	13.0	10.0	7.9	219	C	0.74	L	0.00	12	

Appendix 1.
Bluestone River Mainstem and Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-Hour Precipitation (inches)	Fecal Coliform/100 ml	Comments
B02	LITTLE BLUESTONE RIVER	5/11/1998	11:01	OVC	18.0	13.2	9.7	6.9	40	MI	7.50	H	0.22	104	
B02	LITTLE BLUESTONE RIVER	5/4/1999	11:19	CLR	24.0	10.8	8.7	7.3	67	MI	4.44	H	0.00	22	
B02	LITTLE BLUESTONE RIVER	6/16/1999	12:12	OVC	22.0	19.0	7.8	7.2	122	C	1.92	L	0.00	80	
B02	LITTLE BLUESTONE RIVER	7/14/1999	11:16	OVC	22.0	19.0	7.8	7.5	132	C	1.35	L	0.45	144	
B02	LITTLE BLUESTONE RIVER	9/22/1999	10:59	SCT	12.0	13.0		7.1	142	C	2.12	L	0.11	60	
B02	LITTLE BLUESTONE RIVER	5/25/2000	11:27	OVC,-L	17.0	16.8	12.2	6.9	82	C	1.99	L	0.28	55	
B02	LITTLE BLUESTONE RIVER	6/12/2000	11:08	SCT	27.0	19.5	8.5	7.7	102	C	1.85	L	0.00	39	
B02	LITTLE BLUESTONE RIVER	7/25/2000	11:56	OVC	20.5	17.0	7.4	7.1	62	MR	15.10	H	0.96	80	
B02	LITTLE BLUESTONE RIVER	10/2/2000	11:03	CLR	14.0	12.5	10.1	7.7	103	C	1.54	L	0.00	56	

Key to Comments
1=100 ml colonies smeared
2=102 ml filter no blue colonies

Appendix 2A.
New River Mainstem Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N01	NEW RIVER AT HINTON VC	5/6/1998	13:02	SCT	28.0	14.8	9.7	7.5	100	MR	23.20	27900	0.69	600	
N01	NEW RIVER AT HINTON VC	6/11/1998	11:13	OVC	24.0	19.0	9.6	7.0	135	MR	6.85	10000	0.02	105	
N01	NEW RIVER AT HINTON VC	5/3/1999	10:50	SCT	22.0	15.2	11.2	8.5	115	MI	5.59	7600	0.00	40	
N01	NEW RIVER AT HINTON VC	6/9/1999	11:00	SCT,H	28.5	26.1	5.6	8.2	202	C	3.18	2310	0.00	78	
N01	NEW RIVER AT HINTON VC	7/13/1999	11:43	OVC	21.0	26.5	7.2	7.7	182	C	4.77	3900	0.45	59	
N01	NEW RIVER AT HINTON VC	9/28/1999	10:40	OVC	22.0	20.1	9.8	7.8	170	C	2.32	1540	0.91	52	
N01	NEW RIVER AT HINTON VC	5/17/2000	10:44	SCT	21.5	22.2	8.1	8.3	155	C	1.65	3010	0.03	23	
N01	NEW RIVER AT HINTON VC	6/6/2000	11:30	OVC,-L	14.5	18.0	8.4	7.9	169	C	2.92	2970	0.38	34	
N01	NEW RIVER AT HINTON VC	7/20/2000	10:58	OVC	20.0	25.2	6.6	8.2	195	C	2.35	2340	0.76	21	
N01	NEW RIVER AT HINTON VC	8/9/2000	12:23	SCT	26.1	29.0	7.3	7.9	170	MR	3.30	3700	0.45	18	
N01	NEW RIVER AT HINTON VC	9/19/2000	10:29	BKN	21.0	22.1	7.8	7.6	193	C	1.99	1780	0.52	36	
N04	NEW R. AT SNDSTN FALLS PKLOT	5/6/1998	11:30	SCT	20.1	14.3	9.7	7.5	99	MR	22.50	27900	0.69	505	3
N04	NEW R. AT SNDSTN FALLS PKLOT	6/11/1998	12:01	OVC	24.0	19.2	9.5	7.6	138	MI	7.40	10000	0.02	752	
N04	NEW R. AT SNDSTN FALLS PKLOT	5/3/1999	12:32	SCT	26.2	16.1	10.5	8.4	121	MI	4.27	7600	0.00	5	
N04	NEW R. AT SNDSTN FALLS PKLOT	6/9/1999	11:57	SCT,H	30.5	28.0	7.4	9.0	215	C	1.72	2310	0.00	33	
N04	NEW R. AT SNDSTN FALLS PKLOT	7/13/1999	13:10	OVC	23.0	25.0	8.8	8.7	170	C	3.36	3900	0.45	54	
N04	NEW R. AT SNDSTN FALLS PKLOT	9/28/1999	12:10	OVC	23.0	21.1	11.3	8.9	170	C	1.60	1540	0.91	28	
N04	NEW R. AT SNDSTN FALLS PKLOT	5/17/2000	11:38	BKN	21.8	21.0		8.7	150	C	1.37	3010	0.03	7	4
N04	NEW R. AT SNDSTN FALLS PKLOT	6/6/2000	12:40	OVC,-L	16.0	16.0	8.6	7.8	148	C	3.37	2970	0.38	64	
N04	NEW R. AT SNDSTN FALLS PKLOT	7/20/2000	12:05	BKN	25.2	24.1	9.6	8.9	179	C	2.75	2340	0.76	40	
N04	NEW R. AT SNDSTN FALLS PKLOT	8/9/2000	11:04	SCT	26.0	24.8	8.8	8.4	150	MR	12.70	3700	0.45	220	
N04	NEW R. AT SNDSTN FALLS PKLOT	9/19/2000	11:34	BKN	20.5	21.5	10.5	9.0	174	C	1.79	1780	0.52	16	
N21	NEW R. AT SNDSTN FALLS BDWLK	5/6/1998	11:56	SCT	19.8	15.0	9.7	7.6	99	MR	22.00	27900	0.69	525	
N21	NEW R. AT SNDSTN FALLS BDWLK	6/11/1998	12:23	OVC	23.0	19.5	9.8	7.9	136	MI	8.30	10000	0.02	477	
N21	NEW R. AT SNDSTN FALLS BDWLK	5/3/1999	12:15	SCT	25.0	16.0	10.1	8.5	121	MI	4.25	7600	0.00	6	
N21	NEW R. AT SNDSTN FALLS BDWLK	6/9/1999	12:15	SCT,H	30.5	27.0	5.6	8.5	210	C	1.72	2310	0.00	9	
N21	NEW R. AT SNDSTN FALLS BDWLK	7/13/1999	12:52	OVC	23.0	25.0	7.7	8.3	170	C	4.89	3900	0.45	940	
N21	NEW R. AT SNDSTN FALLS BDWLK	9/28/1999	11:50	OVC,-R	23.0	21.0	9.6	8.5	170	C	1.33	1540	0.91	43	
N21	NEW R. AT SNDSTN FALLS BDWLK	5/17/2000	12:09	OVC	22.8	21.3		8.3	148	C	1.34	3010	0.03	7	4
N21	NEW R. AT SNDSTN FALLS BDWLK	6/6/2000	12:55	OVC,-L	16.2	15.0	9.2	7.8	145	C	5.80	2970	0.38	61	
N21	NEW R. AT SNDSTN FALLS BDWLK	7/20/2000	12:23	BKN	24.0	24.0	7.4	8.5	185	C	2.68	2340	0.76	30	
N21	NEW R. AT SNDSTN FALLS BDWLK	8/9/2000	11:20	SCT	27.9	25.0	7.7	8.1	159	MR	9.99	3700	0.45	110	
N21	NEW R. AT SNDSTN FALLS BDWLK	9/19/2000	11:57	BKN	23.0	21.6	8.8	8.7	176	C	1.92	1780	0.52	39	
N08	NEW RIVER AT PRINCE	5/4/1998	9:38	OVC	17.2	14.2	10.0	7.1	99	TR	25.00	19484	1.44	300	5,6
N08	NEW RIVER AT PRINCE	5/5/1999	9:42	OVC	17.8	16.5	8.9	7.9	118	MI	4.35	6868	0.00	11	
N08	NEW RIVER AT PRINCE	6/8/1999	9:31	SCT,H	24.5	25.3	8.2	7.9	182	C	1.85	2269	0.00	4	
N08	NEW RIVER AT PRINCE	7/12/1999	10:36	OVC,-R	17.5	24.0	7.4	8.0	175	C	2.00	1781	0.34	6	
N08	NEW RIVER AT PRINCE	9/27/1999	9:22	BKN	19.0	20.1	9.5	7.6	170	C	1.99	1118	0.00	3	
N08	NEW RIVER AT PRINCE	5/23/2000	10:26	OVC	15.2	21.0	7.9	7.7	151	C	2.31	3472	0.95	19	7
N08	NEW RIVER AT PRINCE	6/8/2000	10:18	CLR	21.0	22.5	7.8	8.0	157	MR	6.81	4933	0.04	30	

Appendix 2A.
New River Mainstem Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N08	NEW RIVER AT PRINCE	7/17/2000	10:21	SCT	30.0	24.5	7.4	8.0	193	MR	7.76	N	0.44	24	6,8
N08	NEW RIVER AT PRINCE	9/18/2000	9:54	OVC	16.0	19.3	8.5	8.2	160	C	2.11	1978	0.00	20	
N08	NEW RIVER AT PRINCE	12/21/2000	10:45	OVC	3.0	1.3	13.4	7.6	91	MR	5.73	6920	0.11	43	
N12	NEW RIVER AT THURMOND	5/13/1998	10:12	CLR	19.5	15.2	9.6	7.4	101	MR	14.00	24600	0.00	143	
N12	NEW RIVER AT THURMOND	9/14/1998	11:53	SCT	25.0	24.2	7.9	8.4	198	C	1.20	1233	0.00	1	
N12	NEW RIVER AT THURMOND	4/28/1999	10:30	OVC,L	13.0	15.1	9.5	7.6	125	MR	6.89	5160	0.92	352	
N12	NEW RIVER AT THURMOND	6/1/1999	10:12	OVC	22.0	22.5	7.4	8.1	141	C	1.94	3115	0.00	8	
N12	NEW RIVER AT THURMOND	7/15/1999	10:30	CLR	24.0	25.0	7.4	8.0	178	C	4.50	3750	0.00	27	
N12	NEW RIVER AT THURMOND	9/21/1999	10:51	OVC	16.5	20.0	8.3	7.8	170	C	1.38	1162	0.11	2	
N12	NEW RIVER AT THURMOND	4/19/2000	10:31	OVC	12.0	13.3	10.6	7.6	102	TR	50.30	38900	0.82	2625	9
N12	NEW RIVER AT THURMOND	6/5/2000	12:04	OVC	24.0	22.8	8.1	7.9	145	C	1.93	3040	0.02	7	
N12	NEW RIVER AT THURMOND	8/7/2000	10:20	OVC	25.0	24.5	7.4	7.2	170	MR	10.40	6970	0.27	30	6
N12	NEW RIVER AT THURMOND	9/25/2000	12:34	R+	16.0	21.8	8.0		191	C	2.12	2138	0.20	40	
N12	NEW RIVER AT THURMOND	12/19/2000	12:05	S-	-2.0	2.6	14.0	7.2	74	TR	44.90	10600	0.97	280	7
N20	NEW RIVER AT CUNARD	5/12/1998	12:10	OVC	20.8	15.5	9.1	7.6	100	MR	12.00	26620	0.93	73	7
N20	NEW RIVER AT CUNARD	9/15/1998	12:00	SCT	31.0	24.2	7.9	8.4	202	C	1.10	1574	0.00	3	
N20	NEW RIVER AT CUNARD	4/27/1999	11:53	SCT	21.0	17.0	8.6	7.8	129	MI	3.73	5820	0.16	4	
N20	NEW RIVER AT CUNARD	6/7/1999	11:05	SCT,H	28.0	25.0	8.8	8.0	182	C	1.70	2667	0.00	2	
N20	NEW RIVER AT CUNARD	7/21/1999	11:00	OVC	32.0	26.8	8.2	8.0	184	C	2.22	2331	0.56	149	
N20	NEW RIVER AT CUNARD	9/20/1999	11:53	SCT	28.0	20.2		8.4	175	C	1.45	1322	0.00	3	
N20	NEW RIVER AT CUNARD	5/10/2000	12:07	OVC	28.0	22.6	8.5	7.5	140	C	3.15	5425	0.00	4	
N20	NEW RIVER AT CUNARD	6/7/2000	12:09	SCT	23.0	22.0	8.2	7.7	145	MR	4.73	3471	0.49	31	
N20	NEW RIVER AT CUNARD	8/3/2000	13:35	SCT	30.0	24.9	7.0	7.1	168	TR	52.10	11700	0.02	353	
N20	NEW RIVER AT CUNARD	9/27/2000	12:06	SCT	27.0	17.7	8.6	7.8	172	MR	9.56	8690	2.01	320	
N17	NEW RIVER AT FAYETTE STATION	5/12/1998	11:10	OVC	19.8	15.5	9.6	7.6	100	MR	13.00	26620	0.93	96	7,10
N17	NEW RIVER AT FAYETTE STATION	9/15/1998	10:20	H, SCT	25.0	24.0	8.3	8.3	200	C	1.10	1574	0.00	2	
N17	NEW RIVER AT FAYETTE STATION	12/9/1998	9:48	OVC	8.0	10.9	11.2	8.1	149	MI	16.00	2667	1.69	256	
N17	NEW RIVER AT FAYETTE STATION	4/27/1999	10:19	OVC	19.0	16.0	9.6	7.8	129	MI	2.68	5820	0.16	2	
N17	NEW RIVER AT FAYETTE STATION	6/7/1999	9:59	CLR,H	26.5	24.8	9.0	8.1	182	C	1.66	2667	0.00	1	
N17	NEW RIVER AT FAYETTE STATION	7/21/1999	9:53	OVC	26.0	26.2	7.7	8.0	182	C	2.17	2331	0.56	5	
N17	NEW RIVER AT FAYETTE STATION	9/20/1999	10:37	BKN	20.0	20.1		8.1	170	C	1.24	1322	0.00	2	
N17	NEW RIVER AT FAYETTE STATION	5/10/2000	10:36	SCT	26.0	23.0	8.5	8.0	142	C	3.15	5425	0.00	2	
N17	NEW RIVER AT FAYETTE STATION	6/7/2000	10:30	SCT	18.8	20.2	8.7	7.9	138	MR	5.77	3471	0.49	75	
N17	NEW RIVER AT FAYETTE STATION	8/3/2000	12:21	BKN	28.0	24.0	7.8	7.2	165	TR	44.20	11700	0.02	157	
N17	NEW RIVER AT FAYETTE STATION	9/27/2000	9:53	OVC,F	12.0	17.8	9.3	7.7	175	MR	6.75	8690	2.01	580	11

Key to Comments
3=Colonies smeared on 40 ml filter
4=DO probe has bubbles
5=Thurmond gage cfs was 19484
6=48 hour precipitation actually 72 hour
7=48 hour precipitation actually 120 hour
8=No gage reading
9=Waves with flotsam
10=60 ml colonies smeared, not countable
11=Confluent growth with coliforms (30 ml filter)

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N02	MADAM CREEK	5/6/1998	10:39	CLR	23.0	11.9	9.6	7.1	51	MI	12.00	H	0.69	825	
N02	MADAM CREEK	6/11/1998	11:28	OVC	24.0	16.5	10.3	7.9	105	MI	4.35	N	0.02	390	
N02	MADAM CREEK	5/3/1999	11:15	SCT	23.2	11.6	10.9	7.8	60	MI	7.89	H	0.00	650	
N02	MADAM CREEK	6/9/1999	11:20	SCT,H	33.0	23.2	6.2	8.0	228	C	2.11	L	0.00	5650	
N02	MADAM CREEK	7/13/1999	12:03	OVC	22.0	20.0	8.8	8.0	242	C	2.13	L	0.45	10650	
N02	MADAM CREEK	9/28/1999	11:05	OVC	22.0	19.5	4.3	7.5	330	MI	18.20	L	0.91	9400	12
N02	MADAM CREEK	5/17/2000	11:06	SCT	22.0	16.0		8.4	120	C	3.10	L	0.03	2700	4
N02	MADAM CREEK	6/6/2000	12:02	OVC,-L	14.0	11.2	10.6	7.5	88	TR	47.20	H	0.38	10150	
N02	MADAM CREEK	7/20/2000	11:29	OVC	22.0	18.8	8.1	7.2	110	MR	19.50	N	0.76	2000	
N02	MADAM CREEK	8/9/2000	12:08	SCT	28.0	20.0	8.4	7.5	80	MR	37.70	H	0.45	1200	
N02	MADAM CREEK	9/19/2000	10:55	BKN	20.0	16.1	9.1	8.0	165	MR	64.70	N	0.52	69000	
N05	LICK CREEK	5/6/1998	9.55	CLR	18.0	9.9	11.1	7.2	65	MI	13.50	175.43	0.69	140	
N05	LICK CREEK	6/11/1998	9:58	OVC	24.5	18.9	9.6	6.9	180	C	2.40	8 40	0.02	90	
N05	LICK CREEK	5/3/1999	10:00	SCT	18.5	11.0	11.3	7.9	92	MI	5.04	36 09	0.00	95	
N05	LICK CREEK	6/9/1999	9:50	H	25.8	21.5	7.2	8.1	300	C	1.18	2.20	0.00	66	
N05	LICK CREEK	7/13/1999	9:48	OVC	21.0	18.5	9.0	8.1	385	C	1.45	2.50	0.45	90	
N05	LICK CREEK	9/28/1999	9:56	OVC	22.0	17.5	9.7	7.9	448	C	0.78	1.10	0.91	607	
N05	LICK CREEK	5/17/2000	10:04	SCT	20.1	16.0	8 6	8.1	188	C	1.16	3 04	0.03	25	
N05	LICK CREEK	6/6/2000	10:58	OVC	15.0	12.8	10.4	8.0	145	TR	55.40	25.88	0.38	2001	13
N05	LICK CREEK	7/20/2000	10:23	OVC	20.5	20.2	8.2	7.3	235	MI	6.00	9.46	0.76	510	
N05	LICK CREEK	8/9/2000	13:15	SCT	30.0	22.8	8.3	8.1	151	MR	28.10	20.56	0 45	267	
N05	LICK CREEK	9/19/2000	9:56	OVC	19.0	16.3	9.4	7.8	249	C	1.76	2.32	0.52	260	
N06	MEADOW CREEK	5/6/1998	9:35	CLR	14.2	11.0	10.2	6.8	48	MI	10.00	100.20	0.69	170	
N06	MEADOW CREEK	6/11/1998	9:37	OVC	24.0	16.0	9.6	7.0	108	C	2.20	10.56	0.02	108	
N06	MEADOW CREEK	5/3/1999	9:40	SCT	13.2	10.0	11.2	7.6	55	MI	5.14	37.00	0.00	25	
N06	MEADOW CREEK	6/9/1999	9:23	H	22.8	19.5	8.9	7.9	184	C	2.64	4.00	0.00	9	
N06	MEADOW CREEK	7/13/1999	10:19	BKN	21.8	18.5	9.7	8.5	195	C	3.08	1.40	0.45	30	
N06	MEADOW CREEK	9/28/1999	9:27	OVC	19.0	16.8	11.8	8.0	235	C	1.20	0.77	0.91	12	
N06	MEADOW CREEK	5/17/2000	9:40	CLR	17.0	13.5	9.3	7.8	112	C	2.77	8.04	0.03	6	
N06	MEADOW CREEK	6/6/2000	10:32	OVC,-L	16.5	15.0	9.9	6.9	85	TR	111.00	36.00	0.38	5500	
N06	MEADOW CREEK	7/20/2000	9:55	OVC	20.0	18.1	9.2	6.9	118	MR	18.10	24.00	0.76	460	
N06	MEADOW CREEK	8/9/2000	13:32	SCT	28.0	21.0	8.5	7.9	100	MR	15.60	35.00	0.45	280	
N06	MEADOW CREEK	9/19/2000	9:35	OVC,-L	20.0	14.6	10.2	7.7	136	C	1.93	8.04	0.52	134	
N22	GLADE CREEK	3/20/1995	9:56	OVC	13.0	7.5	12.2	8.0	90	MI	2.10	N	0.00	7	
N22	GLADE CREEK	4/5/1995	11:15	CLR	3.0	6.0	13.2	7.3	68	C	0.80	N	0.11	4	
N22	GLADE CREEK	4/19/1995	12:00	CLR	26.0	15.5	10.2	7.5	90	C	0.60	N	0.27	4	
N22	GLADE CREEK	5/2/1995	13:15	OVC	12.0	10.0	11.6	7.4	70	MR	13.00	H	0.89	228	
N22	GLADE CREEK	6/14/1995	12.28	SCT,-H	20.0	16.0	9.8	7.0	105	MI	5.00	N	0.23	42	
N22	GLADE CREEK	7/12/1995	14:20	CLR	28.0	22.3	8.2	7.4	149	C	1.10	L	0.00	2	
N22	GLADE CREEK	8/30/1995	11:32	C,-H	28.0	21.0	7.9	7.7	172	C	0.70	L	0.00	3	
N22	GLADE CREEK	9/13/1995	12:05	OVC	22.0	18.0	7.9	7.9	170	C	0.40	L	0.00	3	
N22	GLADE CREEK	9/26/1995	13:10	OVC	17.0	15.0	9.6	7.4	142	C	0.70	N	1.05	14	
N22	GLADE CREEK	5/16/1996	14:36	OVC	13.5	12.5	10.2	6.5	75	TR	69.00	H	1.82	480	

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N22	GLADE CREEK	5/28/1996	12:26	OVC	19.0	17.0	9.1	6.9	79	MR	10.50	H	3.32	146	7
N22	GLADE CREEK	6/11/1996	10 45	SCT	21.5	17.0	9.2	7.1	91	C	1.70	N	1.30	23	7
N22	GLADE CREEK	6/25/1996	11 20	BKN	23.0	20.8	9.4	8.1	108	MI	5.00	N	1.54	90	7
N22	GLADE CREEK	7/9/1996	14:30	SCT	26 0	21.0	8.4	7.3	130	C	0.80	L	0.26	15	
N22	GLADE CREEK	7/24/1996	12:48	SCT	27.0	20.0	8.6	7.4	138	C	0 80	L	0.05	3	
N22	GLADE CREEK	8/5/1996	17:05	H		19.0	7.5	6.9	160	C	1.50		0.00	2	14
N22	GLADE CREEK	8/5/1996	17:05	H		19.0	7.5	6.9	160	C	1.50		0.00	1	14
N22	GLADE CREEK	5/5/1997	11.50	SCT	20.9	9.8	11.3	7.2	65	C	2.10	N	0.54	12	6
N22	GLADE CREEK	5/15/1997	14:19	SCT	19.0	13.0	10.3	7.0	69	C	2.70	H	0.17	8	
N22	GLADE CREEK	6/4/1997	12:05	SCT	18.0	13.9		7.0	72	C	3 80	H	0.02	9	4
N22	GLADE CREEK	6/17/1997	11:41	BKN	22.5	17.8	8.5	7.2	91	C	1.20	N	0.95	4	15
N22	GLADE CREEK	7/1/1997	15:51	BKN	26.0	19.5	8.9	7.1	89	MR	21.00	N	0.67	342	
N22	GLADE CREEK	7/16/1997	10:48	SCT,H	27.5	20.1	8.5	7.5	118	C	1.20	L	0.00	4	
N22	GLADE CREEK	7/29/1997	11:45	SCT	26.4	21.1	8.5	7.4	100	MI	5.70	N	2.07	56	15
N22	GLADE CREEK	5/4/1998	10:45	OVC	16.0	11.2	10.9	7.0	65	MI	8.20	H	1.44	236	6
N22	GLADE CREEK	5/5/1999	10:42	OVC	18.2	12.5	9.8	7.3	120	MI	1.60	N	0.00	84	
N22	GLADE CREEK	6/8/1999	10:26	OVC	22.5	19.0	7.3	7.2	158	C	0.43	L	0.00	6	
N22	GLADE CREEK	7/12/1999	11:55	OVC,-R	16.2	19.0	8.7	7.4	212	C	0.76	L	0.34	53	
N22	GLADE CREEK	9/27/1999	10:20	OVC	18.0	15.2	10.6	7.4	162	C	0.29	L	0.00	4	
N22	GLADE CREEK	5/23/2000	11:26	OVC	16.0	14.8	9.6	7.3	230	C	1.19	N	0.95	10	7
N22	GLADE CREEK	6/8/2000	9:42	SCT	17.0	13.8	9.8	7.0	99	C	1.45	N	0.04	30	
N22	GLADE CREEK	7/17/2000	11:25	BKN	22.0	19.0	8.6	6.8	148	MI	3.24	N	0.44	19	6
N22	GLADE CREEK	9/18/2000	11:00	OVC	15.1	13.4	9 8	7.2	118	C	0.37	L	0.00	2	
N22	GLADE CREEK	12/21/2000	11:30	OVC	1.0	0.1	14.4	7.6	72	C	0.95	H	0.11	11	16
N07	LAUREL CREEK AT QUINNIMONT	5/4/1998	9:58	OVC	15.9	10.4	10.9	7.0	39	MI	7.20	66.76	1.44	230	6
N07	LAUREL CREEK AT QUINNIMONT	5/5/1999	10:01	OVC	11.0	11.5	10.2	6.8	70	C	2.83	13.82	0.00	4	
N07	LAUREL CREEK AT QUINNIMONT	6/8/1999	9:49	SCT,H	22.5	18.0	7.2	8.0	269	C	1.38	0.30	0.00	15	
N07	LAUREL CREEK AT QUINNIMONT	7/12/1999	10:55	R+	16.0	18.4	8.7	7.9	178	C	1.36	L	0.34	420	
N07	LAUREL CREEK AT QUINNIMONT	9/27/1999	9:40	BKN	19.0	15.0	11.1	7.9	164	C	0.97	L	0.00	16	
N07	LAUREL CREEK AT QUINNIMONT	5/23/2000	10:44	RW,OVC	15.0	14.2	9.9	7.4	91	C	2.33	N	0.95	232	7,8
N07	LAUREL CREEK AT QUINNIMONT	6/8/2000	10:40	SCT	19.0	12.8	10.8	7.4	60		4.79	45.00	0.04	93	
N07	LAUREL CREEK AT QUINNIMONT	7/17/2000	10:55	SCT	23.0	17.5	9.2	7.5	99	C	3.13	18.50	0.44	13	6
N07	LAUREL CREEK AT QUINNIMONT	9/18/2000	10:17	OVC	15.1	12.8	10.3	7.8	117	C	0.82	5.29	0.00	7	
N07	LAUREL CREEK AT QUINNIMONT	12/21/2000	10:56	OVC	-1.0	0.1	14.5	7.1	42	C	1.49	59.90	0.11	9	16
N09	PINEY CREEK AT McCREERY	5/4/1998	9:11	OVC	14 5	11.5	10.6	6.9	122	MR	22.50	H	1.44	1500	6,17
N09	PINEY CREEK AT McCREERY	5/5/1999	9:20	OVC	16.5	14.0	9.8	7.6	190	MI	3.79	159.66	0.00	99	
N09	PINEY CREEK AT McCREERY	6/8/1999	9:08	SCT,H	21.0	19.5	8.5	7.9	389	MI	4.06	33.16	0.00	70	
N09	PINEY CREEK AT McCREERY	7/12/1999	10:05	OVC,-R	18.2	19.3	8.2	7.9	452	MI	6.13	19.24	0 34	170	
N09	PINEY CREEK AT McCREERY	9/27/1999	8:55	OVC	16.8	15.0	8.8	7.9	460	C	0.93	19.24	0.00	31	
N09	PINEY CREEK AT McCREERY	5/23/2000	9:58	OVC,-R	14.0	16.0	8.8	7.8	304	C	4.04	46.28	0.95	180	7
N09	PINEY CREEK AT McCREERY	6/8/2000	9:12	SCT	16.2	15.0	9.7	7.2	248	MR	10.60	60.15	0.04	180	
N09	PINEY CREEK AT McCREERY	7/17/2000	9:54	SCT	20.5	18 9	8.7	6.8	255	MR	12 20	120 09	0.44	150	6

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N09	PINEY CREEK AT McCREERY	9/18/2000	9:35	OVC	13.0	13.4	10.2	7.8	293	C	2.50	34.68	0.00	46	
N09	PINEY CREEK AT McCREERY	12/21/2000	10:25	OVC	2.0	0.3	14.5	7.7	252	MI	3.02	69.01	0.11	290	16
N26	DOWDY CREEK	3/25/1997	11:10	OVC	20.5	8.0	13.7	6.1	18	C	1.10	N	0.00	0	18
N26	DOWDY CREEK	5/14/1998	11:13	SCT	20.0	12.5	10.3	6.7	20	C	0.70	H	0.00	1	19
N26	DOWDY CREEK	5/10/1999	10:31	SCT	15.0	11.8	9.6	6.8	20	C	0.45	N	0.20	4	20
N26	DOWDY CREEK	6/10/1999	9:00	CLR	20.0	15.5	8.1	6.8	59	C	0.40	L	0.00	8	
N26	DOWDY CREEK	7/21/1999	14:10	OVC	28.0	19.2	6.0	6.3	71	C	1.99	L	0.56	0	21
N26	DOWDY CREEK	9/21/1999	12:36	OVC	16.0	15.0	4.6	6.4	45	C	0.34	L	0.11	10	
N26	DOWDY CREEK	4/19/2000	12:12	OVC	15.0	10.2	11.7	5.8	18	C	0.75	H	0.82	2	22
N26	DOWDY CREEK	6/8/2000	11:30	CLR	18.0	13.5	10.5	6.5	21	C	2.83	N	0.04	1	19
N26	DOWDY CREEK	8/7/2000	11:30	OVC	24.0	16.2	8.1	6.6	25	C	0.52	N	0.27	4	6
N26	DOWDY CREEK	9/20/2000	10:22	OVC	17.0	15.3	8.8	6.7	30	C	0.38	L	0.02	2	
N25	SLATER CREEK	3/25/1997	10:30	BKN	18.0	7.9	13.6	7.2	32	C	3.20	N	0.00	1	
N25	SLATER CREEK	5/14/1998	10:33	SCT	19.0	12.5	10.4	6.9	38	MI	6.90	H	0.00	1	23
N25	SLATER CREEK	5/10/1999	11:00	CLR	15.8	11.9	9.8	7.3	42	C	3.17	L	0.20	9	24
N25	SLATER CREEK	6/10/1999	9:23	CLR	22.0	16.5	9.0	7.2	85	C	4.08	L	0.00	5	
N25	SLATER CREEK	7/21/1999	13:30	OVC	25.0	18.9	10.0	7.2	89	C	5.00	L	0.56	23	
N25	SLATER CREEK	9/21/1999	11:57	OVC	15.0	14.5	10.0	7.1	62	MI	4.24	L	0.11	30	
N25	SLATER CREEK	4/19/2000	11:45	OVC	14.0	10.5	11.7	7.1	35	C	8.87	H	0.82	17	25
N25	SLATER CREEK	6/8/2000	12:07	CLR	20.0	14.0	10.2	7.2	49	C	11.20	N	0.04	25	
N25	SLATER CREEK	8/7/2000	11:09	OVC	24.0	19.0	8.0	6.9	52	C	4.43	N	0.27	27	6,26
N25	SLATER CREEK	9/20/2000	10:54	CLR	18.0	14.6	8.8	7.0	57	C	2.36	L	0.02	9	
N24	BUFFALO CREEK	3/25/1997	9:55	SCT	16.0	7.5	13.6	7.2	49	C	2.80	N	0.00	1	
N24	BUFFALO CREEK	5/14/1998	10:03	SCT	19.0	12.5	10.6	6.7	61	MI	2.90	H	0.00	63	27
N24	BUFFALO CREEK	5/10/1999	11:25	CLR	19.0	12.1	9.8	7.4	72	C	1.59	L	0.20	1	28
N24	BUFFALO CREEK	6/10/1999	9:40	CLR	22.0	17.0	8.3	7.4	160	C	1.33	L	0.00	9	29
N24	BUFFALO CREEK	7/21/1999	13:08	OVC	26.5	20.1	8.8	7.3	179	C	1.66	L	0.56	67	30
N24	BUFFALO CREEK	9/21/1999	11:30	OVC	15.2	15.1	8.6	7.2	138	MI	1.94	L	0.11	32	
N24	BUFFALO CREEK	4/19/2000	11:20	OVC,-L	12.5	10.0	11.9	7.1	35	C	5.25	H	0.82	43	31
N24	BUFFALO CREEK	6/8/2000	12:22	SCT	19.0	13.2	10.6	7.4	61	MI	5.14	N	0.04	17	25
N24	BUFFALO CREEK	8/7/2000	10:54	OVC	22.0	18.0	8.4	7.5	60	MI	3.47	N	0.27	5	6
N24	BUFFALO CREEK	9/20/2000	11:13	CLR	18.0	14.7	9.6	7.4	124	C	1.31	L	0.02	10	
N27	CLAREMONT MINE SPRING	5/8/1996	11:55	OVC,R	17.0	10.5	9.6	5.1	48	C	2.50		0.46	1	
N27	CLAREMONT MINE SPRING	5/14/1998	9:32								2.50		0.00	0	21
N27	CLAREMONT MINE SPRING	5/10/1999	9:14	CLR							1.18		0.20	0	21

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N27	CLAREMONT MINE SPRING	6/10/1999	10:00								0.45		0.00	0	21
N27	CLAREMONT MINE SPRING	7/21/1999	12:45								0.34		0.56	0.5	
N27	CLAREMONT MINE SPRING	9/21/1999	13:23	OVC							1.45		0.11	0.4	
N27	CLAREMONT MINE SPRING	4/19/2000	11:00	OVC							3.18		0.82	0	32
N27	CLAREMONT MINE SPRING	6/8/2000	12:42	SCT							1.42		0.04	0.7	33
N27	CLAREMONT MINE SPRING	8/7/2000	10:40	OVC							1.15		0.27	0.4	6
N27	CLAREMONT MINE SPRING	9/20/2000	11:35	CLR							0.71		0.02	0	32
N11	DUNLOUP CREEK	5/13/1998	9:39	CLR	17.5	12.3	10.3	7.7	265	MI	4.50	149.93	0.00	174	
N11	DUNLOUP CREEK	9/14/1998	10:19	SCT	20.0	16.2	8.4	8.4	510	C	1.10	14.00	0.00	23	
N11	DUNLOUP CREEK	12/9/1998	11:45	SCT	5.2	9.2	11.7	8.0	210	MR	37.00	59.73	1.69	1625	34
N11	DUNLOUP CREEK	4/28/1999	9:00	OVC	12.0	13.0	10.6	8.1	259	TR	49.20	131.98	0.92	1262	
N11	DUNLOUP CREEK	4/28/1999	10:55	OVC,-R,L	11.0	13.2	10.1	8.1	240	TR	57.30	140.75	0.92	575	
N11	DUNLOUP CREEK	6/1/1999	8:55	OVC	18.5	16.2	10.4	8.2	495	MI	4.06	18.86	0.00	87	
N11	DUNLOUP CREEK	7/15/1999	8:40	CLR	18.0	18.5	9.2	8.4	510	MI	2.31	8.10	0.00	35	
N11	DUNLOUP CREEK	9/21/1999	9:20	OVC,-R	16.0	16.0	9.5	8.5	510	C	1.33	L	0.11	13	
N11	DUNLOUP CREEK	4/19/2000	9:08	OVC,-L	12.0	11.0	11.2	7.7	186	MR	12.50	100.86	0.82	395	
N11	DUNLOUP CREEK	6/5/2000	10:31	OVC	19.0	15.5	9.0	8.2	378	MI	6.62	33.14	0.02	232	
N11	DUNLOUP CREEK	8/7/2000	9:24	OVC	23.0	19.0	8.7	7.9	410	MI	9.41	27.95	0.27	80	6
N11	DUNLOUP CREEK	9/25/2000	11:03	R-	16.0	16.4	9.44	8.3	459	MI	10.80	24.41	0.20	490	
N11	DUNLOUP CREEK	12/19/2000	10:45	S-	1.0	3.8	14.0	8.5	192	MI	6.11	41.22	0.97	172	7
N13	ARBUCKLE CREEK	5/13/1998	11:10	CLR	20.5	12.8	10.1	7.9	221	MI	5.80	29.40	0.00	770	
N13	ARBUCKLE CREEK	9/14/1998	11:10	SCT	21.0	16.8	8.7	8.4	500	C	2.40	L	0.00	81	
N13	ARBUCKLE CREEK	12/9/1998	12:35	SCT	7.0	9.0	12.1	8.2	210	MR	30.0	19.80	1.69	14950	35
N13	ARBUCKLE CREEK	4/28/1999	9:45	OVC	12.0	12.5	10.8	8.0	247	MR	59.4	43.20	0.92	10350	
N13	ARBUCKLE CREEK	6/1/1999	9:29	OVC	18.0	15.2	9.4	8.3	452	C	4.24	2.10	0.00	410	
N13	ARBUCKLE CREEK	7/15/1999	9:20	CLR	21.0	18.0	9.1	8.4	575	C	6.86	L	0.00	320	
N13	ARBUCKLE CREEK	9/21/1999	9:55	OVC,-L	15.0	15.5	9.4	8.4	590	C	3.26	L	0.11	30	
N13	ARBUCKLE CREEK	4/19/2000	9:47	OVC,-L	13.0	11.0	11.5	7.4	198	MI	4.83	N	0.82	600	36
N13	ARBUCKLE CREEK	6/5/2000	11:12	OVC	19.0	15.0	9.6	8.1	319	C	4.39	L	0.02	140	
N13	ARBUCKLE CREEK	8/7/2000	9:51	OVC	22.0	19.5	8.2	8.0	415	MI	6.42	4.50	0.27	205	6
N13	ARBUCKLE CREEK	9/25/2000	11:42	R+	16.0	16.1	9.4		143	TR	626.00	100.00	0.20	250000	
N13	ARBUCKLE CREEK	12/19/2000	11:20	OVC	-0.5	3.6	13.7	7.7	219	MI	5.61	8.80	0.97	840	7
N15	COAL RUN	5/12/1998	12:30	OVC	17.0	12.8	9.7	7.9	232	MI	5.80	H	0.93	705	7
N15	COAL RUN	9/15/1998	12:26	SCT	25.0	17.9	8.9	8.1	410	MI	4.80	L	0.00	36	
N15	COAL RUN	4/27/1999	12:08	BKN	22.0	13.0	8.6	8.2	288	MI	4.60	N	0.16	30	
N15	COAL RUN	6/7/1999	11:25	SCT,H	21.0	16.8	9.8	7.9	395	MI	10.00	L	0.00	105	
N15	COAL RUN	7/21/1999	11:25	OVC	24.5	20.1	9.6	8.0	460	MI	7.57	L	0.56	30	
N15	COAL RUN	9/20/1999	12:15	SCT	18.0	15.0		8.0	399	C	3.26	L	0.00	7	
N15	COAL RUN	5/10/2000	12:26	OVC	24.0	16.2	8.6	8.1	302	MI	7.36	N	0.00	115	
N15	COAL RUN	6/7/2000	12:27	SCT	17.0	15.8	9.3	7.7	255	MI	8.75	N	0.49	533	
N15	COAL RUN	8/3/2000	13:50	SCT	29.0	18.5	8.6	7.9	273	MR	14.10	N	0.02	241	37

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N15	COAL RUN	9/27/2000	12:25	SCT	15.0	12.4	10.4	8.0	192	MI	8.94	H	2.01	1930	
N16	KEENEY CREEK	5/12/1998	9:40	OVC	16.0	11.3	9.9	6.9	65	MI	3.40	H	0.93	9120	7
N16	KEENEY CREEK	9/15/1998	9:30	SCT	19.0	17.1	6.3	7.4	201	C	0.90	L	0.00	1501	38,39
N16	KEENEY CREEK	12/9/1998	10:50	BKN	6.0	8.0	11.6	7.6	121	C	3.00	N	1.69	1240	
N16	KEENEY CREEK	4/27/1999	9:35	OVC	16.0	11.0	11.7	7.5	102	C	0.65	L	0.16	1320	
N16	KEENEY CREEK	6/7/1999	9:10	SCT	21.0	17.2	8.6	7.2	195	C	0.83	L	0.00	3001	40
N16	KEENEY CREEK	7/21/1999	9.00	OVC	26.0	19.8	7.2	7.2	244	C	2.90	L	0.56	4100	
N16	KEENEY CREEK	9/20/1999	9:33	OVC	16.8	14.2	6.4	7.3	245	C	2.26	L	0.00	6900	
N16	KEENEY CREEK	5/10/2000	9:52	SCT	22.0	14.2	10.0	7.2	109	C	0.72	L	0.00	880	
N16	KEENEY CREEK	6/7/2000	9.45	CLR	11.0	12.5	8.6	7.2	75	MI	5.47	H	0.49	433	
N16	KEENEY CREEK	8/3/2000	11:49	BKN	26.8	17.5	8.6	6.9	100	MI	6.33	N	0.02	3250	
N16	KEENEY CREEK	9/27/2000	9:26	OVC,F	10.0	12.3	10.1	6.9	94	C	3.07	N	2.01	5850	
N18	WOLF CREEK	5/12/1998	10:48	OVC	18.0	12.2	10.2	7.7	115	MI	3.50	38.63	0.93	45	7
N18	WOLF CREEK	9/15/1998	10:38	SCT	23.0	17.0	8.3	8.6	510	C	1.30	2.69	0.00	5	
N18	WOLF CREEK	12/9/1998	9:38	OVC	8.0	9.5	12.5	8.2	205	MR	27.0	36.20	1.69	1460	
N18	WOLF CREEK	4/27/1999	10:29	BKN	18.0	12.0	11.0	8.4	282	C	2.01	5.65	0.16	5	
N18	WOLF CREEK	6/7/1999	9:50	SCT,H	23.0	16.8	10.3	8.6	550	MI	4.31	1.75	0.00	10	
N18	WOLF CREEK	7/21/1999	9:40	OVC	26.0	18.6	9.4	8.5	540	C	3.35	1.55	0.56	17	
N18	WOLF CREEK	9/20/1999	10:20	OVC	18.0	14.7		8.7	499	C	1.72	L	0.00	1	
N18	WOLF CREEK	5/10/2000	10:51	SCT	27.0	17.0	9.4	8.4	277	C	2.20	5.41	0.00	28	
N18	WOLF CREEK	6/7/2000	10:47	SCT	19.0	14.0	9.9	8.2	195	MI	7.37	10.53	0.49	270	
N18	WOLF CREEK	8/3/2000	12:34	BKN	25.0	19.8	8.6	8.2	290	MI	9.40	7.09	0.02	132	
N18	WOLF CREEK	9/27/2000	10:37	OVC	11.0	12.9	10.5	7.8	110	MI	14.60	49.63	2.01	2620	
N28	AJAX MINE SPRING	9/21/1995	10:30							C	0.13		0.00	0	21
N28	AJAX MINE SPRING	10/3/1995	9:00	OVC						C	0.60		0.00	0	21
N28	AJAX MINE SPRING	10/11/1995	8.30	CLR						C	0.60		0.00	0	32
N28	AJAX MINE SPRING	10/17/1995	11:30	CLR						C	0.25		1.21	0	7,32
N28	AJAX MINE SPRING	11/1/1995	8:45	OVC						C	0.26		0.04	0	32
N28	AJAX MINE SPRING	11/21/1995	9:00	BKN						C	0.20			0	41,43
N28	AJAX MINE SPRING	12/5/1995	8:48	OVC						C	0.18			0	41,43
N28	AJAX MINE SPRING	1/18/1996	13:40	OVC										0.7	33,42,43
N28	AJAX MINE SPRING	2/8/1996	14:05	OVC,R						C	0.14			0	41,43
N28	AJAX MINE SPRING	2/21/1996	10:05	SCT						C	0.09			0	41,43
N28	AJAX MINE SPRING	3/6/1996	8:38	OVC,R						C	0.09			0	41,43
N28	AJAX MINE SPRING	3/25/1996	13:10	SCT						C	0.15			0	41,43
N28	AJAX MINE SPRING	4/29/1996	10:30	SCT						C	0.09		0.07	0	6,41
N28	AJAX MINE SPRING	6/4/1996	9:50	CLR						C	0.35		0.13	0	15,21
N28	AJAX MINE SPRING	6/18/1996	9:05	H							0.70		0.00	0	21
N28	AJAX MINE SPRING	7/16/1996	10:05								0.30		1.52	0	15,21
N28	AJAX MINE SPRING	7/30/1996	9:46	SCT							0.50		0.19	0.7	15,33
N28	AJAX MINE SPRING	4/29/1997	11:30	CLR						C	0.25		0.42	1	15,19
N28	AJAX MINE SPRING	6/9/1997	9:25	OVC						C	0.16		0.08	0	15,21

Appendix 2B.
New River Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-hour Precipitation (inches)	Fecal Coliform/100ml	Comments
N28	AJAX MINE SPRING	5/12/1998	9:08								0.20		0.93	0	7,21
N28	AJAX MINE SPRING	9/15/1998	10:06	SCT							0.11		0.00	0	21
N28	AJAX MINE SPRING	12/9/1998	9:25	OVC							1.70		1.69	0	21
N28	AJAX MINE SPRING	4/27/1999	10:05								0.29		0.16	0	44
N28	AJAX MINE SPRING	6/7/1999	9:37								0.15		0.00	0	21
N28	AJAX MINE SPRING	7/21/1999	9:30								0.27		0.56	0	21
N28	AJAX MINE SPRING	9/20/1999	10:10								0.17		0.00	0.4	
N28	AJAX MINE SPRING	1/24/2000	13:40								0.42		0.04	0	6,32
N28	AJAX MINE SPRING	1/24/2000	13:41								0.20		0.04	0	6,32
N28	AJAX MINE SPRING	5/10/2000	10:28								0.63		0.00	0	21
N28	AJAX MINE SPRING	6/7/2000	10:17								0.18		0.49	0	21
N28	AJAX MINE SPRING	8/3/2000	12:15								0.82		0.02	0	21
N28	AJAX MINE SPRING	9/27/2000	9:50								1.91		2.01	6.8	
N28	AJAX MINE SPRING	10/4/2000	11:29								0.22		0.00	0.5	45
N28	AJAX MINE SPRING	10/4/2000	11:41								0.15		0.00	0.7	33,46
N28	AJAX MINE SPRING	10/4/2000	11:41								0.26		0.00	0	21,47
N19	MARR BRANCH	5/12/1998	10:20	OVC	16.5	11.5	9.5	7.1	98	MI	5.10	7.80	0.93	200	7
N19	MARR BRANCH	9/15/1998	11:14	SCT	26.0	17.5	7.0	8.0	599	C	2.20	0.69	0.00	56	
N19	MARR BRANCH	12/9/1998	10:17	OVC	6.0	9.5	11.0	7.2	125	MI	22.0	24.50	1.69	8580	48
N19	MARR BRANCH	4/27/1999	11:12	BKN	20.0	13.0	10.0	7.5	130	MI	3.18	4.10	0.16	206	
N19	MARR BRANCH	6/7/1999	10:25	CLR,H	25.5	19.8	7.9	7.8	480	C	1.97	0.25	0.00	1892	
N19	MARR BRANCH	7/21/1999	10:15	OVC	25.5	21.1	9.0	8.1	590	MI	3.16	0.28	0.56	536	
N19	MARR BRANCH	9/20/1999	11:08	OVC	19.0	16.0		8.2	580	C	2.22	0.58	0.00	78	
N19	MARR BRANCH	5/10/2000	11:15	SCT	25.0	17.4	8.7	7.4	190	C	2.10	0.75	0.00	120	
N19	MARR BRANCH	6/7/2000	11:15	SCT	18.0	14.2	9.2	7.4	142	MI	3.93	3.04	0.49	275	
N19	MARR BRANCH	8/3/2000	12:55	BKN	26.0	20.5	7.9	7.2	240	C	5.00	0.51	0.02	633	
N19	MARR BRANCH	9/27/2000	11:05	OVC	12.0	13.3	9.5	7.2	112	MI	9.31	N	2.01	2330	49

Key to Comments

4=DO probe has bubbles
6=48 hour precipitation actually 72 hour
7=48 hour precipitation actually 120 hour
8=No gage reading
12=Bad smell, hardly any flow
13=Actual FC/100ml was >2000
14=2 samples collected at same time
15=48 hour precipitation actually 96 hour
16=Ice in creek
17=Water too high to reach gage
18=Actual FC/100ml was <0.6
19=Actual FC/100ml was 1.3 est.
20=Actual FC/100ml was 3.5 est.
21=Actual FC/100ml was <0.5
22=Actual FC/100ml was 1.5 est.
23=Actual FC/100ml was 0.6 est.
24=Actual FC/100ml was 8.6 est.
25=Actual FC/100ml was 16.6 est.
26=Actual FC/100ml was 26.6 est.
27=Actual FC/100ml was 62.6 est.
28=Actual FC/100ml was 0.5 est.
29=Actual FC/100ml was 8.5 est.
30=Actual FC/100ml was 66.6 est.
31=Actual FC/100ml was 43.3 est.
32=Actual FC/100ml was <0.4
33=Actual FC/100ml was 0.66 est.
34=Mt. Hope STP Bypass 12/8-12/9/98
35=Oak Hill STP Bypass 12/8/98
36=Gage bent
37=Actual FC/100ml was >240
38=Actual FC/100ml was >1500
39=Sewage Odor
40=Actual FC/100ml was >3000
41=Actual FC/100ml was <0.3
42=No turbidity data
43=No precipitation data
44=Actual FC/100ml was <0.7
45=Spring Box
46=Big green hose
47=Composite spigots
48=Fayetteville STP spill 12/8-12/9/98
49=Gage covered with debris

Appendix 3.
Gauley River Mainstem and Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-Hour Precipitation (inches)	Fecal Coliform/100ml	Comments
G01	SUMMERSVILLE DAM	5/18/1998	9:39	CLR	21.0	12.0	9.4	7.0	47	C	3.50	705	0.00	16	
G01	SUMMERSVILLE DAM	9/16/1998	9:39	OVC	23.0	20.0	7.4	7.3	59	C	2.80	1117	0.00	1	28
G01	SUMMERSVILLE DAM	4/26/1999	10:21	OVC	16.0	5.8		9.5	40	C	4.28	200	0.00	0	4,50,51
G01	SUMMERSVILLE DAM	6/2/1999	9:40	OVC	18.0	8.5	12.6	7.3	120	C	1.82	516	0.01	1	28
G01	SUMMERSVILLE DAM	7/22/1999	9:35	OVC	18.5	11.0	8.4	6.9	60	C	2.96	100	0.06	8	
G01	SUMMERSVILLE DAM	9/16/1999	9.50	OVC	17.0	13.3	10.8	6.8	50	C	1.69	200	0.00	0	21
G01	SUMMERSVILLE DAM	5/24/2000	10:06	SCT	21.5	10.0	14.0	7.2	42	C	1.99	1739	0.38	3	
G01	SUMMERSVILLE DAM	6/14/2000	10:07	BKN	22.0	16.8	10.9	7.0	50	C	2.39	260	0.00	8	
G01	SUMMERSVILLE DAM	7/26/2000	10:44	SCT	23.0	18.8	8.7	7.0	52	C	2.27	388	0.20	5	
G01	SUMMERSVILLE DAM	10/11/2000	9.52	CLR	11.0	17.6	8.8	7.3	72	C	2.24	530	0.02	3	
G06	GAULEY R. AT MASON BRANCH	5/18/1998	10:40	CLR	24.0	11.2	9.6	7.1	55	C	3.20	705	0.00	15	
G06	GAULEY R. AT MASON BRANCH	9/16/1998	10:35	SCT	25.0	22.0	7.8	7.5	60	C	2.40	1117	0.00	2	
G06	GAULEY R. AT MASON BRANCH	4/26/1999	11:18	OVC	20.5	11.5		7.5	51	MI	6.37	200	0.00	7	4
G06	GAULEY R. AT MASON BRANCH	6/2/1999	10:33	SCT	23.5	12.1	10.5	7.2	139	C	1.55	516	0.01	12	
G06	GAULEY R. AT MASON BRANCH	7/22/1999	11:30	BKN	26.0	21.5	5.8	7.3	128	C	1.47	100	0.06	47	
G06	GAULEY R. AT MASON BRANCH	9/16/1999	10:50	SCT	20.5	15.2	10.2	6.8	68	C	0.91	200	0.00	6	
G06	GAULEY R. AT MASON BRANCH	5/24/2000	10:58	SCT	25.0	11.5	11.8	6.9	50	C	2.64	1739	0.38	9	
G06	GAULEY R. AT MASON BRANCH	6/14/2000	10:45	SCT	23.2	27.8	8.5	6.9	72	C	1.50	260	0.00	18	
G06	GAULEY R. AT MASON BRANCH	7/26/2000	11:20	SCT	24.0	19.2	8.1	7.1	75	C	1.54	388	0.20	8	
G06	GAULEY R. AT MASON BRANCH	10/11/2000	10:45	CLR	15.5	15.0	9.6	7.3	73	C	1.85	530	0.02	4	
G04	SOUTH SIDE SWISS	5/18/1998	12:13	CLR	29.0	15.8	8.5	7.3	62	C	2.40	705	0.00	2	
G04	SOUTH SIDE SWISS	9/16/1998	12:13	SCT	28.0	23.0	7.2	7.3	70	C	1.80	1117	0.00	5	
G04	SOUTH SIDE SWISS	4/26/1999	13:07	OVC	21.0	11.2		7.4	65	MI	3.63	200	0.00	12	4
G04	SOUTH SIDE SWISS	6/2/1999	12:00	SCT	28.0	17.0	9.2	7.1	142	C	1.70	516	0.01	4	
G04	SOUTH SIDE SWISS	7/22/1999	12:40	SCT	32.0	27.0	5.6	7.2	132	MR	6.18	100	0.06	58	
G04	SOUTH SIDE SWISS	9/16/1999	12:37	SCT	21.8	17.2	8.5	6.8	62	C	0.86	200	0.00	2	
G04	SOUTH SIDE SWISS	5/24/2000	12:30	SCT	27.0	14.9	11.6	7.2	60	C	1.75	1739	0.38	10	
G04	SOUTH SIDE SWISS	6/14/2000	11:58	SCT	32.0	25.0	8.4	7.0	80	C	2.04	260	0.00	15	
G04	SOUTH SIDE SWISS	7/26/2000	12:30	SCT	28.0	20.1	7.8	7.2	180	C	1.26	388	0.20	25	
G04	SOUTH SIDE SWISS	10/11/2000	12:15	CLR	19.0	14.8	9.5	7.1	74	C	1.47	530	0.02	3	
G05	MEADOW RIVER	5/18/1998	9:02	CLR	20.0	18.0	6.2	6.6	88	MR	3.10	368	0.00	20	
G05	MEADOW RIVER	9/16/1998	9:00	OVC	20.0	23.0	6.6	7.6	189	C	0.70	L	0.00	3	52,53
G05	MEADOW RIVER	4/26/1999	9:37	OVC	18.2	11.8		7.3	53	MI	6.11	648	0.00	21	4
G05	MEADOW RIVER	6/2/1999	9:03	BKN	18.5	19.5	8.2	7.2	195	C	1.36	115	0.01	42	
G05	MEADOW RIVER	7/22/1999	9:05	OVC	24.0	24.0	6.8	7.3	221	MI	2.51	19	0.06	9	
G05	MEADOW RIVER	9/16/1999	9:09	OVC	16.2	18.5	8.4	7.0	160	C	0.55	20	0.00	7	

Appendix 3.
Gauley River Mainstem and Tributary Sites

Site Number	Site	Date	Time	Weather	Air Temperature C	Water Temperature C	Dissolved Oxygen (mg/l)	pH	Field Conductivity (umhos/cm)	Clarity (visual)	Turbidity (NTU)	Discharge (cfs) Stage (visual)	48-Hour Precipitation (inches)	Fecal Coliform/100ml	Comments
G05	MEADOW RIVER	5/24/2000	9:30	SCT	22.5	16.9	10.4	7.1	81	C	3.09	340	0.38	30	
G05	MEADOW RIVER	6/14/2000	9:35	SCT	25.0	28.0	6.8	6.8	125	C	1.63	135	0.00	104	
G05	MEADOW RIVER	7/26/2000	10:15	BKN	20.0	18.0	8.0	6.9	102	MI	1.90	340	0.20	22	
G05	MEADOW RIVER	10/11/2000	9:15	CLR	3.0	8.1	10.5	7.0	93	C	1.35	99	0.02	124	
G07	PETERS CREEK AT FORD	5/18/1998	11:32	CLR	28.0	16.2	8.3	7.4	268	C	2.1	27	0.00	157	54
G07	PETERS CREEK AT FORD	9/16/1998	11:27	SCT	27.0	23.0	7.1	8.1	465	C	2.0	L	0.00	406	
G07	PETERS CREEK AT FORD	4/26/1999	12:20	OVC	20.0	12.0		8.1	192	C	1.84	N	0.00	45	4
G07	PETERS CREEK AT FORD	6/2/1999	11:23	SCT	28.0	19.2	8.5	8.1	472	C	2.07	L	0.01	388	
G07	PETERS CREEK AT FORD	7/22/1999	12:10	BKN	29.0	24.0	6.2	8.1	585	C	2.56	L	0.06	61	
G07	PETERS CREEK AT FORD	9/16/1999	11:50	SCT	22.0	17.2	7.4	8.1	480	MI	4.37	L	0.00	10	
G07	PETERS CREEK AT FORD	5/24/2000	11:44	SCT	26.2	17.0	9.3	7.9	325	C	1.71	N	0.38	130	
G07	PETERS CREEK AT FORD	6/14/2000	11:28	SCT	30.5	26.0	8.2	7.8	378	C	3.59	N	0.00	83	
G07	PETERS CREEK AT FORD	7/26/2000	12:02	SCT	23.0	18.9	8.5	7.3	330	C	2.01	N	0.20	120	
G07	PETERS CREEK AT FORD	10/11/2000	11:40	CLR	12.0	7.4	11.2	8.0	264	C	1.18	L	0.02	106	

Key to Comments
4=DO probe has bubbles
21=Actual FC/100ml was <0.5
28=Actual FC/100ml was 0.5 est.
50=Actual FC/100ml was <1
51=High pH may be due to dam construction
52=Actual FC/100ml was <4
53=Gage out
54=Gage reading from internet (NAWQA site)

Appendix 4.

Codes for Weather, Visual Clarity, and Visual Stage Used in Appendices 1-3.

Weather

CLR	Clear: less than 1% sky cover
SCT	Scattered: 1% to 50% sky cover
BKN	Broken: 60% to 90% sky cover
OVC	Overcast: More than 90% sky cover
(-)	Thin (When prefixed to the above symbols)
-X	Partial obscuration: 1% to less than 10% sky hidden by precipitation or obstruction to vision
X	Obscuration: 10% sky hidden by precipitation or obstruction to vision
A	Hail
BS	Blowing Snow
D	Dust
F	Fog
GF	Ground Fog
H	Haze
K	Smoke
L	Drizzle
R	Rain
RW	Rain Showers
S	Snow
SW	Snow Showers
T	Thunderstorms
T+	Severe Thunderstorms
ZL	Freezing Drizzle
ZR	Freezing Rain

Precipitation Intensities

(-)	Light
(no sign)	Moderate
(+)	Heavy

Clarity

C = Clear
MI = Milky
MR = Murky
TR = Turbid

Stage

L = Low
N = Normal
H = High

Appendix 5.

Sources of River Level Information

U. S. Geological Survey

Continuously updated stage and discharge information for gaged streams in West Virginia can be found on the following USGS websites:

http://www-wv.er.usgs.gov
http://wv.usgs.gov/wrt

The U. S. Geological Survey, through its stream gaging network, is the primary provider of stage and discharge level throughout the country. Except for reservoir release levels provided by the U. S. Army Corps of Engineers, all other source of river level information provided below is based on USGS data.

U. S. Army Corps of Engineers

Continuously updated release levels, stage, and discharge information for selected West Virginia streams can be found on the following website:

http://www.lrh-wc.usace.army.mil/wc/whitewater.html

Daily updated information on the Bluestone, Greenbrier, and New Rivers is available by telephone recording from the Bluestone Dam office at (304) 466-0156.

Daily updated information on the Gauley and Meadow Rivers is available by telephone recording from the Summersville Dam office at (304) 872-5809.

National Park Service

Daily update information on stage and discharge of gaged rivers within Bluestone National Scenic River, New River Gorge National River, and Gauley River National Recreation Area is available at the following website:

http://www.nps.gov/neri/w-water.htm

and at the following National Park Service facilities:

Canyon Rim Visitor Center	304-574-2115
Grandview Visitor Center	304-763-3715
Hinton Visitor Center	304-466-1597
Thurmond Visitor Center	304-465-8550

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.