Data on surface-water, streambed-interstitial water, and bed-sediment quality for selected locations in the small arms impact area of central Fort Gordon, Georgia, September 4–6, 2001

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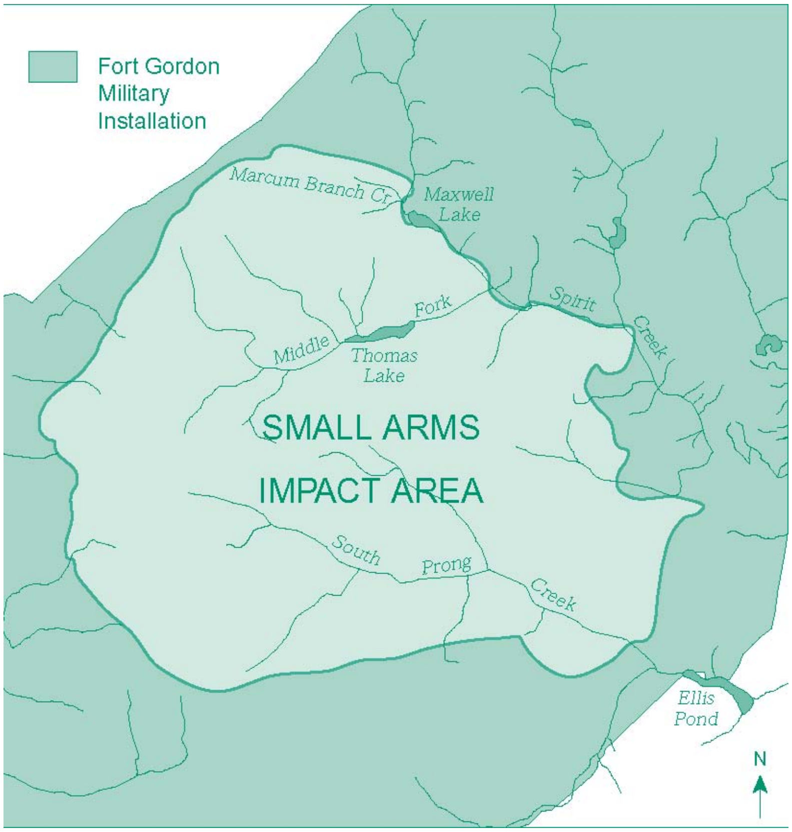
Version 1.1, May 2023



Prepared in cooperation with the

U.S. Department of the Army
Environmental and Natural Resources Management
Office of the U.S. Army Signal Center *and* Fort Gordon

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

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By Sherlyn Priest, Timothy C. Stamey, and Stephen J. Lawrence

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2002

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U.S. GEOLOGICAL SURVEY
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Data on surface-water, streambed-interstitial water, and bed-sediment quality for selected locations in the small arms impact area of central Fort Gordon, Georgia, September 4–6, 2001

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ABSTRACT

In September 2001, the U.S. Geological Survey, in cooperation with the Environmental and Natural Resources Management Office of the U.S. Army Signal Center and Fort Gordon (U.S. Department of the Army), conducted a chemical assessment of surface water, streambed-interstitial water, and bed sediments within the small arms impact area of Fort Gordon Military Installation. The study was conducted in support of the development of an Integrated Natural Resources Management Plan (INRMP) for Fort Gordon, Georgia. An effective INRMP ensures that natural resources conservation measures and U.S. Army activities on the military base are integrated and consistent with Federal requirements to manage military installations on an ecosystem basis.

Filtered water samples were collected from five sites along South Prong Creek and three sites along Marcum Branch Creek for chemical analyses of major ions, nutrients, and selected trace elements. On-site measurements of pH, temperature, specific conductance, and dissolved oxygen were made at the eight sites. Filtered water collected showed varying concentrations in both surface- and streambed-interstitial water. Bed-sediment samples collected from South Prong Creek contain elevated levels of arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, vanadium, and total organic carbon relative to previous concentrations (McConnell and others, 2000). Bed-sediment samples collected from Marcum Branch Creek contain elevated levels of beryllium, copper, lead, manganese, mercury, selenium, and total organic carbon relative to previous concentrations (McConnell and others, 2000).

INTRODUCTION

The U.S. Army uses water-quality data related to stormwater pollution prevention to support development of an Integrated Natural Resources Management Plan (INRMP) for Fort Gordon, Georgia. An effective INRMP ensures that natural resource conservation measures and Army activities on the military base are integrated, and consistent with Federal requirements (Sikes Act, 1998), to manage military installations on an ecosystem basis. Information on the occurrence and distribution of toxic substances in surface water on the base is needed to develop an INRMP at Fort Gordon, because when transported from source areas and deposited in streams, these substances may adversely affect stream ecosystems.

In September 2001, the U.S. Geological Survey (USGS), in cooperation with the Environmental and Natural Resources Management Office of the U.S. Army Signal Center and Fort Gordon, conducted a spatial survey within the small arms impact area (figs. 1a and 1b and table 1) to assess the concentrations of major ions, selected trace elements, and nutrients in surface water and streambed-interstitial water at Fort Gordon and to determine if concentrations of major ions and selected trace elements in bed sediments were elevated relative to previous concentrations (McConnell and others, 2000). Trace elements and nutrients associated with small arms munitions generally have low solubility in natural waters and tend to accumulate on silt- and clay-sized particles and organic matter (McConnell and others, 2000). The majority of stream nonpoint-source contributions of trace elements and nutrients likely are intermittent or related to storm events relative to trace elements associated with small arms.

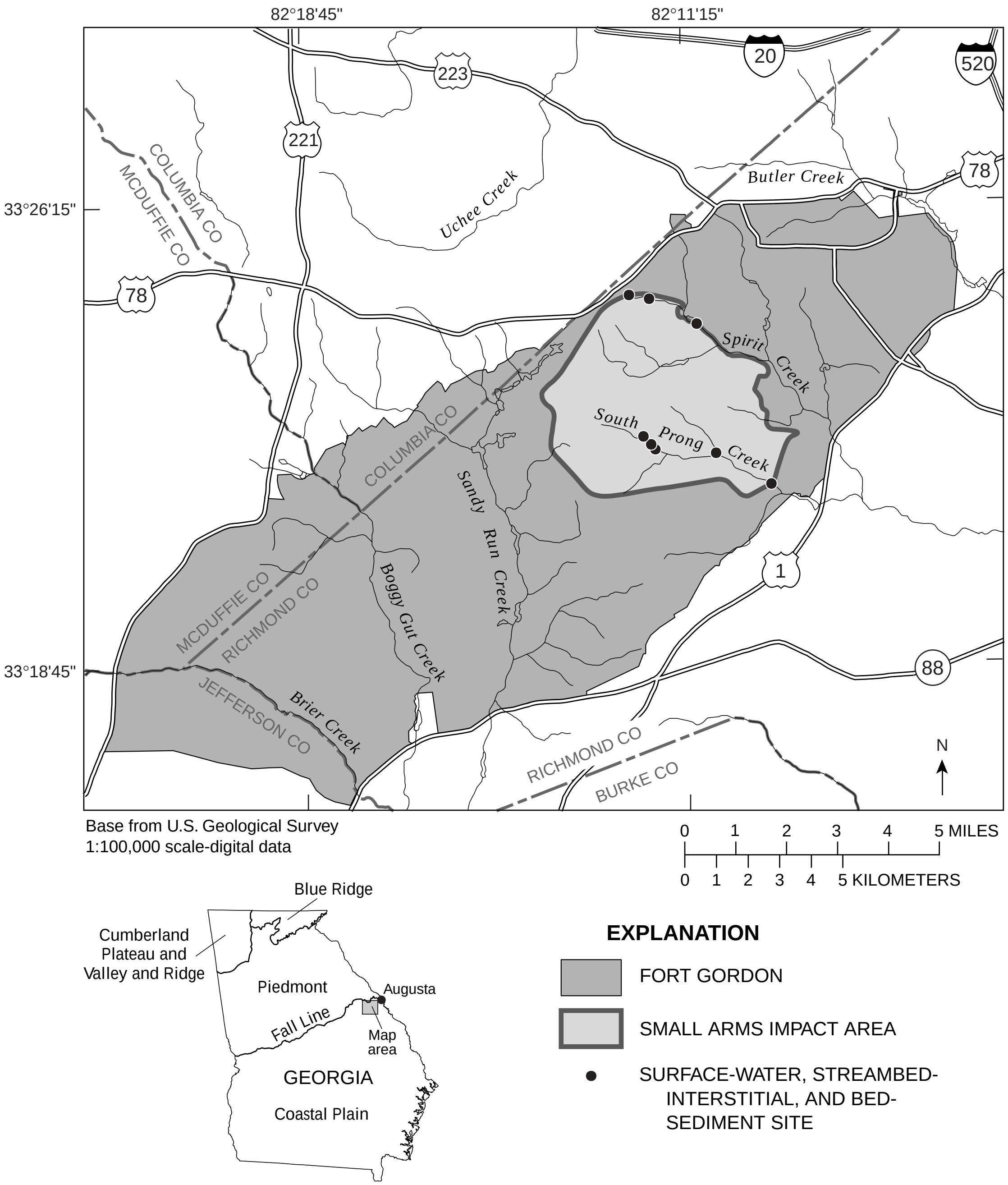
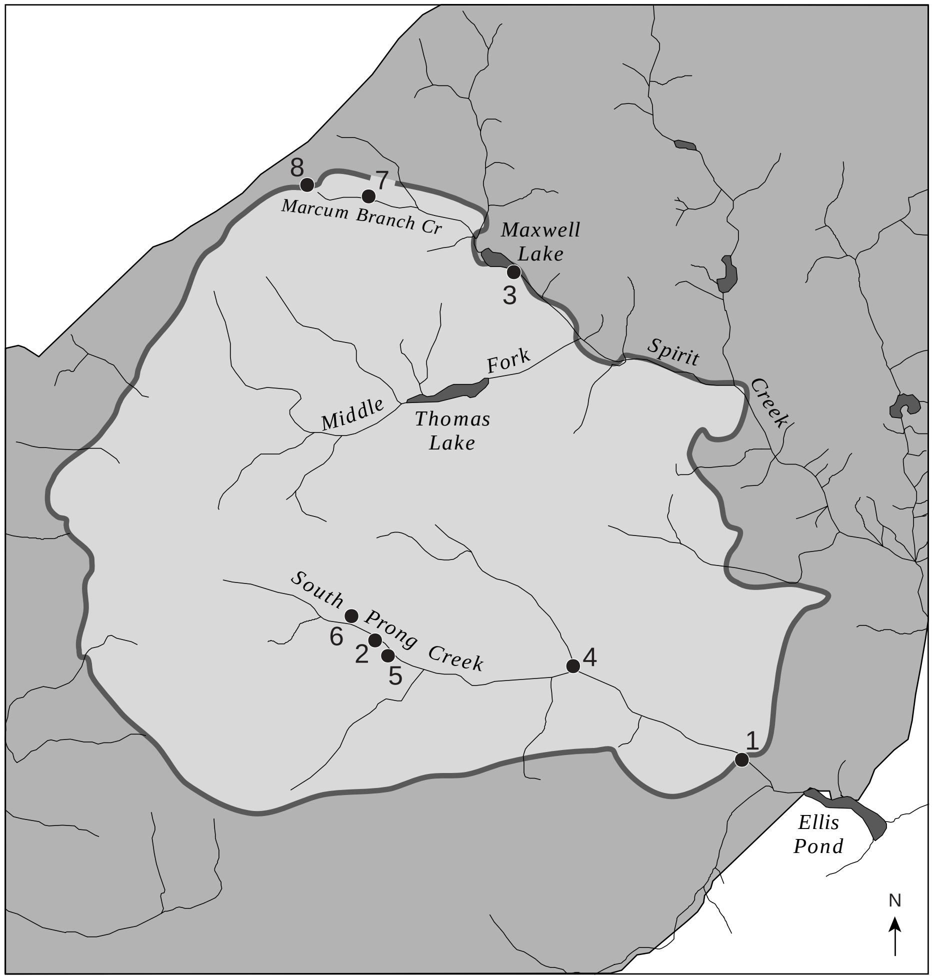


Figure 1a. Study area and selected surface-water, streambed-interstitial water, and bed-sediment sampling sites within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001.



Base from U.S. Geological Survey
1:100,000 scale-digital data

0 1 2 MILES
0 1 2 KILOMETERS

EXPLANATION

FORT GORDON

SMALL ARMS IMPACT AREA

4 SURFACE-WATER, STREAMBED-INTERSTITIAL, AND BED-SEDIMENT SITE AND SITE NUMBER

Figure 1b. Surface-water, streambed-interstitial water, and bed-sediment sampling sites within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001.

Table 1: Location of sites where surface-water, streambed-interstitial water, and bed-sediment quality samples were collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[BS, bed sediment; SIW, streambed-interstitial water; SW, surface water]

Site number (fig. 1b)	Sample type	Station number	Station Name	Latitude (degrees, minutes, seconds)	Longitude (degrees, minutes, seconds)	Date	Time
1	BS	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	33°21'39"	82°09'34"	09-05-01	1620
1	SIW	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	33°21'39"	82°09'34"	09-05-01	1620
1	SW	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	33°21'39"	82°09'34"	09-05-01	1615
2	BS	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	33°22'19"	82°11'56"	09-05-01	1000
2	SIW	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	33°22'19"	82°11'56"	09-05-01	1000
2	SW	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	33°22'19"	82°11'56"	09-05-01	0955
3	BS	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	33°24'17"	82°11'00"	09-05-01	1750
3	SIW	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	33°24'17"	82°11'00"	09-05-01	1750
3	SW	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	33°24'17"	82°11'00"	09-05-01	1745
4	BS	332210082103901	South Prong tributary at Fort Gordon, Ga.	33°22'10"	82°10'39"	09-05-01	1445
4	SIW	332210082103902	South Prong tributary at Fort Gordon, Ga.	33°22'10"	82°10'39"	09-05-01	1435
4	SW	332210082103901	South Prong tributary at Fort Gordon, Ga.	33°22'10"	82v10'39"	09-05-01	1430
5	BS	332214082115102	South Prong near tributary at Fort Gordon, Ga.	33°22'14"	82v11'51"	09-05-01	1100
5	SIW	332214082115102	South Prong near tributary at Fort Gordon, Ga.	33°22'14"	82°11'51"	09-05-01	1100
5	SW	332214082115101	South Prong near tributary at Fort Gordon, Ga.	33°22'14"	82°11'51"	09-05-01	1055
6	BS	332227082120501	South Prong at headwaters at Fort Gordon, Ga.	33°22'27"	82°12'05"	09-04-01	1550
6	SIW	332227082120502	South Prong at headwaters at Fort Gordon, Ga.	33°22'27"	82°12'05"	09-04-01	1555
6	SW	332227082120501	South Prong at headwaters at Fort Gordon, Ga.	33°22'27"	82°12'05"	09-04-01	1550
7	BS	332442082115601	Marcum Branch at firing range at Fort Gordon, Ga.	33°24'42"	82°11'56"	09-06-01	1035
7	SIW	332442082115602	Marcum Branch at firing range at Fort Gordon, Ga.	33°24'42"	82°11'56"	09-06-01	1030
7	SW	332442082115601	Marcum Branch at firing range at Fort Gordon, Ga.	33°24'42"	82°11'56"	09-06-01	1035
8	BS	332446082122001	Marcum Branch at Range Road at Fort Gordon, Ga.	33°24'46"	82°12'20"	09-06-01	1135
8	SIW	332446082122002	Marcum Branch at Range Road at Fort Gordon, Ga.	33°24'46"	82°12'20"	09-06-01	1130
8	SW	332446082122001	Marcum Branch at Range Road at Fort Gordon, Ga.	33°24'46"	82°12'20"	09-06-01	1135

Storm runoff eventually deposits into surface water, resulting in increased concentrations of trace elements and nutrients. As a result, contaminants may not be detected in water samples that are collected randomly or even systematically. However, bed sediments in depositional environments of stream systems provide an integrated repository of particulate matter transported by a stream. Thus, a spatial survey of surface water, streambed-interstitial water, and bed sediment can identify locations, potential source areas, and distributions of major ions, trace elements, and nutrients within the small arms impact area.

Purpose and Scope

This report presents data on the occurrence and distribution of major ions, selected trace elements, and nutrients in surface water, streambed-interstitial water, and bed sediments collected within the small arms impact area at Fort Gordon. These data are intended to help identify potential source areas of contaminants and sites where stream quality can indicate an increased potential for adverse effects on stream ecosystems. The report contains concentration data for major ions, trace elements, nutrients, and field water-quality parameters for surface-water, streambed-interstitial water, and bed-sediment samples collected at eight sites along South Prong and Marcum Branch Creeks within the small arms impact area for the period September 4–6, 2001.

Description of Study Area

Fort Gordon is located in the Coastal Plain physiographic province southwest of Augusta, Georgia, in northwestern Richmond County, and in small parts of the adjacent counties of Columbia, Jefferson, and McDuffie (fig. 1a). Fort Gordon is located near the Fall Line (Clark and Zisa, 1976)—a transition zone between the Coastal Plain and Piedmont physiographic provinces (fig. 1a). The general topography along the Fall Line is typified by rolling hills, with some rock outcroppings in stream valleys. Topographic relief at Fort Gordon is moderate; the minimum altitude is about 225 feet (ft) above NAVD 88 to the east and the maximum altitude is about 475 ft to the northwest.

The climate of the Augusta area is humid subtropical, characterized by hot, wet summers and mild, dry winters. The average daily high temperature is about 90 degrees Fahrenheit (°F) in the summer, and the daily average low temperature is about 35°F in the winter. In 2001, the total precipitation recorded at Augusta Bush Field Airport was 33.55 inches (National Oceanic and Atmospheric Administration, 2002). Based on the 30-year period (1961–90), average rainfall in the Augusta area is about 46 inches, and snowfall is rare (National Oceanic and Atmospheric Administration, 2002). In general, October and November are the driest months; and March, June, and July are the wettest months.

Past military activities at Fort Gordon have included division training for Infantry and Armored Divisions, Southeastern Signal School, Military Police, and antiaircraft Artillery Brigade operations. After the Vietnam War, the U.S. Army consolidated the majority of the communications training at Fort Gordon. In 1974, Fort Gordon was designated as the U.S. Army Signal Center. Currently, Fort Gordon is one of the largest communications-electronics facilities in the world.

General land use in the eastern part of the base consists of industrial and military activities. The western part of the base consists of upland areas, which are typically cleared and developed, and stream valleys, which are mostly forested and contain wetlands and some small impoundments.

Streamflow Station, Streambed-Interstitial Water, and Bed-Sediment Numbering System

Since October 1, 1950, the USGS has used the same numbering system to identify surface-water stations. The order of listing stations is in a downstream direction along the mainstream. All stations on a tributary entering upstream of a mainstream station are listed before that station. Each streamflow station is assigned a unique 8- to 14-digit number. The station number, such as 02197500, includes the 2-digit number “02,” which refers to the regional basin identifier, plus the 6- to 12-digit downstream order “1975000.” Streambed-interstitial water and bed-sediments sites without a USGS-assigned number are identified by the unique 15-digit number derived from the site's latitude, longitude, and a sequential number. For example, two different types of samples collected from one site with latitude 33°22'10" and longitude 082°10'39" would be assigned identification numbers 332210082103901 and 332210082103902, respectively.

Acknowledgments

The authors extend thanks to John B. Wellborn, U.S. Army Signal Center and Fort Gordon, for his cooperation. A special thanks is extended to Alan M. Cressler and Charles M. Hacke, U.S. Geological Survey, who collected samples in the field and Arthur J. Horowitz, U.S. Geological Survey, who supervised analyses of the bed-sediment samples.

METHODS OF STUDY

Surface-water samples were collected using modified USGS depth- and width-integrated methods (Webb and others, 1999) because of the small size of the sampled streams. The width and depth of all sampled streams was less than 8 ft and 1 ft, respectively. Each water sample was collected with a wide-mouth, 1-liter polyethylene bottle, which was allowed to fill while it was slowly lowered by hand from the water surface to the stream bottom; thus, providing a vertically integrated subsample. Depending on the width of the stream, three to six vertically integrated subsamples were collected and composited in a polyethylene USGS churn splitter. A beaver pond (surface-water site number 1, fig. 1b) was sampled with multiple, vertically integrated grab samples. At least 5 liters of water were collected and composited in the churn splitter at each site.

Streambed-interstitial water samples were collected in the hyporheic zone (boundary between streambed and groundwater) of each surface-water site using Hydropunch, or a drivepoint apparatus (Gibs and Wilde, 1999). The drivepoint was driven from 2 to 3 feet below the stream bottom in the hyporheic zone. A peristaltic pump was used to purge the drivepoint and collect a water sample. Water samples were collected when field parameters were stable, which typically took from 15 to 30 minutes. Field parameters were measured in a flow-through chamber using Hydrolab DataSonde 4 Water Quality equipment. Whole-water samples were stored in polyethylene bottles. Water for dissolved analysis was pumped from the drivepoint, through a 0.45-micron capsule filter, into the polyethylene bottles. Filtered water for dissolved mercury analyses was stored in a nitric acid-rinsed glass bottle. Samples were preserved and sent by overnight carrier to the USGS National Water Quality Laboratory, Denver, Colorado (NWQL).

After collection, water sample processing followed standard USGS methods. Polyethylene bottles for whole-water (unfiltered) analyses were filled from the churn splitter while "churning" the water in the prescribed manner (Wilde and others, 1999). Polyethylene bottles for filtered analyses were filled by pumping water (peristaltic pump) from the churn splitter through a 0.45-micron capsule filter. Mercury samples were stored in a nitric acid-rinsed glass bottle. Samples were preserved and sent by overnight carrier to the NWQL. Samples at stream sites were collected from exposed and/or submerged depositional areas that contain fine-grained sediments. Samples were collected using a Teflon™ spatula to scoop the upper 1–2 centimeters (cm) of fine-grained material from the bed deposits. Samples were composited in an acid-rinsed baked-glass container until enough material was collected for chemical analysis. Samples were delivered to the USGS Sediment Partitioning Research Laboratory in Atlanta, Georgia. Samples were prepared for chemical analysis in the Atlanta laboratory by freeze drying and then sieving through a 63-micrometer (µm) mesh screen.

Aliquots from the prepared samples were digested in a strong acid mixture to solubilize completely the metals from the sediment matrix. The aliquots were analyzed for total trace element concentrations by a combination of atomic absorption and Inductively Coupled Plasma Atomic Spectrometry (ICPAS) methods (Arthur J. Horowitz, U.S. Geological Survey, oral communication with Sherlyn Priest, 2002).

Field parameters such as water temperature, pH, dissolved oxygen, and specific conductance were measured in the stream using a Hydrolab multiprobe, following standard USGS protocols (Wilde and Radtke, 1999). Specific conductance and pH measurements were made after the Hydrolab was field calibrated with standard solutions. The Hydrolab dissolved oxygen probe was calibrated in water-saturated air within a closed chamber that was allowed to equilibrate to ambient air temperature.

USGS National Water Quality Assessment (NAWQA) program assurance procedures (Mueller and others, 1997) were followed throughout the sampling program. This included the collection of a duplicate water sample at one site (table 2) and three equipment blanks (table 3). Duplicate samples allow evaluation of variability introduced by sampling procedures. Duplicate samples were collected sequentially within 60 seconds of each other. Equipment blanks are produced by passing trace-element-free water through each step of sample collection, field processing, preservation, transportation, and laboratory handling. The NWQL followed quality-assurance practices described by Pritt and Raese (1995) and Pirkey and Glodt (1998). Bed-sediment samples were analyzed in accordance with Horowitz and others (1989) at the USGS laboratory.

PRESENTATION OF WATER-QUALITY AND BED-SEDIMENT DATA

Surface-water- (table 4) and streambed-interstitial water-quality data (table 5) presented in this report include field water-quality parameters and concentrations of major ions, trace elements, and nutrients. Bed-sediment data (table 6) includes concentration of major ions and trace elements.

Limitations of the data reported reflect the limits of precision and accuracy for the laboratory analytical procedures. A less than (<) value reported with analytes in water samples is reported when an analyte is at a concentration less than the method detection limit. The minimum reporting level is defined as the smallest measured concentration of a substance that can be reliably measured by using a given analytical method (Timme, 1995). An estimated value (e) is reported for data where the analyte was detected above the method detection limit, but below the minimum reporting level (Childress and others, 1999). For the situation when the analyte was detected below the minimum reporting level, the compound has passed all criteria used to identify its presence, and only the concentration is estimated (Connor and others, 1998).

Table 2: Duplicate bed-sediment samples collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[mg/kg, milligrams per kilogram;%, percent (1%=10,000 mg/kg); <, less than; TOC, total organic carbon; minimum reporting levels in parentheses below constituent name]

Duplicate	Station number	Station name	Phosphorus (mg/kg) (10)	Aluminum (%) (0.1)	Antimony (mg/kg) (0.1)	Arsenic (mg/kg) (0.1)	Barium (mg/kg) (1)
1	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	540	12	0.5	3.1	320
DUP 1	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	540	12	0.5	3.3	320

Duplicate	Beryllium (mg/kg) (0.1)	Cadmium (mg/kg) (0.1)	Chromium (mg/kg) (1)	Cobalt (mg/kg) (1)	Copper (mg/kg) (1)	Iron (%) (0.1)	Lead (mg/kg) (1)	Lithium (mg/kg) (1)	Manganese (mg/kg) (10)	Mercury (mg/kg) (0.01)	Molybdenum (mg/kg) (1)
1	1.9	0.3	92	4	12	0.9	47	27	66	0.07	2
DUP 1	1.9	0.1	90	4	12	0.9	44	27	65	0.08	2

Duplicate	Nickel (mg/kg) (1)	Selenium (mg/kg) (0.1)	Silver (mg/kg) (0.5)	Strontium (mg/kg) (1)	Thallium (mg/kg) (50)	Tin (mg/kg) (0.1)	Titanium (%) (0.01)	Uranium (mg/kg) (50)	Vanadium (mg/kg) (1)	Zinc (mg/kg) (1)	TOC (%) (0.1)
1	17	0.7	<0.5	82	<50	4.4	0.79	<50	95	39	5.9
DUP 1	17	0.7	<0.5	80	<50	3.2	0.79	<50	95	39	5.9

Table 3: Nutrient concentrations measured in equipment blanks collected during water sampling within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[e, estimated value between method detection limit and minimum reporting level; mg/L, milligrams per liter; minimum reporting levels in parentheses below constituent name]

Quality control sample type	Date	Time	Nitrogen, nitrite, dissolved (mg/L as N) (0.01)	Nitrogen (NO_2+NO_3), dissolved (mg/L as N) (0.05)	Nitrogen, ammonia, dissolved (mg/L as N) (0.02)	Nitrogen, ammonia + organic, total (mg/L as N) (0.1)	Phosphorus, total (mg/L as P) (0.05)	Phosphorus, dissolved (mg/L as P) (0.05)	Phosphorus, ortho, dissolved (mg/L as P) (0.01)
Bottle and churn splitter blank	09-05-01	0800	0.006–e	0.026–e	0.04	0.08–e	0.06	0.06	0.02
Drivepoint blank	09-05-01	0801	.006–e	.025–e	.04	.08–e	.06	.06	.02
Source water blank	09-05-01	0802	.006–e	.027–e	.04	.08–e	.06	.06	.02

Table 4: Concentrations of major ions, nutrients, selected trace elements, and field parameters in surface-water samples collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[e, estimated; mi^2, square miles; µS/cm, microSiemens per centimeter at 25 degrees Celsius; —, no data; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; %, percent by weight; <, less than; ANC, acid neutralizing capacity; TIT 4.5, titration to pH 4.5; minimum reporting levels are in parentheses below constituent name]

Site number (fig. 1b)	Station number	Station name	Date	Time	Drainage area (mi^2)	Specific conductance filed (µS/cm)	Specific conductance lab (µS/cm)	pH water whole field (standard units)	pH water whole lab (standard units)
1	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	09-05-01	1620	5.9	9	10	4.3	5.7
2	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	09-05-01	0955	1.3	9	11	4.5	5.4
3	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	09-05-01	1750	2.8	11	14	4.9	5.7
4	332210082103901	South Prong tributary at Fort Gordon, Ga.	09-05-01	1430	—	8	11	4.5	5.4
5	332214082115101	South Prong near tributary at Fort Gordon, Ga.	09-05-01	1055	—	8	11	4.5	5.8
6	332227082120501	South Prong at headwaters at Fort Gordon, Ga.	09-04-01	1550	—	13	13	3.8	5.1
7	332442082115601	Marcum Branch at firing range at Fort Gordon, Ga.	09-06-01	1035	—	13	15	4.5	5.5
8	332116082122001	Marcum Branch at Range Road at Fort Gordon, Ga.	09-06-01	1135	—	26	23	4.0	5.6

Site number (fig. 1b)	Date	Temperature, water (°C)	Oxygen, dissolved (mg/L) (0.1)	Hardness, total (mg/L as Ca CO_3)	Calcium, dissolved (mg/L as Ca) (0.02)	Magnesium, dissolved (mg/L as Mg) (0.004)	Sodium, adsorption ratio	Sodium, dissolved (mg/L as Na) (0.1)	Sodium (%)	Potassium, dissolved (mg/L as K) (0.1)	ANC unfiltered TIT 4.5 lab (mg/L as $CaCO_3$) (1.0)	Sulfate, dissolved (mg/L as SO_4) (0.1)
1	09-05-01	20.7	6.5	1	0.22	0.192	0.3	0.8	55	0.13	2	0.6
2	09-05-01	23.3	4.6	1	.29	.177	.3	.8	53	.13	2	.5
3	09-05-01	25.2	5.5	2	.46	.267	.4	1.3	54	.17	3	.7
4	09-05-01	22.7	6.1	1	.17	.171	.3	.8	56	.18	2	.5
5	09-05-01	21.2	5.8	1	.27	.178	.3	.9	54	.12	2	.5
6	09-04-01	21.1	4.2	0	.16	.127	.3	.7	—	.06–e	<1	.4
7	09-06-01	23.2	2.1	2	.34	.275	.4	1.2	52	.27	2	.8
8	09-06-01	21.2	3.5	2	.38	.241	.5	1.7	64	.17	3	2.7

Table 4: Concentrations of major ions, nutrients, selected trace elements, and field parameters in surface-water samples collected within the small arms area, Fort Gordon, Georgia, September 4–6, 2001—Continued

Site number (fig. 1b)	Date	Chloride, dissolved (mg/L as Cl) (0.1)	Fluoride, dissolved (mg/L as F) (0.1)	Silica, dissolved (mg/L as SiO_2) (0.1)	Solids, dissolved (tons per acre-feet)	Solids, residue at 180°C, dissolved (mg/L) (10)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, nitrite, dissolved (mg/L as N) (0.01)	Nitrogen (NO_2+NO_3), dissolved (mg/L as N) (0.05)	Nitrogen, ammonia, dissolved (mg/L as N) (0.02)	Nitrogen, ammonia + organic, total (mg/L as N) (0.1)	Nitrogen,[a] total (mg/L as N)
1	09-05-01	1.6	<0.2	5.8	0.03	20	11	<0.006	0.027–e	<0.040	0.26	—
2	09-05-01	1.7	<.2	3.9	.02	14	9	<.006	.032–e	.028–e	.29	—
3	09-05-01	2	<.2	6.7	—	16	14	<.006	.053	.031–e	.2	0.26
4	09-05-01	1.3	<.2	7.6	.04	28	12	<.006	.036–e	.022–e	.22	—
5	09-05-01	1.6	<.2	4.6	.01	<10	10	<.006	.050	<.040	.17	.22
6	09-04-01	1.5	<.2	5.4	—	16	—	<.006	.034–e	.031–e	.64	—
7	09-06-01	1.9	<.2	5.9	.02	18	12	<.006	.030–e	.022–e	.34	—
8	09-06-01	2.8	<.2	9.5	.04	32	20	<.006	.039–e	.034–e	.23	—

Site number (fig. 1b)	Date	Phosphorus, total (mg/L as P) (0.05)	Phosphorus, dissolved (mg/L as P) (0.05)	Phosphorus, ortho, dissolved (mg/L as P) (0.01)	Carbon dioxide, dissolved (mg/L as CO_2)	Aluminum, dissolved (µg/L as Al) (1)	Barium, dissolved (µg/L as Ba) (1)	Cobalt, dissolved (µg/L as Co) (1)	Iron, dissolved (µg/L as Fe) (10)	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn) (1)	Molybdenum, dissolved (µg/L as Mo) (1)
1	09-05-01	<0.06	<0.06	<0.02	176	42	7.7	<13	110	<4	6.6	<50
2	09-05-01	<.06	<.06	<.02	125	40	11.2	<13	220	<4	13.6	<50
3	09-05-01	<.06	<.06	<.02	—	14–e	10.2	<13	308	<4	18	<50
4	09-05-01	<.06	<.06	<.02	115	56	7.3	<13	190	<4	6.3	<50
5	09-05-01	<.06	<.06	<.02	124	25	8.1	<13	110	<4	9.3	<50
6	09-04-01	.039–e	<.06	.017–e	—	91	7.3	<13	120	1.9–e	3.7	<50
7	09-06-01	<.06	<.06	<.02	149	28	11.5	<13	100	<4	13.7	<50
8	09-06-01	<.06	<.06	<.02	633	207	12.5	<13	410	<4	7.2	<50

Site number (fig. 1b)	Date	Nickel, dissolved (µg/L as Ni) (1)	Selenium, dissolved (µg/L as Se) (2)	Silver, dissolved (µg/L as Ag) (1)	Strontium, dissolved (µg/L as Sr) (1)	Vanadium, dissolved (µg/L as V) (10)
1	09-05-01	<2	<2	<0.2	2.86	<8
2	09-05-01	<2	<2	<.2	3.68	<8
3	09-05-01	<2	<2	<.2	4.02	<8
4	09-05-01	<2	<2	<.2	2.38	<8
5	09-05-01	<2	<2	<.2	2.86	<8
6	09-04-01	<2	<2	<.2	1.4	<8
7	09-06-01	<2	<2	<.2	3.71	<8
8	09-06-01	<2	<2	<.2	2.78	<8

a. Nitrogen total is a calculated value. Where concentrations of nitrogen are estimated, the total is not calculated.

Table 5: Concentrations of major ions, nutrients, selected trace elements, and field parameters in streambed-interstitial water samples collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[e, estimated; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; µS/cm, microSiemens per centimeter at 25 degrees Celsius; mi^2, square miles; —, no data; %, percent by weight; <, less than; ANC, acid neutralizing capacity; TIT 4.5, titration to pH 4.5; minimum reporting levels are in parentheses below constituent name]

Site number (fig. 1b)	Station number	Station name	Date	Time	Drainage area (mi^2)	Specific conductance filed (µS/cm)	Specific conductance lab (µS/cm)	pH water whole field (standard units)	pH water whole lab (standard units)
1	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	09-05-01	1615	5.9	18	16	4.7	5.3
2	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	09-05-01	1000	1.3	42	26	5.2	5.5
3	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	09-05-01	1745	2.8	32	15	5.8	5.5
4	332210082103901	South Prong tributary at Fort Gordon, Ga.	09-05-01	1445	—	13	16	4.8	5.3
5	332214082115101	South Prong near tributary at Fort Gordon, Ga.	09-05-01	1100	—	8	8	4.3	5.3
6	332227082120501	South Prong at headwaters at Fort Gordon, Ga.	09-04-01	1555	—	13	15	3.9	4.9
7	332442082115601	Marcum Branch at firing range at Fort Gordon, Ga.	09-06-01	1030	—	10	12	4.6	5.3
8	332116082122001	Marcum Branch at Range Road at Fort Gordon, Ga.	09-06-01	1130	—	50	23	5.5	4.9

Site number (fig. 1b)	Date	Temperature, water (°C)	Oxygen, dissolved (mg/L) (0.1)	Hardness, total (mg/L as Ca CO_3)	Calcium, dissolved (mg/L as Ca) (0.02)	Magnesium, dissolved (mg/L as Mg) (0.004)	Sodium, adsorption ratio	Sodium, dissolved (mg/L as Na) (0.1)	Sodium (%)	Potassium, dissolved (mg/L as K) (0.1)	ANC unfiltered TIT 4.5 lab (mg/L as $CaCO_3$) (1.0)	Sulfate, dissolved (mg/L as SO_4) (0.1)
1	09-05-01	26.6	<0.5	2	0.31	0.239	0.3	0.8	47	0.17	3	0.2
2	09-05-01	24.1	1.6	3	.65	.396	.3	1	37	.47	7	.2
3	09-05-01	23.6	10.5	2	.41	.126	.4	1	56	.19	4	.8
4	09-05-01	22.9	.7	2	.30	.212	.3	.9	52	.15	4	.2
5	09-05-01	20.7	3.1	0	.10	.131	.3	.6	60	.11	2	.5
6	09-04-01	22.6	.8	0	.08	.105	.4	.7	—	<.09	<1	.5
7	09-06-01	23.3	<.5	0	.14	.145	.3	.7	57	.11	2	.2
8	09-06-01	22.5	<.5	2	.45	.218	.5	1.5	58	.23	<1	.9

Table 5: Concentrations of major ions, nutrients, selected trace elements, and field parameters in streambed-interstitial water samples collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001—Continued

Site number (fig. 1b)	Date	Chloride, dissolved (mg/L as Cl) (0.1)	Fluoride, dissolved (mg/L as F) (0.1)	Silica, dissolved (mg/L as SiO_2) (0.1)	Solids, dissolved (tons per acre-feet)	Solids, residue at 180°C, dissolved (mg/L) (10)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, nitrite, dissolved (mg/L as N) (0.01)	Nitrogen (NO_2+NO_3), dissolved (mg/L as N) (0.05)	Nitrogen, ammonia, dissolved (mg/L as NH_4)	Nitrogen, ammonia, dissolved (mg/L as N) (0.02)	Nitrogen, ammonia + organic, total (mg/L as N) (0.1)
1	09-05-01	1.5	<0.2	6.2	0.02	18	15	<0.006	0.029–e	0.29	0.222	0.67
2	09-05-01	1.6	<.2	5.6	.07	50	24	<.006	.029–e	1.64	1.27	1.6
3	09-05-01	1.7	<.2	8.3	.04	26	23	<.006	.028–e	.48	.374	.52
4	09-05-01	1.4	<.2	8.5	.03	20	16	<.006	.027–e	.62	.483	.59
5	09-05-01	1.1	<.2	4.5	.01	<10	8	<.006	.068	—	<.040	<.08
6	09-04-01	1.5	<.2	5.6	—	24	—	<.006	.027–e	—	.038–e	.19
7	09-06-01	1.2	<.2	4.3	.01	10	9	<.006	.068	—	.028–e	.33
8	09-06-01	2.5	<.2	10	—	46	—	<.006	.029–e	.78	.609	1.1

Site number (fig. 1b)	Date	Nitrogen, organic, total (mg/L as N)	Nitrogen, total (mg/L as N)	Phosphate, ortho, dissolved (mg/L as PO_4)	Phosphorus, total (mg/L as P) (0.05)	Phosphorus, dissolved (mg/L as P) (0.05)	Phosphorus, ortho, dissolved (mg/L as P) (0.01)	Carbon dioxide, dissolved (mg/L as CO_2)	Aluminum, dissolved (µg/L as Al) (1)	Barium, dissolved (µg/L as Ba) (1)	Cobalt, dissolved (µg/L as Co) (1)	Iron, dissolved (µg/L as Fe) (10)
1	09-05-01	0.45	—	—	0.045–e	<0.06	<0.02	117	79	10.6	<13	3,370
2	09-05-01	.34	—	0.055	<.06	<.06	.018	83	208	19.1	9.26–e	8,220
3	09-05-01	.14	—	.11	.041–e	.034–e	.036	13	31	7.6	<13	7,840
4	09-05-01	.11	—	—	<.06	.03–e	.016–e	119	94	10.8	<13	1,110
5	09-05-01	—	—	—	<.06	<.06	<.02	168	13–e	3.6	<13	<10
6	09-04-01	—	—	—	<.06	<.06	.013–e	—	99	8.1	<13	170
7	09-06-01	—	0.39	—	.065	<.06	<.02	90	56	7.6	<13	360
8	09-06-01	.44	—	.055	.149	<.06	.018	—	107	9.8	10.9–e	11,200

Site number (fig. 1b)	Date	Lithium, dissolved (µg/L as Li)	Manganese, dissolved (µg/L as Mn) (1)	Molybdenum, dissolved (µg/L as Mo) (1)	Nickel, dissolved (µg/L as Ni) (1)	Selenium, dissolved (µg/L as Se) (2)	Silver, dissolved (µg/L as Ag) (1)	Strontium, dissolved (µg/L as Sr) (1)	Vanadium, dissolved (µg/L as V) (10)
1	09-05-01	<4	13	<50	<2	<2	<0.2	3.73	<8
2	09-05-01	<4	55.8	<50	<2	<2	<.2	7.66	<8
3	09-05-01	<4	19.8	<50	<2	<2	<.2	3.3	<8
4	09-05-01	<4	9.7	<50	<2	<2	<.2	3.33	<8
5	09-05-01	<4	<3	<50	<2	<2	<.2	.97	<8
6	09-04-01	<4	3–e	<50	<2	<2	<.2	1.11	<8
7	09-06-01	<4	2.4–e	<50	<2	<2	<.2	1.5	<8
8	09-06-01	<4	37.3	<50	<2	<2	<.2	3.39	<8

Table 6: Concentrations of major ions, selected trace elements, and total organic carbon in the less than 63-micrometer fraction of bed-sediment samples collected within the small arms impact area, Fort Gordon, Georgia, September 4–6, 2001

[mg/kg, milligrams per kilogram;%, percent (1%=10,000 mg/kg); bold, elevated relative to previous concentrations; <, less than; TOC, total organic carbon; minimum reporting levels are in parentheses below constituent name]

Site number (fig. 1b)	Station number	Station name	Date	Time	Phosphorus (mg/kg) (10)	Aluminum (%) (0.1)	Antimony (mg/kg) (0.1)
1	02197023	South Prong Creek above Ellis Pond at Fort Gordon, Ga.	09-05-01	1620	540	12	0.5
2	02197022	South Prong Creek near headwaters at Fort Gordon, Ga.	09-05-01	1000	770	8.7	.8
3	021970135	Marcum Branch at Maxwell Lake at Fort Gordon, Ga.	09-05-01	1750	920	9.9	5.9
4	332210082103901	South Prong tributary at Fort Gordon, Ga.	09-05-01	1445	650	6.7	.5
5	332214082115101	South Prong near tributary at Fort Gordon, Ga.	09-05-01	1100	740	7.8	.5
6	332227082120501	South Prong at headwaters at Fort Gordon, Ga.	09-04-01	1550	720	4.4	.4
7	332442082115601	Marcum Branch at firing range at Fort Gordon, Ga.	09-06-01	1035	530	8.1	3.4
8	332116082122001	Marcum Branch at Range Road at Fort Gordon, Ga.	09-06-01	1135	840	8.9	.9

Site number (fig. 1b)	Date	Arsenic (mg/kg) (0.1)	Barium (mg/kg) (1)	Beryllium (mg/kg) (0.1)	Cadmium (mg/kg) (0.1)	Chromium (mg/kg) (1)	Cobalt (mg/kg) (1)	Copper (mg/kg) (1)	Iron (%) (0.1)	Lead (mg/kg) (1)	Lithium (mg/kg) (10)	Manganese (mg/kg) (10)	Mercury (mg/kg) (0.01)
1	09-05-01	3.2	**320**	**1.9**	**0.2**	**91**	**4**	12	0.9	45	27	66	0.08
2	09-05-01	4.3	**310**	**1.3**	**.2**	**86**	4	**72**	1.1	240	23	100	.17
3	09-05-01	13	390	**1.7**	.5	100	5	**59**	4.3	250	26	130	.29
4	09-05-01	2.1	360	1.3	.1	62	4	21	.8	49	13	90	.29
5	09-05-01	5.1	**330**	**1.4**	.1	**83**	3	16	**1.7**	49	17	110	.12
6	09-04-01	1.1	210	**1.2**	**.2**	45	2	**75**	.4	150	7	56	.14
7	09-06-01	2	270	1.4	.1	56	4	**110**	.5	640	19	75	.34
8	09-06-01	8.9	360	1.5	.3	85	4	21	3.4	43	21	160	.06

Site number (fig. 1b)	Date	Molybdenum (mg/kg) (1)	Nickel (mg/kg) (1)	Selenium (mg/kg) (0.1)	Silver (mg/kg) (0.5)	Strontium (mg/kg) (1)	Thallium (mg/kg) (50)	Tin (mg/kg) (0.1)	Titanium (%) (0.01)	Uranium (mg/kg) (50)	Vanadium (mg/kg) (1)	Zinc (mg/kg) (1)	TOC (%) (0.1)
1	09-05-01	2	**17**	0.7	<0.5	81	<50	3.8	0.79	<50	**95**	39	5.9
2	09-05-01	2	12	1.2	<.5	98	<50	4.3	.82	<50	**91**	37	**9.9**
3	09-05-01	4	17	**2.8**	.5	89	<50	8.3	.98	<50	120	110	7.3
4	09-05-01	2	13	2.8	<.5	110	<50	2.9	.90	<50	71	34	10
5	09-05-01	2	12	**4.1**	<.5	120	<50	6.8	.75	<50	**91**	32	**10**
6	09-04-01	<1	9	**2.6**	<.5	54	<50	2.6	.35	<50	32	21	**22**
7	09-06-01	1	12	**4.7**	<.5	57	<50	3.6	.63	<50	56	35	**16**
8	09-06-01	3	22	**2**	<.5	130	<50	4.5	.84	<50	120	56	4.3

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