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Microbial and Nutrient Concentration and Load Data During Stormwater Runoff at a Swine Concentrated Animal Feeding Operation in the North Carolina Coastal Plain, 2006–2007

Open-File Report 2008–1156

U.S. Department of the Interior
U.S. Geological Survey

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By Stephen L. Harden

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Conversion Factors

Inch/Pound to SI

Multiply	By	To obtain
	Length	
foot (ft)	0.3048	meter (m)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Flow rate	
gallon per minute (gal/min)	0.06309	liter per second (L/s)

SI to Inch/Pound

Multiply	By	To obtain
	Volume	
liter (L)	2.113	pint (pt)
liter (L)	1.057	quart (qt)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)

Water-quality measurements are given in metric units.

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations and Acronyms

CAFO	concentrated animal feeding operation
EPA	U.S. Environmental Protection Agency
E. coli	*Eschericia coli*
mL	milliliter
MPN/100 mL	most probable number per 100 milliliters
NCDENR DWQ	North Carolina Department of Environment and Natural Resources, Division of Water Quality
NRMRL	National Risk Management Research Laboratory
PZF	point of zero flow

Microbial and Nutrient Concentration and Load Data During Stormwater Runoff at a Swine Concentrated Animal Feeding Operation in the North Carolina Coastal Plain, 2006–2007

By Stephen L. Harden

Abstract

This report summarizes water-quality and hydrologic data collected during 2006–2007 to characterize bacteria and nutrient loads associated with overland runoff and subsurface tile drainage in spray fields at a swine concentrated animal feeding operation. Four monitoring locations were established at the Lizzie Research Site in the North Carolina Coastal Plain Physiographic Province for collecting discharge and water-quality data during stormwater-runoff events. Water stage was measured continuously at each monitoring location. A stage-discharge relation was developed for each site and was used to compute instantaneous discharge values for collected samples. Water-quality samples were collected for five storm events during 2006–2007 for analysis of nutrients and fecal indicator bacteria. Instantaneous loads of nitrite plus nitrate, total coliform, *Escherichia coli* (*E. coli*), and enterococci were computed for selected times during the five storm events.

Introduction

Several phases of scientific investigations at the Lizzie Research Site in the Contentnea Creek subbasin of the Neuse River, NC (fig. 1), have been conducted through collaborative efforts between the North Carolina Department of Environment and Natural Resources Division of Water Quality (NCDENR, DWQ), the U.S. Environmental Protection Agency (EPA), and the U.S. Geological Survey (USGS) to characterize the site and identify contaminant fate and transport processes occurring in the watershed. Results of previous investigations conducted at the Lizzie Research Site are discussed by Harden and Spruill (2004, 2008), Spruill and others (2005), Tesoriero and others (2005), and Walker and others (2008).

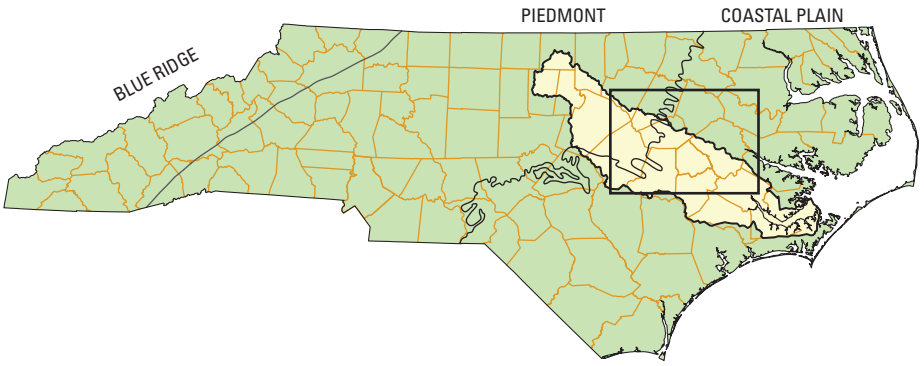
In 2003, EPA initiated a study at the Lizzie Research Site to examine the environmental implications of spray fields as a component of typical waste-management strategies in commercial hog production. The focus of the EPA project was to assess water-quality changes in adjacent streams that receive runoff from an agricultural field sprayed with hog waste and to monitor air-quality changes resulting from the local transport of airborne ammonia (Walker and others, 2008). During 2006–2007, the EPA, NCDENR, and USGS conducted a cooperative study at the Lizzie Research Site to better understand the release of microorganisms and nutrients into the watershed through overland runoff and subsurface drains (commonly referred to as tile drains) from a swine concentrated animal feeding operation (CAFO) using spray-field waste-treatment technology.

Purpose and Scope

This report summarizes the analytical and hydrologic data collected during February 2006–September 2007 at four monitoring locations at the Lizzie Research Site. Data compiled in this report support one of the principal objectives of the ongoing research at the study site to characterize bacteria and nutrient loads associated with overland runoff and subsurface drainage from spray fields at the swine CAFO. The stage-discharge relation determined for each site was used to compute instantaneous discharge values for collected samples. Instantaneous loads of nitrite plus nitrate, total coliform, *Escherichia coli* (*E. coli*), and enterococci were computed for selected times during five stormwater-runoff events.

Description of Study Area

The Lizzie Research Site is located in Greene County, in the North Carolina Coastal Plain Physiographic Province, south of the confluence of Sandy Run and Middle Swamp (figs. 1, 2). Most of the site is drained by a first-order stream, known locally as Plum Tree Branch, which is a tributary to Sandy Run and drains 0.59 square miles (mi^2). Land use in the area is primarily agricultural, with row crops typically of corn,



LOCATION OF STUDY AREA, PHYSIOGRAPHIC PROVINCES, AND THE NEUSE RIVER BASIN IN NORTH CAROLINA

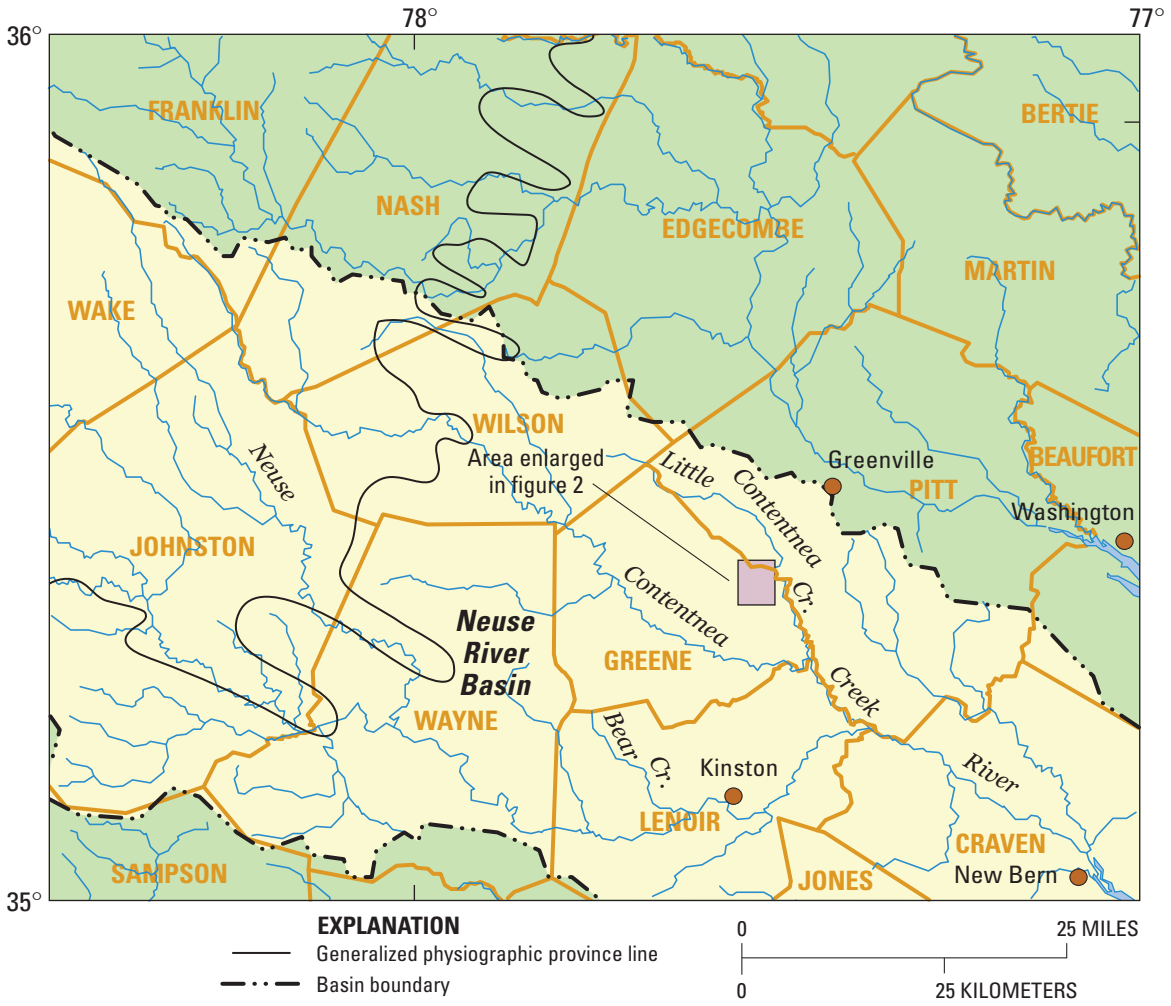


Figure 1. Location of study area in the Neuse River basin, North Carolina.

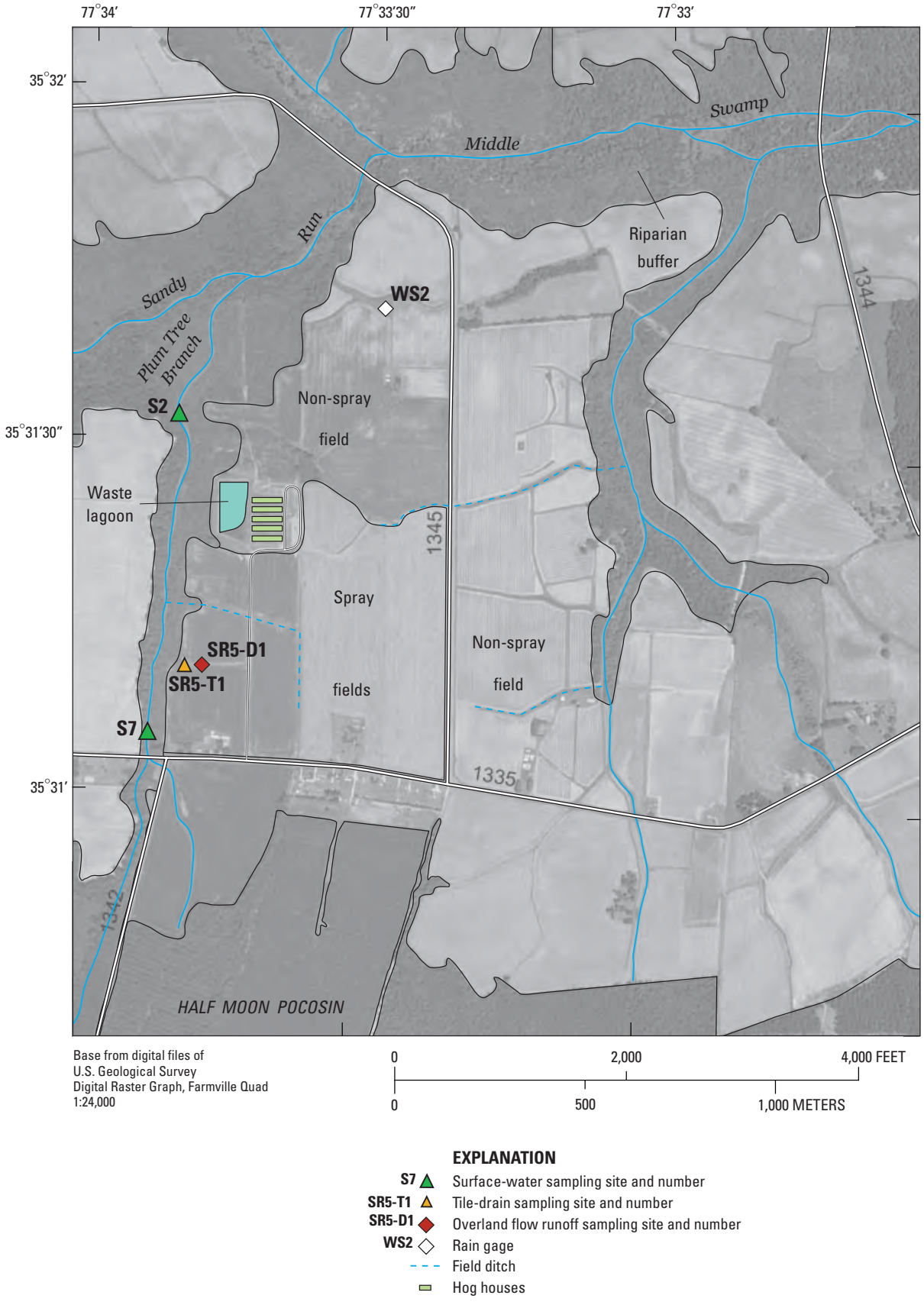


Figure 2. Surface-water, tile-drain, and overland flow runoff locations and rain-gage site at the Lizzie Research Site, Greene County, North Carolina.

wheat, and soybeans. Agricultural fields at the site consist of somewhat poorly drained to well-drained soils.

Farming practices at the Lizzie Research Site changed during the mid-1990s. Prior to 1995, crops were fertilized using conventional inorganic fertilizer. In 1995, a swine CAFO with five hog houses and a waste lagoon was placed in operation at the site. After 1995, fertilizing practices shifted from the use of conventional inorganic fertilizers to field spraying of lagoon effluent from the swine operation.

Methods

During the study, rainfall was monitored at site WS2, and a network of automated water-quality samplers and water-stage recorders was utilized at four locations along Plum Tree Branch for obtaining water-quality information (table 1; fig. 2). The four sampling locations included stream sites S7 (upstream) and S2 (downstream), overland runoff site SR5–D1, and tile-drain site SR5–T1. The weather-station site WS2 (USGS station name: Weather station no. 2 near Lizzie, NC; USGS site number: 353137077332801) and downstream site S2 on Plum Tree Branch (USGS station name: Unnamed trib to Sandy Run near Lizzie, NC, USGS site number: 0209173190) are existing sites used in previous investigations and have been in operation since November 2000 and March 1999, respectively. Collection of water-stage data, also referred to as gage-height data, at sites S7, SR5–D1, and SR5–T1 began in May 2006 (table 1).

A tipping-bucket rain gage was used at weather station site WS2 to record precipitation at 15-minute intervals. Calibration checks were conducted semiannually on the rain gage to ensure the accuracy of recorded data. Submersible pressure transducers were used at sampling sites S7, S2, SR5–D1, and SR5–T1 to record water stage at 15-minute intervals. Occasionally, a recording interval of 5 minutes was used at sites SR5–D1 and SR5–T1 to document rapid water-level change during storm events. The installation setup for stage recorders and automated samplers is shown for sites SR5–D1 and SR5–T1 in figure 3. The culvert at SR5–D1 is at the end of a grassed waterway that receives overland runoff from a portion of the spray fields. Site SR5–D1 is upstream from tile-drain site SR5–T1. Water from sites SR5–D1 and SR5–T1 discharges into a receiving ditch that empties into Plum Tree Branch between sites S7 and S2 (figs. 2, 3).

At sites S7 and S2, the recorded water-stage data represent stream stage that is reported above an arbitrary datum. Stream-stage values of 3.73 feet (ft) and 0.42 ft represent stagnant conditions, or the point of zero flow (PZF), at sites S7 and S2, respectively. The recorded water-stage data at overland-runoff site SR5–D1 and tile-drain site SR5–T1 represent water depth in the plastic corrugated culvert and the PVC pipe, respectively. No-flow, or dry, conditions at SR5–D1 and SR5–T1 are denoted by water depths equal to zero. Discharge measurements at these four sampling sites were determined by using a velocity meter or by volumetric methods (Rantz and others, 1982). Discrete discharge measurements were combined with the continuous water-stage data to develop a stage-discharge relation at each sampling location.

Water-quality sampling was conducted for five stormwater-runoff events from June 2006 to June 2007. For each sampling event and site, the automated samplers were programmed to collect up to 24 individual water samples. For an individual sample, a sample-bag holder fitted with a clean and sterile collection bag was filled with approximately 800 milliliters (mL) of water drawn through a sample intake line. The intake line was flushed with native water before each sample collection. Samples collected with the automated sampler were subdivided such that nutrient analyses were performed on one subset of five to six samples and microbiological analyses

Table 1. Precipitation and stormwater-runoff monitoring locations at the Lizzie Research Site, Greene County, North Carolina, 2006–2007.

[USGS, U.S. Geological Survey; —, not applicable]

USGS station name	Local name	USGS site number	Type of data collected	Data-collection interval	Period of collection
Weather station no. 2 near Lizzie, NC	WS2	353137077332801	Precipitation	15 minute	11/29/00 – 09/30/07[a]
Unnamed trib to Sandy Run at SR 1335 near Lizzie, NC	S7	0209173150	Water stage Water-quality samples	15 minute —	05/02/06 – 09/30/07 02/21/06 – 07/18/07
Drainage ditch (SR5D1) to trib to Sandy Run near Lizzie	SR5–D1	353111077334801	Water stage Water-quality samples	5 or 15 minute —	05/11/06 – 09/30/07 06/14/06 – 06/04/07
Tile drain (SR5T1) to trib to Sandy Run near Lizzie	SR5–T1	353111077334901	Water stage Water-quality samples	5 or 15 minute —	05/11/06 – 09/30/07 02/21/06 – 06/04/07
Unnamed trib to Sandy Run near Lizzie, NC	S2	0209173190	Water stage Water-quality samples	15 minute —	03/19/99 – 09/30/07[a] 02/21/06 – 07/18/07

[a] This period of collection reflects both current and previously collected data.

Figure 3. Stage recorder and ISCO sampler instrumentation at ditch site SR5–D1 and tile site SR5–T1, Lizzie Research Site, Greene County, North Carolina.

were performed on a second subset of five to six samples. The sample subsets consisted of individual samples representing rising, peak, and falling stage conditions throughout the event hydrograph. In some cases, grab samples were obtained to supplement the samples collected with the automated samplers during runoff events. In addition to stormwater sampling, grab samples for microbiological analyses were collected periodically during base-flow conditions from the monitoring sites.

Established, documented protocols for collecting and processing samples for chemical analyses were followed (U.S. Geological Survey, variously dated; U.S. Geological Survey, Quality-assurance plan for water-quality activities of the North Carolina Water Science Center, written commun., 2007). Water-quality samples were processed in the field and shipped on ice by overnight delivery to the USGS National Water Quality Laboratory in Denver, CO, for analysis of nutrients or to the EPA analytical laboratory in Cincinnati, Ohio, for analysis of microorganisms. Nutrient analyses included measurement of dissolved ammonia, total and dissolved ammonia plus organic nitrogen, dissolved nitrite plus nitrate, dissolved nitrite, and total and dissolved phosphorus according to methods described in Fishman (1993) and Patton and Truitt (2000). Microbial analyses included measurement of fecal indicator bacteria, including total coliform, *E. coli*, and enterococci using IDEXX analytical methods (IDEXX Laboratories, Inc., 2008). Quality-control samples, including blanks and replicates, were collected and processed during each stormwater-runoff sampling event in order to validate results from the environmental samples.

Data Summary

Information on stormwater sampling events, discharge, bacteria analyses, and nutrient analyses compiled for the Lizzie Research Site during 2006–2007 is summarized in this section. Instantaneous loads of nitrate, total coliform, *E. coli*, and enterococci at monitoring sites S7, SR5–D1, SR5–T1, and S2 (fig. 2) were computed from discharge and concentration data.

Stormwater-Runoff Sampling Events

Water-quality samples for bacteria and nutrient analyses were collected for five stormwater-runoff events from June 2006 to June 2007 (table 2). No automated sampling was conducted after June 2007 because of limited stormwater

runoff at the study area during mid- to late-summer 2007. Daily precipitation data recorded at the Lizzie Research Site rain gage (WS2, fig. 2) are provided in figure 4.

The number of samples collected for laboratory analysis of bacteria and nutrients varied among the sites and events. During sampling events 1, 2, and 3, approximately five to eight samples per event at upstream site S7 and downstream site S2 were analyzed for bacteria and nutrients (table 2). At site SR5–D1, flow during events 1 and 3 was minimal; therefore, no samples were collected with the automated sampler. At tile site SR5–T1, a cap was placed on the outlet of the tile drain during event 2 as part of an experiment to examine the effect of reduced tile outflow on water-quality conditions in the stream; thus, no automated samples were collected. Tile flow during event 3 was insufficient to initiate sampling with the automated sampler; however, two grab samples were collected for analysis of bacteria and nutrients. Although bacteria samples and nutrient samples were collected at each site during event 4, the bacteria samples exceeded holding-time requirements and were not analyzed. For event 5, samples only were collected and analyzed for bacteria.

Table 2. Summary of stormwater-runoff event sampling at the Lizzie Research Site, Greene County, North Carolina, 2006–2007.

[#, number; na, not analyzed; —, not sampled]

Stormwater-runoff sampling site (locations in fig. 2)	Event 1 June 14–19, 2006		Event 2 July 23–24, 2006		Event 3 October 17–19, 2006		Event 4 October 27–29, 2006		Event 5[a] June 3–4, 2007	
	# bacteria samples	# nutrient samples	# bacteria samples	# nutrient samples	# bacteria samples	# nutrient samples	# bacteria samples	# nutrient samples	# bacteria samples	# nutrient samples
S7	6	6	5	8	7	6	na[b]	6	6	—
S2	6	6	5	8	7	6	na[b]	7	7	—
SR5–D1	1[c]	1[c]	5	6	—[d]	—[d]	na[b]	7	2[e]	—
SR5–T1	5[f]	6	—	1[g]	2[c]	2[c]	na[b]	7	6	—

[a]This event only targeted for collection and analysis of bacteria samples.

[b]Automated samples were collected but not analyzed because holding times could not be met.

[c]Insufficient flow to enable collection with the automated sampler. Grab samples were collected for bacteria and nutrient analyses.

[d]Insufficient flow to enable collection with the automated sampler or to obtain grab samples.

[e]Sufficient flow but equipment malfunction prevented collection of ISCO samples. Grab samples were collected for bacteria analyses.

[f]*E. coli* bacteria analyzed for all five samples and only four samples were able to be analyzed for enterococci bacteria.

[g]The tile drain was capped to prevent outflow during this event; no automated samples were collected. A nutrient grab sample was collected on July 26, 2006, when the cap was removed and outflow stabilized.

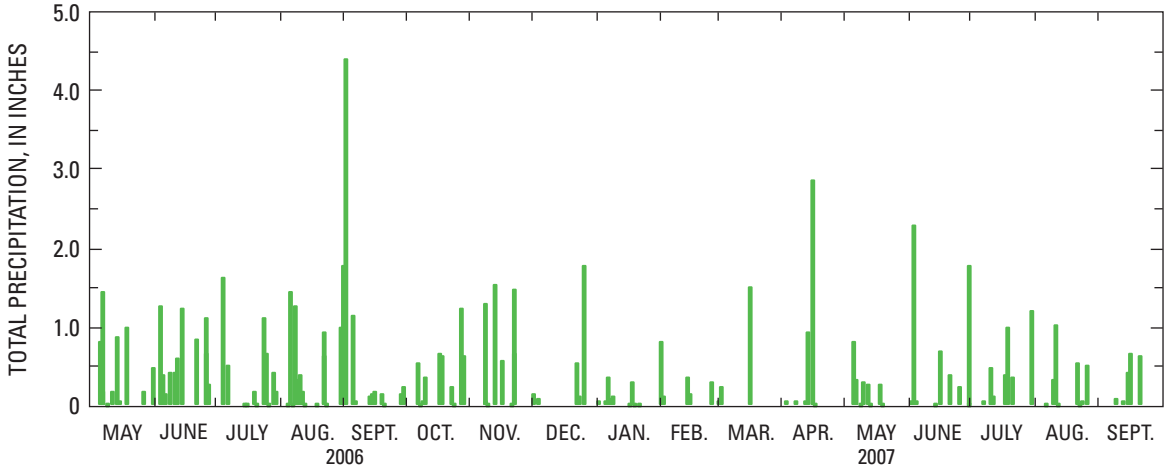


Figure 4. Daily total precipitation at site WS2 (USGS station number 353137077332801), Lizzie Research Site, Greene County, North Carolina.

Water Stage and Flow

Daily mean stage, or gage height, data recorded at sites S7, S2, SR5–D1, and SR5–T1 from May 2006 through September 2007 are provided in figure 5. The storm events sampled at each location also are noted on the daily mean gage-height plots. Drought conditions observed during the study are reflected in the stream-stage data at sites S7 and S2 where Plum Tree Branch became dry during summer 2007 (fig. 5A, B). Dry conditions also were observed from June to September 2007 at overland runoff site SR5–D1 and tile drain site SR5–T1 (fig. 5C, D). Gaps in the data record at sites SR5–D1 and SR5–T1 from late December 2006 through mid-March 2007 and in May 2007 represent periods when the pressure transducers were removed to avoid damage from freezing conditions and to perform maintenance.

The stage data and measured discharge values obtained during the study were used to develop a stage-discharge relation for each sampling site (rating curve). The rating curves were then used to determine discharge for those times samples were collected, based on the stage values. Typically, it is desirable to make manual measurements of discharge over the observed range in stage for computing flow at a site. Conditions at the monitoring locations were not conducive for making discharge measurements near the highest recorded stage values because peak flows during runoff events are very flashy and short lived. The rating curves developed for sites S7, S2, and SR5–T1 are limited to computing sample discharges that do not exceed twice the highest measured discharge at each location. The upper limit of use for the rating curve at site S7 is 2,693 gallons per minute (gal/min; stage of 4.33 ft), site S2 is 22,441 gal/min (stage of 2.52 ft), and site SR5–T1 is 74 gal/min (stage of 0.14 ft). The rating curve for site SR5–D1 only was used to compute discharges up to 103 gal/min (stage of 0.23 ft), which represents the highest flow during which a water-quality sample was collected for laboratory analysis. In addition, sample discharge values computed at sites SR5–D1 and SR5–T1 are considered estimated on the basis of limited discharge measurements used in developing the rating curves and measurement uncertainties associated with the recorded stage values. Computed values of sample discharge are presented with the analytical results for each sample site in the following section.

Microbial and Nutrient Concentrations and Loads

The analytical results for the water-quality samples collected at stormwater-runoff monitoring site S7 (table 3), site S2 (table 4), site SR5–D1 (table 5), and site SR5–T1 (table 6) are presented in this section. The concentration data for total coliforms, *E. coli*, and enterococci presented in this report were provided by EPA (Shane Rogers, written commun., November 2007). Many of the bacteria concentrations, especially for total coliform, are reported as a lower or upper censored value. The specific censoring levels varied among the samples because of differences in sample dilutions associated with the laboratory analyses. A compilation of all nutrient analytical results, arranged by site, is provided in the appendix. The nutrient data also can be accessed online from the USGS National Water Information System database (U.S. Geological Survey, 2007).

The four monitoring sites provide information on runoff pathways from the spray fields through grassed waterways, subsurface drainage, and riparian buffers. One interesting observation with the runoff data from the Lizzie Research Site spray fields is that the nitrite plus nitrate concentrations for tile drain site SR5–T1 were higher than overland runoff site SR5–D1; conversely, the bacteria concentrations were higher at SR5–D1 than at SR5–T1. Concentrations of nitrite plus nitrate ranged from 22.2 to 45.4 mg/L at site SR5–T1 (table 6) and 1.43 to 13.60 mg/L at site SR5–D1 (table 5). At site SR5–D1, concentrations of *E. coli* ranged from 86 to 15,988 most probable number per 100 milliliters (MPN/100 mL) and enterococci ranged from 100 to 770,100 MPN/100 mL. At site SR5–T1, concentrations of *E. coli* ranged from less than 1 to 975 MPN/100 mL and enterococci ranged from less than 1 to 1,553 MPN/100 mL.

At each site, the computed sample discharge data and the analytical concentration data were used to compute instantaneous loads of nitrite plus nitrate, total coliform, *E. coli*, and enterococci (tables 3–6). Note that the values for loads reported in tables 3–6 have been rounded to reflect the significant figures used in the calculations. For nitrite plus nitrate concentrations presented in this report, nitrite typically represents a small fraction, less than a few percent, of the total nitrite plus nitrate concentration. The computed values of instantaneous load are reported in grams per minute for nitrite plus nitrate and most probable number per minute for total coliform, *E. coli*, and enterococci. In cases where loads were computed using censored results for total coliform, *E. coli*, and enterococci, the stated censoring value was used as the concentration, and the resultant load was qualified as censored.

For comparison between sites and events, the computed loads for nitrite plus nitrate, *E. coli*, and enterococci are plotted for each monitoring site for the five runoff events (figs. 6–10). Censored results for *E. coli* and enterococci included in the plots are denoted as open symbols. Total coliform data were not plotted because of the numerous censored values associated with these results (tables 3–6). In general, instantaneous loads of nitrite plus nitrate, *E. coli*, and enterococci increased from upstream site S7 to downstream site S2 on Plum Tree Branch. Additional data are needed to further document and evaluate microbial transport from the spray fields during stormwater runoff.

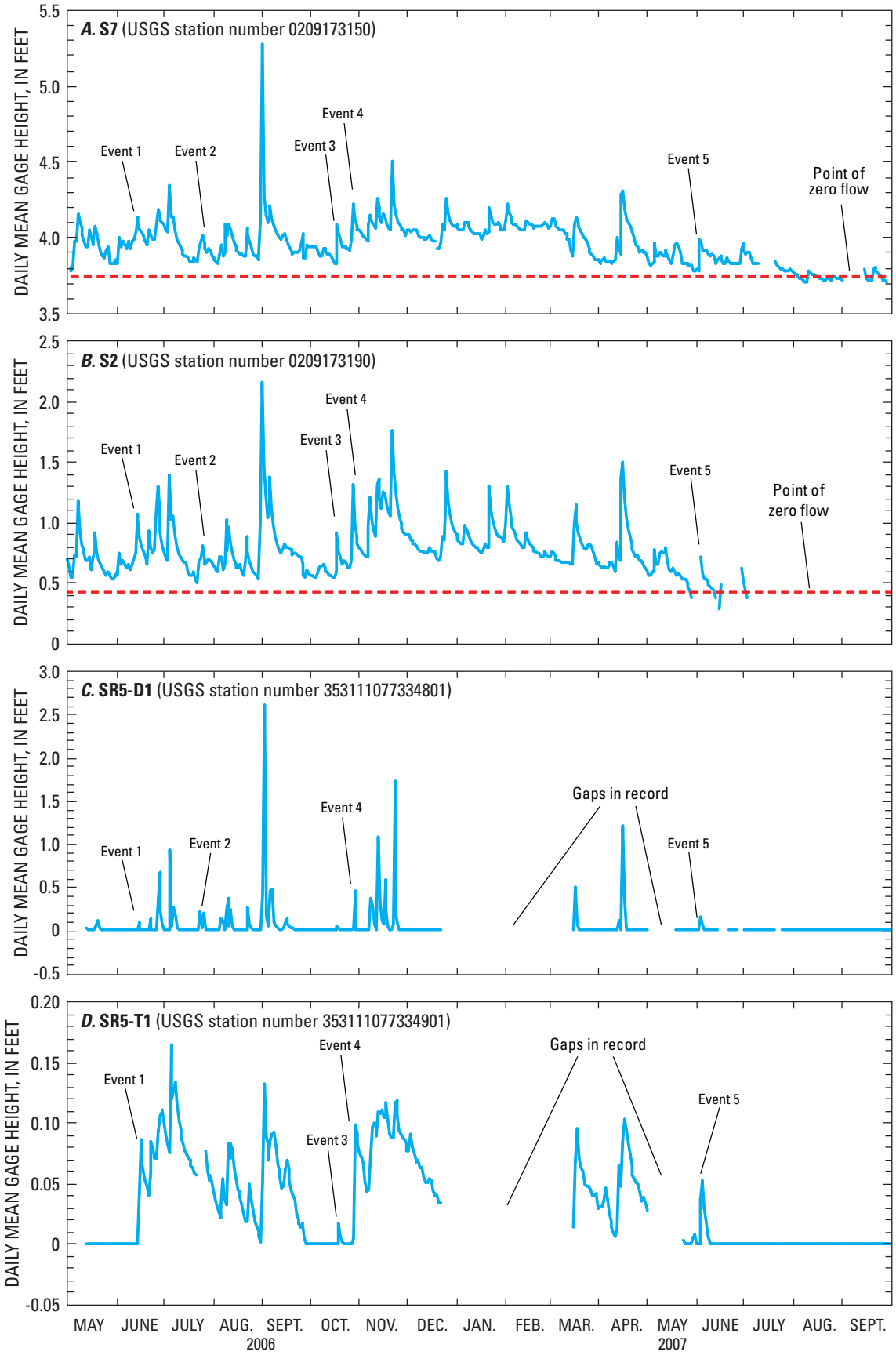


Figure 5. Daily mean gage heights at sites S7, S2, SR5–D1, and SR5–T1 at the Lizzie Research Site, Greene County, North Carolina.

Table 3. Concentrations and loads for site S7, Greene County, North Carolina, 2006–2007.

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
2/21/06 15:40	—	—	—	671	—	1	—	1	—
3/15/06 15:05	—	—	—	913	—	1	—	1	—
3/28/06 09:00	—	—	—	500	—	1	—	11	—
5/3/06 14:40	4.94	—	—	4,410	823,600	9	1,680	193	36,000
5/8/06 13:45	339	—	—	8,164	104,600,000	148	1,900,000	462	5,920,000
6/14/06 11:47	323	2.03	2.48	—	—	—	—	—	—
6/14/06 12:17	840	—	—	>241,960	>7,682,700,000	11,370	361,000,000	48,840	1,551,000,000
6/14/06 12:47	1,300	1.54	7.57	—	—	—	—	—	—
6/14/06 13:17	1,440	—	—	>241,960	>13,170,000,000	>241,960	>13,170,000,000	64,880	3,531,500,000
6/14/06 15:17	nd	1.68	—	—	—	—	—	—	—
6/14/06 16:17	nd	—	—	155,310	—	3,730	—	43,520	—
6/14/06 19:17	670	5.19	13.1	—	—	—	—	—	—
6/14/06 21:17	580	—	—	198,630	4,354,800,000	3,410	74,761,000	2,880	63,100,000
6/15/06 11:17	234	—	—	14,560	128,790,000	165	1,460,000	122	1,080,000
6/15/06 13:17	211	7.50	5.98	—	—	—	—	—	—
6/19/06 12:25	49.4	7.14	1.33	396	740,000	<1	<1,870	24	44,800
7/23/06 17:59	251	4.66	4.42	98,040	930,180,000	<100	<949,000	1,210	11,500,000
7/23/06 18:29	2,650	1.59	15.9	—	—	—	—	—	—
7/23/06 18:59	2,650	—	—	>241,960	>24,237,000,000	980	98,200,000	11,960	1,198,000,000
7/23/06 19:29	1,440	1.70	9.25	—	—	—	—	—	—
7/23/06 19:59	780	—	—	>241,960	>7,134,000,000	200	5,900,000	12,670	373,600,000
7/23/06 20:29	580	2.08	4.56	—	—	—	—	—	—
7/24/06 01:29	108	3.40	1.39	—	—	—	—	—	—
7/24/06 03:29	82.1	—	—	4,350	13,500,000	88	273,000	6,250	19,400,000
7/24/06 17:15	18.0	5.92	0.40	630	429,000	2	1,400	378	257,000
7/25/06 10:45	144	1.85	1.01	—	—	—	—	—	—
7/26/06 14:25	26.9	5.22	0.53	—	—	—	—	—	—
8/15/06 15:55	13.9	—	—	1,239	651,000	1	525	41	21,500
10/17/06 14:45	4.49	—	—	7,330	1,244,000	15	2,550	663	113,000
10/17/06 23:44	40.4	2.05	0.31	—	—	—	—	—	—

Table 3. Concentrations and loads for site S7, Greene County, North Carolina, 2006–2007. — Continued

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
10/17/06 23:59	65.5	—	—	>241,960	>599,070,000	19,890	49,250,000	81,640	202,100,000
10/18/06 00:44	162	2.04	1.25	—	—	—	—	—	—
10/18/06 00:59	209	—	—	>241,960	>1,911,500,000	2,470	19,500,000	57,940	457,700,000
10/18/06 02:44	490	—	—	173,290	3,209,700,000	3,730	69,100,000	22,820	422,700,000
10/18/06 03:14	630	1.15	2.74	—	—	—	—	—	—
10/18/06 05:14	205	2.43	1.88	—	—	—	—	—	—
10/18/06 06:14	241	—	—	>241,960	>2,204,200,000	13,960	127,200,000	104,620	953,100,000
10/18/06 12:45	130	9.19	4.52	>241,960	>1,189,000,000	6,970	34,300,000	81,640	401,200,000
10/19/06 12:55	89.8	9.63	3.27	>24,196	>82,132,000	1,400	4,750,000	823	2,800,000
10/28/06 01:13	2,420	1.66	15.2	—	—	—	—	—	—
10/28/06 01:28	nd	1.37	—	—	—	—	—	—	—
10/28/06 02:43	nd	1.31	—	—	—	—	—	—	—
10/28/06 03:13	nd	1.33	—	—	—	—	—	—	—
10/28/06 12:43	670	4.99	12.6	—	—	—	—	—	—
10/29/06 08:30	269	6.25	6.36	—	—	—	—	—	—
3/14/07 13:20	6.28	—	—	406	96,500	<1	<240	84	19,900
4/3/07 10:35	7.18	—	—	1,844	500,600	21	5,700	2,184	592,700
4/12/07 12:05	66.4	—	—	41,058	103,050,000	1,335	3,351,000	4,959	12,450,000
4/25/07 12:30	4.49	—	—	1,407	238,800	<1	<170	1,013	171,900
5/14/07 09:40	4.49	—	—	2,080	353,000	<1	<170	6,131	1,041,000
5/30/07 09:40	0.90	—	—	12,033	409,400	411	14,000	107	3,640
6/3/07 11:25	82.6	—	—	173,289	541,060,000	1,066	3,328,000	2,937	9,170,000
6/3/07 22:19	164	—	—	46,111	285,850,000	451	2,800,000	180	1,120,000
6/3/07 22:34	425	—	—	>241,960	>3,887,100,000	173,289	2,783,900,000	86,644	1,391,900,000
6/4/07 00:04	252	—	—	>241,960	>2,304,800,000	81,641	777,680,000	30,759	293,000,000
6/4/07 06:04	83.9	—	—	19,349	61,364,000	316	1,000,000	635	2,010,000
6/4/07 12:15	29.2	—	—	745	822,000	5	5,740	341	376,000
7/18/07 11:20	—	—	—	—	—	2,909	—	12,033	—

Table 4. Concentrations and loads for site S2, Greene County, North Carolina, 2006–2007.

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
2/21/06 14:35	18.0	—	—	702	478,000	—	—	4	2,800
3/15/06 15:30	—	—	—	1,935	—	199	—	20	—
3/28/06 11:30	8.98	—	—	1,291	438,200	3	1,050	6	2,140
5/3/06 15:35	13.5	—	—	6,309	3,220,000	41	20,900	784	400,000
5/8/06 14:55	443	—	—	14,136	236,710,000	439	7,350,000	1,392	23,320,000
6/14/06 11:33	274	5.61	5.81	—	—	—	—	—	—
6/14/06 12:03	570	—	—	92,080	1,984,000,000	980	21,100,000	6,290	135,500,000
6/14/06 12:33	1,480	2.53	14.2	—	—	—	—	—	—
6/14/06 13:03	2,510	—	—	>241,960	>22,957,000,000	3,840	364,300,000	111,990	10,626,000,000
6/14/06 15:03	3,230	2.04	24.9	—	—	—	—	—	—
6/14/06 16:03	3,290	—	—	>241,960	>30,091,000,000	6,630	824,500,000	61,310	7,625,000,000
6/14/06 18:03	1,970	—	—	129,970	9,678,300,000	18,420	1,372,000,000	47,860	3,564,000,000
6/14/06 19:03	1,620	4.02	24.6	—	—	—	—	—	—
6/15/06 05:03	490	7.30	13.5	—	—	—	—	—	—
6/15/06 07:03	440	—	—	13,540	225,200,000	1,785	29,690,000	805	13,400,000
6/19/06 14:00	26.9	8.75	0.89	17,329	17,620,000	255	259,000	152	154,000
7/23/06 18:12	314	10.70	12.7	38,110	452,300,000	225	2,670,000	520	6,170,000
7/23/06 18:27	1,210	7.26	33.2	—	—	—	—	—	—
7/23/06 18:42	2,420	2.40	22.0	—	—	—	—	—	—
7/23/06 18:57	2,540	—	—	>241,960	>23,231,000,000	6,500	624,100,000	120,330	11,553,000,000
7/23/06 19:42	1,710	2.17	14.0	—	—	—	—	—	—
7/23/06 20:12	1,340	—	—	>241,960	>12,256,000,000	600	30,400,000	>241,960	>12,256,000,000
7/23/06 21:42	540	3.07	6.27	—	—	—	—	—	—
7/24/06 00:12	230	—	—	198,630	1,726,900,000	100	869,000	98,040	852,400,000
7/24/06 17:40	26.9	7.92	0.81	77,010	78,300,000	357	363,000	9,590	9,750,000
7/25/06 11:55	328	3.49	4.33	—	—	—	—	—	—
7/26/06 15:25	44.9	9.21	1.56	—	—	—	—	—	—
8/15/06 16:25	18.0	—	—	>24,196	>16,463,000	80	54,700	4,352	2,961,000
10/17/06 15:20	14.8	—	—	10,860	6,076,000	105	58,700	2,010	1,124,000
10/18/06 00:29	58.4	10.6	2.34	—	—	—	—	—	—

Table 4. Concentrations and loads for site S2, Greene County, North Carolina, 2006–2007. — Continued

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
10/18/06 00:44	79.4	—	—	37,250	111,800,000	750	2,250,000	4,570	13,700,000
10/18/06 02:29	382	7.56	10.9	—	—	—	—	—	—
10/18/06 02:59	660	—	—	198,630	4,955,400,000	2,685	66,980,000	92,080	2,297,000,000
10/18/06 03:29	990	5.70	21.3	—	—	—	—	—	—
10/18/06 03:59	900	—	—	>241,960	>8,231,500,000	7,980	271,500,000	41,060	1,397,000,000
10/18/06 04:59	720	2.51	6.83	—	—	—	—	—	—
10/18/06 05:59	540	—	—	>241,960	>4,938,900,000	7,940	162,100,000	72,700	1,484,000,000
10/18/06 11:45	251	6.56	6.22	>241,960	>2,295,700,000	15,530	147,300,000	77,010	730,700,000
10/19/06 14:15	103	9.59	3.73	>24,196	>94,205,000	1,150	4,480,000	1,297	5,050,000
10/27/06 22:40	408	6.73	10.4	—	—	—	—	—	—
10/27/06 23:09	900	5.36	18.2	—	—	—	—	—	—
10/28/06 01:09	1,570	2.98	17.7	—	—	—	—	—	—
10/28/06 03:09	3,370	2.57	32.7	—	—	—	—	—	—
10/28/06 08:09	1,350	4.42	22.6	—	—	—	—	—	—
10/28/06 17:10	630	6.68	15.9	—	—	—	—	—	—
10/29/06 10:15	346	7.92	10.4	—	—	—	—	—	—
3/14/07 13:45	35.9	—	—	1,405	1,907,000	1	1,360	56	76,500
4/3/07 11:10	22.4	—	—	5,475	4,636,000	12	10,500	198	168,000
4/12/07 12:45	238	—	—	54,750	492,600,000	2,924	26,300,000	11,685	105,120,000
4/25/07 14:00	44.9	—	—	2,480	4,210,000	2	3,390	198	337,000
5/14/07 11:20	16.6	—	—	6,131	3,847,000	18	11,400	607	381,000
5/30/07 10:30	0.0	—	—	15,531	0	94	0	204	0
6/3/07 12:05	71.8	—	—	>241,960	>656,690,000	6,314	17,140,000	29,866	81,058,000
6/3/07 22:53	254	—	—	198,629	1,907,100,000	1,711	16,430,000	2,500	24,000,000
6/3/07 23:08	414	—	—	>241,960	>3,786,500,000	5,633	88,150,000	10,144	158,750,000
6/3/07 23:38	520	—	—	>241,960	>4,756,000,000	5,731	112,600,000	9,590	188,500,000
6/4/07 00:38	406	—	—	>241,960	>3,713,300,000	46,111	707,660,000	19,179	294,340,000
6/4/07 02:38	226	—	—	>241,960	>2,067,000,000	43,517	371,760,000	14,012	119,700,000
6/4/07 10:00	53.9	—	—	173,289	353,060,000	3,103	6,322,000	4,568	9,307,000
7/18/07 12:20	13.5	—	—	365,400	186,460,000	8,664	4,421,000	26,200	13,370,000

Table 5. Concentrations and loads for site SR5–D1, Greene County, North Carolina, 2006–2007.

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
6/14/06 13:20	0.95	1.95	0.01	538,000	19,300,000	5,380	193,000	67,850	2,437,000
7/23/06 18:02	.23	5.42	.01	—	—	—	—	—	—
7/23/06 18:17	21.9	—	—	>2,419,600	>2,003,000,000	1,808	1,497,000	248,100	205,400,000
7/23/06 18:32	15.8	13.60	.81	—	—	—	—	—	—
7/23/06 18:47	49.2	—	—	1,986,300	3,694,000,000	15,531	28,884,000	66,300	123,300,000
7/23/06 19:02	99.3	9.90	3.72	—	—	—	—	—	—
7/23/06 19:17	80.7	—	—	>2,419,600	>7,381,000,000	5,736	17,500,000	344,800	1,051,800,000
7/23/06 19:32	65.5	7.03	1.74	—	—	—	—	—	—
7/23/06 20:17	33.4	6.68	.84	—	—	—	—	—	—
7/23/06 20:47	21.5	—	—	980,400	796,800,000	3,441	2,797,000	214,260	174,130,000
7/23/06 22:47	4.8	4.09	.07	—	—	—	—	—	—
7/23/06 23:47	3.2	—	—	579,400	70,080,000	1,467	177,400	145,000	17,540,000
10/28/06 00:14	4.5	3.04	.05	—	—	—	—	—	—
10/28/06 00:34	27.4	4.11	.43	—	—	—	—	—	—
10/28/06 01:29	48.7	2.26	.42	—	—	—	—	—	—
10/28/06 02:14	86.1	2.28	.74	—	—	—	—	—	—
10/28/06 03:14	68.6	1.49	.39	—	—	—	—	—	—
10/28/06 04:44	34.3	1.43	.19	—	—	—	—	—	—
10/28/06 14:10	.95	1.77	.01	—	—	—	—	—	—
4/12/07 12:20	.31	—	—	>2,419,600	>28,353,000	14,173	166,100	770,100	9,024,000
6/3/07 11:40	.23	—	—	>24,196,000	>210,360,000	15,988	139,000	259,000	2,252,000
6/4/07 08:40	.41	—	—	109,894	1,703,000	86	13,340	100	1,550

Table 6. Concentrations and loads for site SR5–T1, Greene County, North Carolina, 2006–2007.

[gal/min, gallons per minute; mg/L, milligrams per liter; N, nitrogen; g/min, grams per minute; MPN/100 mL, most probable number per 100 milliliters; MPN/min, most probable number per minute; —, not available or not analyzed; nd, not determined (flow exceeded upper limit of discharge rating curve); <, less than; >, greater than]

Sample date and time	Discharge (gal/min)	Nitrite + nitrate (mg/L as N)	Nitrite + nitrate load (g/min as N)	Total coliform (MPN/100 mL)	Total coliform load (MPN/minute)	*E. coli* (MPN/100 mL)	*E. coli* load (MPN/minute)	Enterococci (MPN/100 mL)	Enterococci load (MPN/minute)
2/21/06 15:30	—	—	—	8	—	<1	—	<1	—
6/14/06 13:10	4.7	28.2	0.50	—	—	—	—	—	—
6/14/06 13:30	5.6	—	—	<100	<21,200	24	5,140	980	208,000
6/14/06 14:10	12.5	29.0	1.37	—	—	—	—	—	—
6/14/06 14:40	36.6	30.1	4.16	—	—	—	—	—	—
6/14/06 15:10	16.9	—	—	51,720	33,040,000	49	31,200	414	264,000
6/15/06 00:40	26.8	34.2	3.46	—	—	—	—	—	—
6/15/06 03:40	26.8	—	—	210	213,000	7	7,500	39	39,300
6/15/06 09:40	19.1	—	—	410	296,000	9	6,140	—	—
6/15/06 12:40	7.7	36.6	1.07	—	—	—	—	—	—
6/19/06 13:00	2.61	45.4	.45	232	22,900	4	395	<1	<99
7/26/06 14:55	5.6	34.3	.73	—	—	—	—	—	—
8/15/06 15:45	2.3	—	—	52	4,520	2	174	19	1,600
10/18/06 10:15	1.63	29.8	.18	57,940	3,570,000	975	60,100	850	52,400
10/19/06 13:40	.27	37.4	.04	9,804	100,100	37	378	84	859
10/27/06 22:46	4.8	33.8	.61	—	—	—	—	—	—
10/27/06 23:16	14.7	28.3	1.57	—	—	—	—	—	—
10/28/06 01:31	35.6	22.9	3.08	—	—	—	—	—	—
10/28/06 03:31	60.8	22.2	5.10	—	—	—	—	—	—
10/28/06 06:31	47.6	23.3	4.19	—	—	—	—	—	—
10/28/06 16:30	11.4	28.1	1.21	—	—	—	—	—	—
10/29/06 09:15	18.0	31.2	2.12	—	—	—	—	—	—
3/14/07 13:25	.41	—	—	15	233	<1	<15	101	1,560
4/12/07 12:20	7.1	—	—	2,785	747,400	345	92,500	1,553	416,800
4/25/07 13:05	1.9	—	—	214	15,400	1	72	4	290
5/14/07 10:00	na	—	—	39	—	<1	—	2	—
6/3/07 11:40	1.9	—	—	29,093	2,089,500	55	3,940	31	2,200
6/3/07 22:42	5.6	—	—	2,334	494,100	17	3,660	365	77,300
6/3/07 23:12	6.5	—	—	86,644	21,288,000	162	39,700	—	—
6/4/07 00:57	7.4	—	—	3,361	940,100	579	162,000	727	203,000
6/4/07 04:27	6.3	—	—	1,869	445,100	228	54,300	74	17,700
6/4/07 10:55	4.5	—	—	<100	<17,000	22	3,670	6	1,100

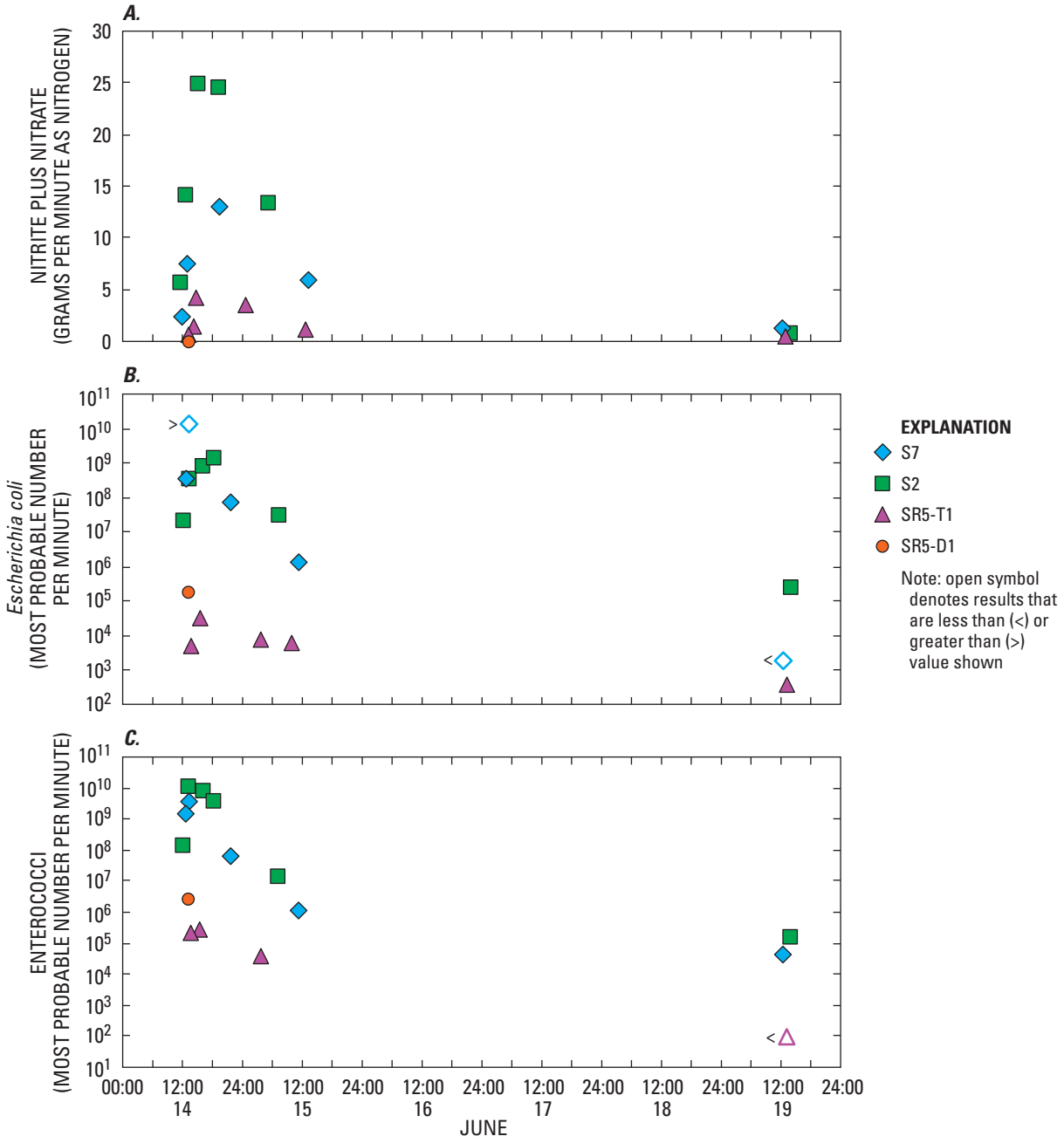


Figure 6. Instantaneous loads of nitrite plus nitrate, *Escherichia coli*, and enterococci for sampling event 1, June 14–19, 2006, Lizzie Research Site, Greene County, North Carolina.

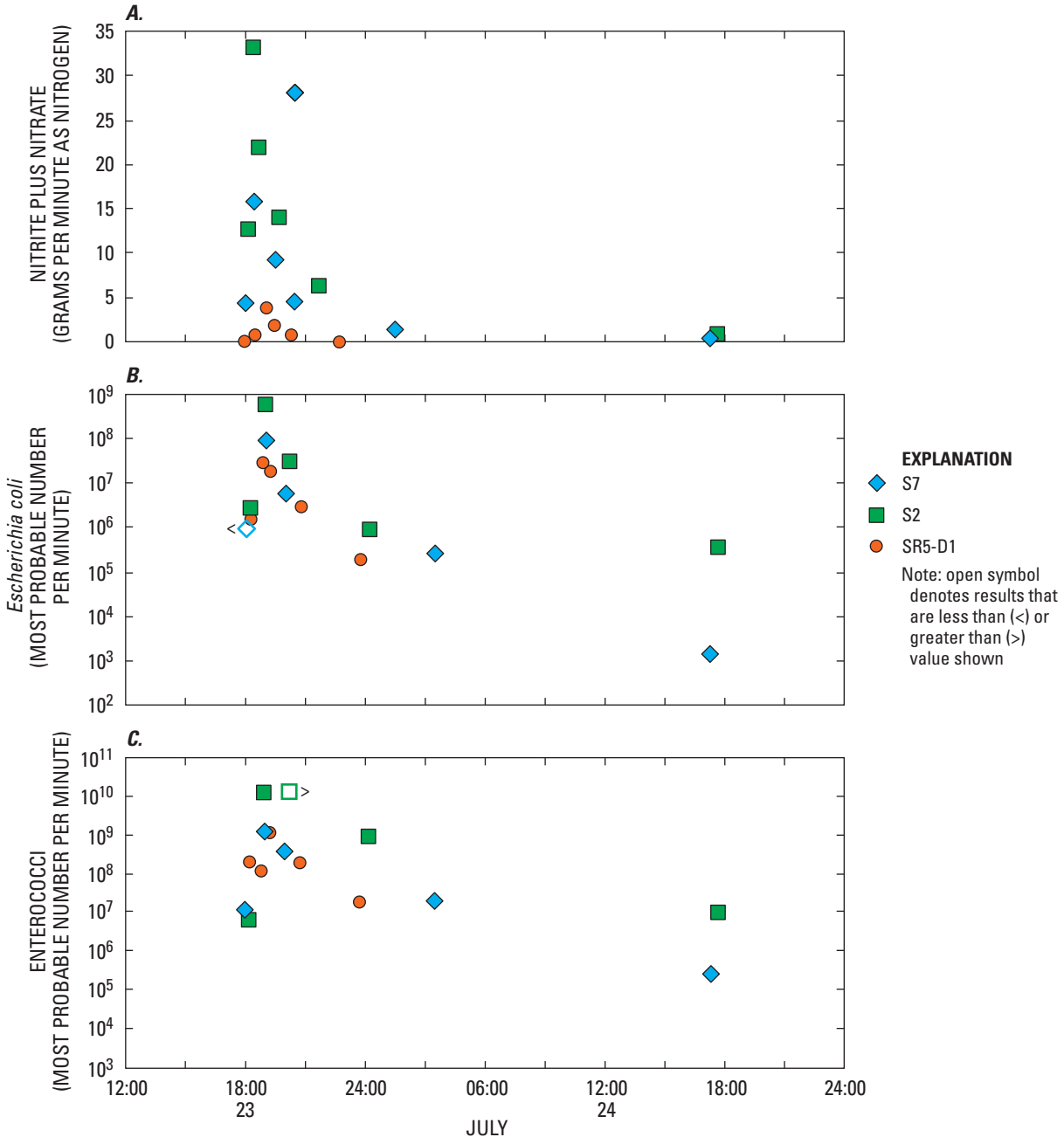


Figure 7. Instantaneous loads of nitrite plus nitrate, *Eschericia coli*, and enterococci for sampling event 2, July 23–24, 2006, Lizzie Research Site, Greene County, North Carolina.

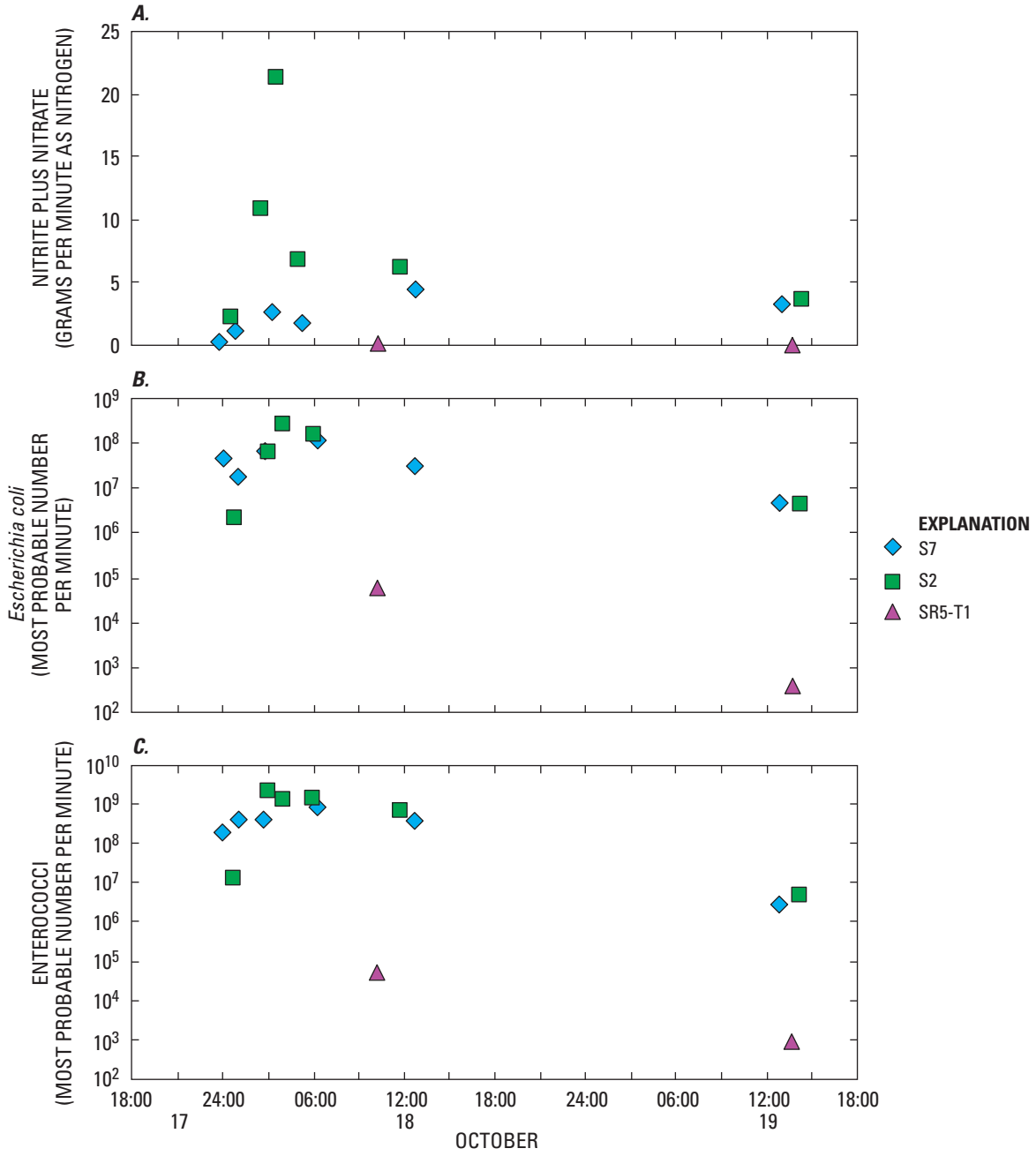


Figure 8. Instantaneous loads of nitrite plus nitrate, *Eschericia coli*, and enterococci for sampling event 3, October 17–19, 2006, Lizzie Research Site, Greene County, North Carolina.

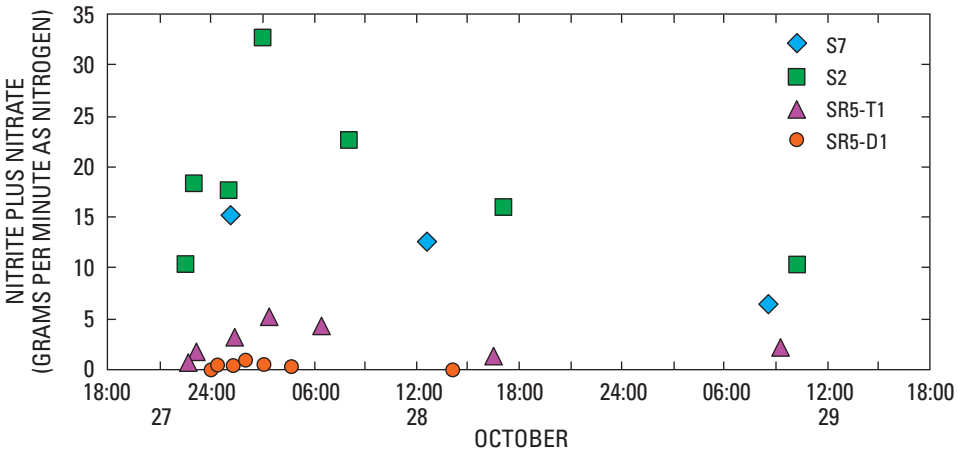


Figure 9. Instantaneous loads of nitrite plus nitrate for sampling event 4, October 27–29, 2006, Lizzie Research Site, Greene County, North Carolina.

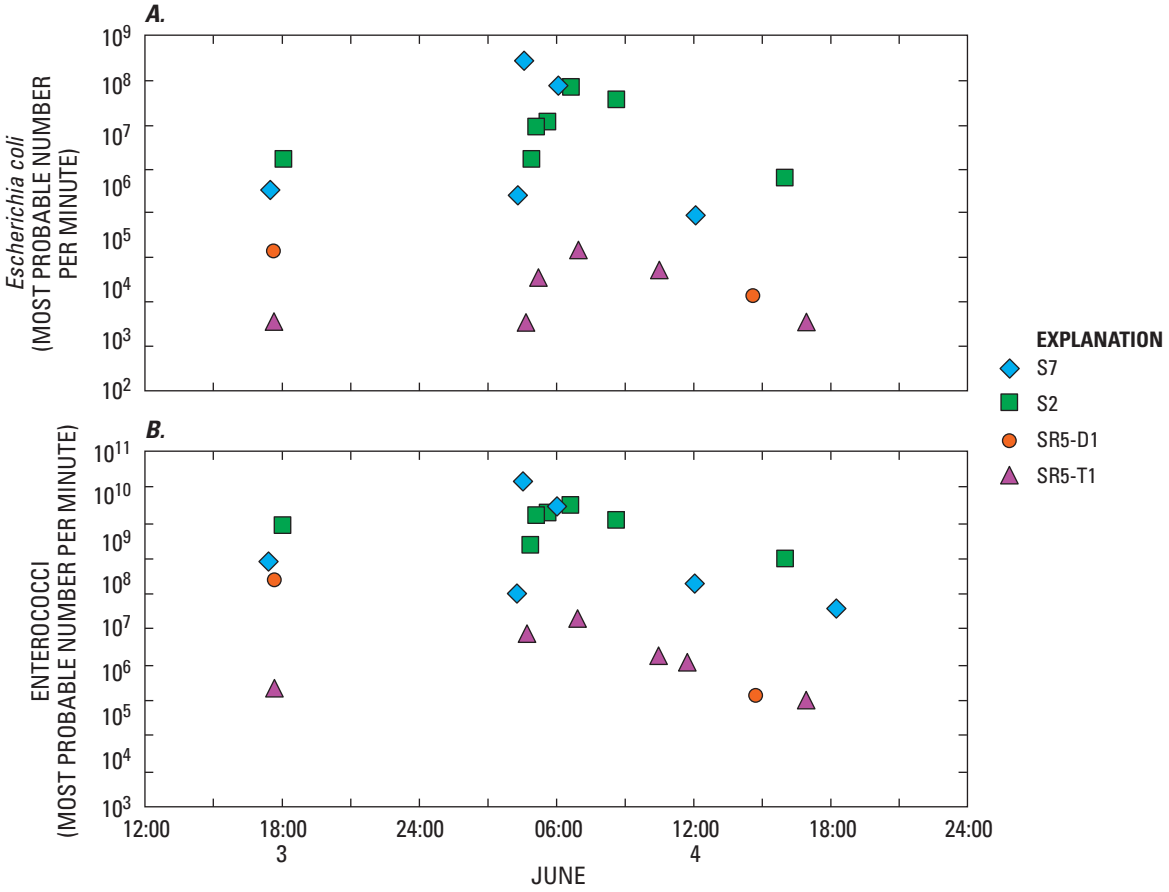


Figure 10. Instantaneous loads of *Eschericia coli* and enterococci for sampling event 5, June 3–4, 2007, Lizzie Research Site, Greene County, North Carolina.

Acknowledgments

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Appendix. Summary of nutrient analytical results for stormwater event samples collected at the Lizzie Research Site, Greene County, North Carolina, 2006–2007.

[N, nitrogen; mg/L, milligrams per liter; PC, parameter code; P, phosphorus; E, estimated; <, less than; —, not analyzed]

Date	Time	Ammonia + organic N, water, filtered, mg/L as N (PC00623)	Ammonia + organic N, water, unfiltered, mg/L as N (PC00625)	Ammonia, water, filtered, mg/L as N (PC00608)	Nitrite + nitrate, water, filtered, mg/L as N (PC00631)	Nitrite, water, filtered, mg/L as N (PC00613)	Phosphorus, water, filtered, mg/L as P (PC00666)	Phosphorus, water, unfiltered, mg/L as P (PC00665)
Site S7								
06/14/06	1147	0.73	1.5	0.051	2.03	0.01	0.073	0.35
06/14/06	1247	.98	2.2	.037	1.54	.01	.200	.65
06/14/06	1517	1.10	2.1	.069	1.68	.01	.270	.64
06/14/06	1917	1.70	2	.590	5.19	.01	.094	.21
06/15/06	1317	1.10	1.2	.307	7.50	.01	.018	.08
06/19/06	1225	.41	0.52	.054	7.14	.01	E .003	.04
07/23/06	1759	1.30	1.9	.148	4.66	.02	.042	.40
07/23/06	1829	1.80	3.2	.210	1.59	.02	.420	1.10
07/23/06	1929	2.00	2.2	.234	1.70	.03	.290	.52
07/23/06	2029	1.90	2	.236	2.08	.03	.188	.38
07/24/06	0129	1.20	1.1	.123	3.40	.02	.038	.14
07/24/06	1715	.52	.7	.076	5.92	.01	.014	.07
07/25/06	1045	1.50	1.5	.056	1.85	.01	.090	.25
07/26/06	1425	1.00	0.72	.083	5.22	.01	.011	.06
10/17/06	2344	.97	1.1	.030	2.05	.01	.061	.27
10/18/06	0044	1.10	1.1	.049	2.04	.01	.075	.34
10/18/06	0314	1.50	1.5	.117	1.15	.01	.219	.58
10/18/06	0514	1.30	1.6	.081	2.43	.01	.174	.35
10/18/06	1245	1.10	1.2	.090	9.19	.02	.043	.19
10/19/06	1255	.88	.72	.060	9.63	.01	.016	.07
10/28/06	0113	1.20	1.7	< .020	1.66	.01	.245	.62
10/28/06	0128	1.20	1.6	< .020	1.37	.004	.245	.79
10/28/06	0243	1.10	1.7	< .020	1.31	.01	.330	.72
10/28/06	0313	1.00	1.3	< .020	1.33	.01	.328	.53
10/28/06	1243	1.20	1.2	.025	4.99	.01	.081	.29
10/29/06	0830	.84	.71	.036	6.25	.00	.021	.08
Site S2								
06/14/06	1133	2.00	2.6	1.230	5.61	0.07	0.022	0.30
06/14/06	1233	1.40	4	.598	2.53	.03	.124	1.06
06/14/06	1503	1.20	3	.263	2.04	.01	.112	.79
06/14/06	1903	1.50	2.1	.451	4.02	.02	.110	.32
06/15/06	0503	1.50	1.9	.734	7.30	.02	.028	.15
06/19/06	1400	1.70	2	1.290	8.75	.10	.007	.06
07/23/06	1812	4.70	3.7	2.000	10.70	.81	.033	.24
07/23/06	1827	2.60	4.4	1.300	7.26	.61	.044	.84
07/23/06	1842	2.00	7.9	.873	2.40	.09	.036	1.77
07/23/06	1942	1.70	3.2	.235	2.17	.04	.290	1.04

Appendix. Summary of nutrient analytical results for stormwater event samples collected at the Lizzie Research Site, Greene County, North Carolina, 2006–2007. — Continued

[N, nitrogen; mg/L, milligrams per liter; PC, parameter code; P, phosphorus; E, estimated; <, less than; —, not analyzed]

Date	Time	Ammonia + organic N, water, filtered, mg/L as N (PC00623)	Ammonia + organic N, water, unfiltered, mg/L as N (PC00625)	Ammonia, water, filtered, mg/L as N (PC00608)	Nitrite + nitrate, water, filtered, mg/L as N (PC00631)	Nitrite, water, filtered, mg/L as N (PC00613)	Phosphorus, water, filtered, mg/L as P (PC00666)	Phosphorus, water, unfiltered, mg/L as P (PC00665)
Site S2 (Continued)								
07/23/06	2142	2.10	2.1	0.328	3.07	0.06	0.260	0.51
07/24/06	1740	2.80	2.4	1.300	7.92	.13	.033	.09
07/25/06	1155	2.20	2.3	.470	3.49	.03	.128	.35
07/26/06	1525	2.40	2.1	1.410	9.21	.14	.019	.06
10/18/06	0029	3.50	3.5	2.380	10.60	.32	.023	.13
10/18/06	0229	2.80	2.8	1.510	7.56	.19	.084	.21
10/18/06	0329	3.10	3.4	1.800	5.70	.10	.067	.37
10/18/06	0459	1.30	1.6	.269	2.51	.03	.112	.35
10/18/06	1145	1.40	1.6	.435	6.56	.05	.065	.19
10/19/06	1415	1.60	1.5	.792	9.59	.12	.017	.06
10/27/06	2240	2.60	3	1.780	6.73	.15	.021	.14
10/27/06	2309	2.50	2.4	1.180	5.36	.07	.094	.31
10/28/06	0109	1.60	2	.284	2.98	.02	.208	.59
10/28/06	0309	1.20	2.6	.093	2.57	.02	.288	.97
10/28/06	0809	1.20	1.6	.147	4.42	.01	.157	.40
10/28/06	1710	1.60	1.3	.221	6.68	.02	.048	.19
10/29/06	1015	1.20	1	.494	7.92	.02	.018	.08
Site SR5–D1								
06/14/06	1320	4.20	5.2	0.084	1.95	0.03	1.670	1.91
07/23/06	1802	4.80	7.1	1.040	5.42	.04	3.740	4.25
07/23/06	1832	6.90	8	1.060	13.60	.10	3.950	4.11
07/23/06	1902	6.50	7	1.040	9.90	.12	3.870	4.23
07/23/06	1932	5.10	6.1	.694	7.03	.22	3.280	3.34
07/23/06	2017	4.90	5.8	.529	6.68	.43	3.030	3.51
07/23/06	2247	4.80	5.4	.412	4.09	.18	3.270	3.60
10/28/06	0014	3.90	4.5	.098	3.04	.02	1.970	2.81
10/28/06	0034	3.90	4.5	.163	4.11	.04	2.520	3.04
10/28/06	0129	2.80	2.5	.091	2.26	.02	1.690	2.12
10/28/06	0214	2.40	2.3	.054	2.28	.03	1.710	1.97
10/28/06	0314	2.00	2.1	E .017	1.49	.02	1.580	1.69
10/28/06	0444	2.20	2.5	.021	1.43	.01	1.710	1.79
10/28/06	1410	3.00	2.7	.041	1.77	.01	1.810	2.21
Site SR5–T1								
06/14/06	1310	0.83	—	0.280	28.20	—	0.022	—
06/14/06	1410	.77	—	.257	29.00	—	.019	—
06/14/06	1440	.66	—	.104	30.10	—	.033	—
06/15/06	0040	.48	—	.014	34.20	—	.013	—

Appendix. Summary of nutrient analytical results for stormwater event samples collected at the Lizzie Research Site, Greene County, North Carolina, 2006–2007. — Continued

[N, nitrogen; mg/L, milligrams per liter; PC, parameter code; P, phosphorus; E, estimated; <, less than; —, not analyzed]

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Site SR5–T1 (Continued)								
06/15/06	1240	0.43	—	0.014	36.60	—	0.009	—
06/19/06	1300	.26	—	E .006	45.40	—	.008	—
07/26/06	1455	.38	—	.012	34.30	—	.010	—
10/18/06	1015	.58	—	< .020	29.80	—	.013	—
10/19/06	1340	.51	—	E .016	37.40	—	.011	—
10/27/06	2246	1.00	—	.030	33.80	—	.021	—
10/27/06	2316	.94	—	.025	28.30	—	.030	—
10/28/06	0131	.89	—	E .018	22.90	—	.019	—
10/28/06	0331	.90	—	.020	22.20	—	.017	—
10/28/06	0631	1.10	—	.028	23.30	—	.015	—
10/28/06	1630	.69	—	E .017	28.10	—	.008	—
10/29/06	0915	.38	—	< .020	31.20	—	.007	—