

LEVEL ONE WATER-QUALITY INVENTORY AND MONITORING

GEORGE WASHINGTON BIRTHPLACE NATIONAL MONUMENT (GEWA), VIRGINIA



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INTRODUCTION

The U.S. Geological Survey conducted a Level 1 Water-Quality Inventory and Monitoring (WAQIM) data-collection effort for George Washington Birthplace National Monument (GEWA) from October 1998 through June 1999. The primary objective of the WAQIM program was to provide the National Park Service (NPS) and GEWA with at least a nominal inventory of its natural resources and to provide those data in a data-management system consistent with park management needs. Water-quality inventory data (physical, chemical, and biological) were collected from “key” water bodies within the boundaries of GEWA. The key water bodies are those waters within park boundaries that are essential to the central cultural, historical or natural resources management themes of the parks or provide habitats to threatened or endangered plants and animals. Data were collected during the fall, winter, spring, and summer over a range of hydrologic conditions. Because of the drought conditions that persisted during the study period, variations in flow between seasons were less pronounced than during normal hydrologic conditions.

George Washington Birthplace National Monument is a 550-acre unit of the National Park System along the tidal portion of the Potomac River in Westmoreland County, Virginia. While the primary purpose of the park is the preservation of the historic setting, the park contains significant water-related resources including tidal estuaries that support extensive wetlands, freshwater wetlands, and a number of small streams, ponds, and springs. Many of these water-related resources are closely linked with the cultural and historic context of the site. The combined drainage basin area of the three-subbasin area within which the park is found is approximately 13,500 acres, of which the park, at 550 acres, comprises less than 5 percent. Although the area is rural and not heavily populated, the proximity of the park to the Washington, DC metropolitan area is expected to cause increased future developmental pressures, as roads are improved and sewer lines installed. GEWA and adjacent farms have been aggressively farmed in the past, and the surrounding area continues to be used for pastureland, cropland, and logging. As one of the earliest historic National Parks, farming at GEWA has been controlled, and recent and historic land use have been relatively well-documented.

Potential threats to water-quality in the park include: (1) encroaching development (primarily outside of the immediate area of the park) and (2) agricultural activities. Data-collection sites and the parameters analyzed were selected based on the spatial distribution of land-use activities inside and immediately outside of the park’s boundaries and the nature of the potential threats to park water-quality.

DESCRIPTION OF INVENTORY PROCESS

Site Descriptions

The water-quality inventory for GEWA included the periodic collection of physical, chemical, and microbiological data from two sites on Popes Creek, one site on Bridges Creek, and one spring (fig. 1). These sites are: (1) Popes Creek at Point of Point near

Wakefield, Va (0166087750), (2) Popes Creek at Burnt House Point near Wakefield, Va (0166087760), (3) Bridges Creek at Mouth near Wakefield, Va (01660860), (4) Dancing Marsh near Wakefield, Va (0166087770), and (5) Spring at Dancing Marsh near Wakefield, Va - 55PS1 (381108076551101). Data-collection plans had originally targeted Digwood Swamp Creek for sampling, but due to drought conditions that persisted though the study, the site remained dry and no samples were collected.

Popes Creek at Point of Point near Wakefield, Va (0166087750) is located approximately 0.5 miles upstream from the south boundary of GEWA and 1.5 miles upstream from the Potomac River. The site is tidally influenced. Stream width is approximately 200 feet. Surrounding areas include woodlands, wetlands, and pasture. Access is via boat. Popes Creek at Burnt House Point near Wakefield, Va (0166087760) is located immediately adjacent to the southeastern boundary of GEWA and is approximately 0.75 miles upstream from the Potomac River. The site is tidally influenced. Stream width is approximately 2,000 feet. Surrounding areas include woodlands, wetlands, and pasture. Access is via boat. Bridges Creek at Mouth near Wakefield, Va (01660860) is located at the extreme northwest corner of the park. The site is immediately upstream from the Potomac River and is tidally influenced—a high sand beach can isolate exchange between the creek and river except during periods of high tide. The creek's headwaters are located outside the park boundaries. Stream width is typically less than 20 feet. The surrounding area includes woodlands and wetlands. Access is via a GEWA tour road. Dancing Marsh near Wakefield, Va (0166087770) is located in the southern end of GEWA and is approximately 1,000 feet upstream from Popes Creek. The site is tidally influenced. The headwaters of the creek are located outside and to the west of GEWA. Stream width is typically less than 10 feet. Surrounding area includes woodlands, wetlands, and pasture. The site is immediately downstream from a footbridge. Access is via footpath behind a private residence (park staff). Spring at Dancing Marsh near Wakefield, Va - 55PS1 (381108076551101) is located at the base of a terrace in GEWA approximately 200 feet upstream from site 0166087770. The surrounding area includes woodlands, wetlands, and pasture.

Description of Data Collection

Data-collection activities were conducted in October and December 1998 and in February and June 1999 (table 1). Data-collection and analysis were conducted according to standard USGS protocols (U.S. Geological Survey, 1997, 1998, 1999; Rantz and others, 1982). Stream water-quality samples were collected as point samples or cross-sectional depth-integrated samples, depending on streamflow conditions. Discharge, water temperature, pH, specific conductivity, dissolved oxygen, and alkalinity were measured at every site on every visit. Water samples were collected and analyzed for nutrients and bacteria at every site on every visit. Samples were collected and analyzed for major ion and trace element analysis on one visit.

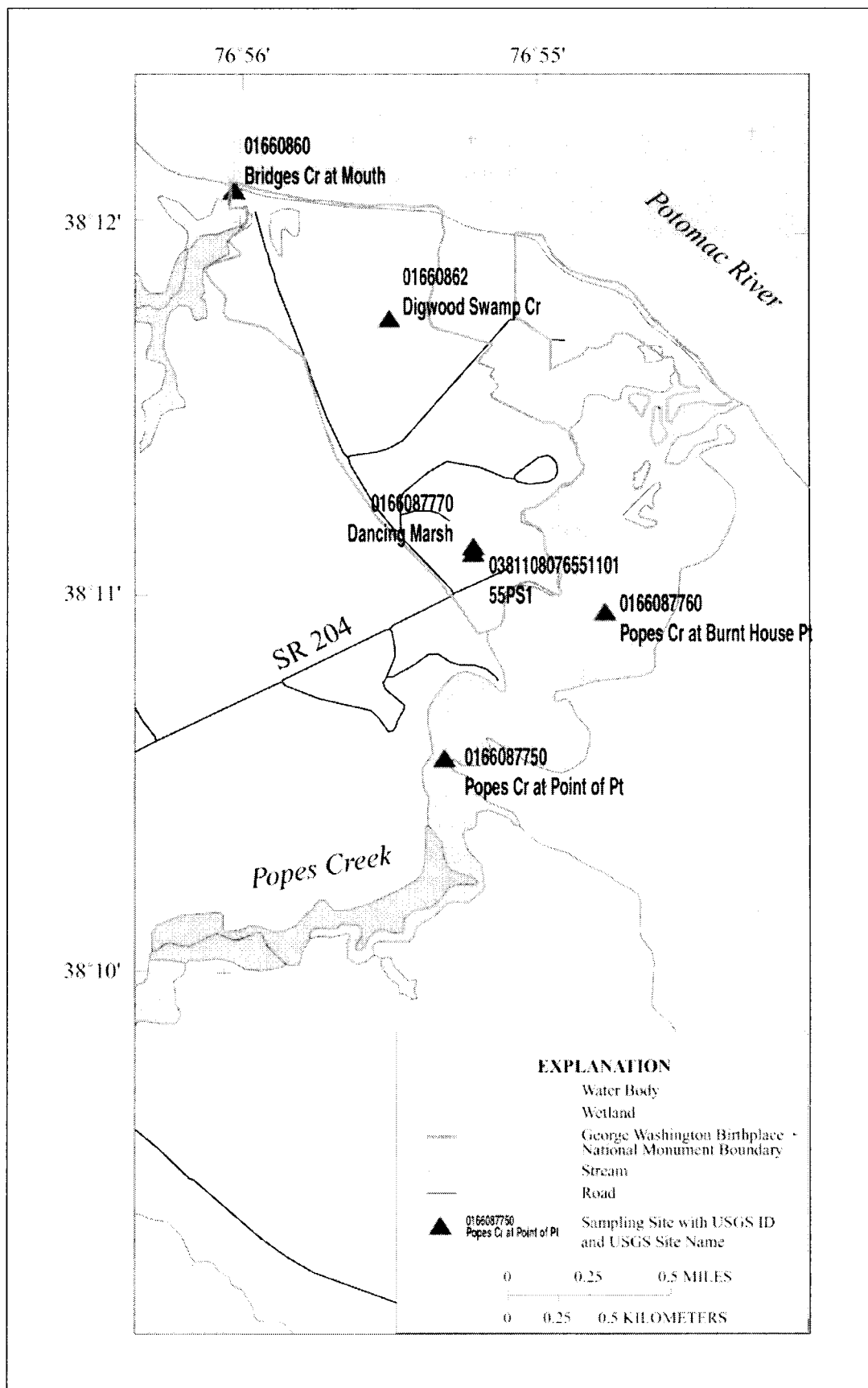


Figure 1. Location of study area and data-collection sites.

Table 1. Data-collection schedule

Parameter	Data-collection period			
	October 1998	December 1998	February 1999	June 1999
Field parameters	X	X	X	X
Fecal bacteria	X	X	X	X
Nutrients	X	X	X	X
Major Ions	X		X	
Trace elements				X

PRINCIPAL INVESTIGATORS

The principal investigators of the WAQIM program included staff of the U.S. Geological Survey (USGS), Water Resources Division (WRD) district office in Richmond, Virginia. Michael E. Lewis, Supervisory Hydrologist, supervised all work. J. Michael Gearheart, Hydrologic Technician, implemented all fieldwork. All water-quality samples collected as part of the inventory, with the exception of bacteriological samples, were submitted for analysis to the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado. Bacteriological samples were processed by field personnel at each site and analyzed in the Richmond, Virginia office of the USGS.

WATER-QUALITY RESULTS

Tables 2-6 provide all physical, microbiological, and chemical data collected as part of the GEWA WAQIM project. Four additional files of supporting documentation are included as attachments to this report:

- (1) "GEWA ATTACHMENT 1 SITES.XLS";
- (2) "GEWA ATTACHMENT 2 PARMS.DOC";
- (3) "GEWA ATTACHMENT 3 DATA.XLS", and
- (4) "README.DOC"

"GEWA Attachment 1 sites.xls" is a Microsoft Excel file that contains specific location information for each site where water-quality data were collected. "GEWA Attachment 2 parms.doc" is a Microsoft Word file that explicitly defines each water-quality parameter included in the tables of this report and also in the water-quality data spreadsheet.

"GEWA Attachment 3 data.xls" is a Microsoft Excel spreadsheet that contains all water-quality data collected during this study. "Readme.doc" is a Microsoft Word file that contains basic information related to the project, such as contact information for those who conducted the work and analyzed the samples

Table 2. Field parameter data

[ft³/s, cubic feet per second; °C, degrees Celsius; uS/cm, microsiemens per centimeter at 25 °C;
mg/L, milligrams per liter; mg/L as CaCO₃, milligrams per liter as calcium carbonate; <, less than;
e, estimated value; --, no data]

Date	Time	Discharge (ft ³ /s)	Water temperature (°C)	pH (units)	Specific conductance (uS/cm)	Dissolved oxygen (mg/L)	Alkalinity (mg/L as CaCO ₃)
Popes Creek at Point of Point near Wakefield, VA (0166087750)							
Oct 07, 1998	11:00	--	18.4	7.4	17,100	6.0	84
Dec 16, 1998	12:15	--	6.7	7.3	18,800	9.4	61
Feb 02, 1999	09:20	--	6.1	7.2	15,000	10.8	48
Jun 14, 1999	11:45	--	26.8	7.4	15,700	--	66
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)							
Oct 07, 1998	08:05	--	18.8	7.1	17,400	7.0	83
Dec 16, 1998	09:00	--	6.7	7.4	20,000	7.5	56
Feb 02, 1999	08:30	--	5.9	7.4	16,800	11.4	67
Jun 14, 1999	10:30	--	25.1	7.8	14,300	--	68
Bridges Creek at Mouth near Wakefield, VA (01660860)							
Oct 06, 1998	12:00	0	--	--	--	--	--
Dec 15, 1998	10:00	0	5.8	7.4	1,210	9.1	159
Feb 03, 1999	08:20	2.9	6.2	6.9	4,000	5.0	109
Jun 15, 1999	09:35	4.95	23.0	6.6	16,300	2.5	89
Dancing Marsh near Wakefield, VA (0166087770)							
Oct 06, 1998	13:00	0.07	18.7	6.8	655	9.3	26
Dec 15, 1998	13:00	.063	7.4	7.1	2,050	9.9	60
Feb 03, 1999	10:45	0.17	8.0	6.7	550	10.6	13
Jun 15, 1999	10:45	0.046	21.4	6.5	3,000	4.7	39
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)							
Oct 06, 1998	11:00	0.05	17.0	6.6	311	8.7	65
Dec 15, 1998	14:40	<0.01e	11.0	--	296	--	--
Feb 03, 1999	12:30	0.00	12.6	6.5	240	3.2	44
Jun 15, 1999	13:30	0.002	16.5	6.5	220	2.5	36

Table 3. Bacteria data.

[col/100 ml; colonies per 100 milliliters; >, greater than;

K, non-ideal colony count; --, no data, *, exceeds State water quality standard]

Date	Time	Total coliform (col/100 ml)	Fecal coliform (col/100 ml)	Fecal streptococcus (col/100 ml)
Popes Creek at Point of Point near Wakefield, VA (0166087750)				
Oct 07, 1998	11:00	>1,300	1,100 *	580
Dec 16, 1998	12:15	180	67K	94K
Feb 02, 1999	09:20	>250	200	220
Jun 14, 1999	11:45	500	260	100
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)				
Oct 07, 1998	08:05	310	150K	170
Dec 16, 1998	09:00	160K	76K	97K
Feb 02, 1999	08:30	100K	20K	67K
Jun 14, 1999	10:30	300	130	16K
Bridges Creek at Mouth near Wakefield, VA (01660860)				
Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	4,000	2,700 *	1,800
Feb 03, 1999	08:20	1,700	660	740
Jun 15, 1999	09:35	1,500	1,080 *	1,440
Dancing Marsh near Wakefield, VA (0166087770)				
Oct 06, 1998	13:00	2,800	1,200 *	1,300
Dec 15, 1998	13:00	380	200	460
Feb 03, 1999	10:45	310	73K	170K
Jun 15, 1999	10:45	10,455	2,200 *	4,600
Spring at Dancing Marsh near Wakefield, VA -55PS1 (381108076551101)				
Oct 06, 1998	11:00	>10,000	>10,000 *	>10,000
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	>10,000	>10,000 *	>10,000
Jun 15, 1999	13:30	310	26K	64K

Table 4. Nutrient data

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous;

< less than; --, no data]

Date	Time	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, nitrate + nitrite, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + organic, total (mg/L as N)	Nitrogen, ammonia + organic, dissolved (mg/L as N)
Popes Creek at Point of Point near Wakefield, VA (0166087750)						
Oct 07, 1998	11:00	<0.01	0.05	0.03	0.6	0.3
Dec 16, 1998	12:15	<0.01	0.06	0.03	0.4	0.3
Feb 02, 1999	09:20	0.01	0.22	0.09	0.5	0.3
Jun 14, 1999	11:45	<0.01	<0.05	<0.02	0.8	0.1
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)						
Oct 07, 1998	08:05	<0.01	<0.05	0.02	1	0.3
Dec 16, 1998	09:00	0.01	0.05	0.03	0.5	0.3
Feb 02, 1999	08:30	0.01	0.36	0.12	0.5	0.4
Jun 14, 1999	10:30	<0.01	<0.05	<0.02	0.7	0.2
Bridges Creek at Mouth near Wakefield, VA (01660860)						
Oct 06, 1998	12:00	--	--	--	--	--
Dec 15, 1998	10:00	0.01	0.05	0.04	2.6	1.3
Feb 03, 1999	08:20	0.01	0.12	0.56	2.2	1.5
Jun 15, 1999	09:35	<0.01	<0.05	<0.02	0.8	0.4
Dancing Marsh near Wakefield, VA (0166087770)						
Oct 06, 1998	13:00	<0.01	0.39	0.18	0.8	0.4
Dec 15, 1998	13:00	0.01	0.07	0.07	0.6	0.4
Feb 03, 1999	10:45	0.01	0.32	0.06	0.5	0.4
Jun 15, 1999	10:45	<0.01	<0.05	<0.02	1.1	1.1
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)						
Oct 06, 1998	11:00	0.04	4.9	0.03	0.7	0.2
Dec 15, 1998	14:40	--	--	--	--	--
Feb 03, 1999	12:30	0.01	3	0.03	0.6	0.2
Jun 15, 1999	13:30	--	--	--	--	--

Table 4. Nutrient data--Continued.

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous;

< less than; e, estimated value; --, no data]

Date	Time	Phosphorus, total (mg/L as P)	Phosphorus, dissolved (mg/L as P)	Orthophosphate, dissolved (mg/L as P)
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Popes Creek at Point of Point near Wakefield, VA (0166087750)

Oct 07, 1998	11:00	0.09	<0.05	0.03
Dec 16, 1998	12:15	0.04e	<0.05	0.01
Feb 02, 1999	09:20	0.034	0.011	0.01
Jun 14, 1999	11:45	0.097	0.012	0.01

Popes Creek at Burnt House Point near Wakefield, VA (0166087760)

Oct 07, 1998	08:05	0.17	0.03e	0.03
Dec 16, 1998	09:00	0.05	<0.05	0.01
Feb 02, 1999	08:30	0.028	0.012	<0.01
Jun 14, 1999	10:30	0.076	0.011	0.01

Bridges Creek at Mouth near Wakefield, VA (01660860)

Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	1.4	0.85	0.78
Feb 03, 1999	08:20	0.69	0.56	0.51
Jun 15, 1999	09:35	0.19	0.13	0.01

Dancing Marsh near Wakefield, VA (0166087770)

Oct 06, 1998	13:00	0.10	0.05e	0.05
Dec 15, 1998	13:00	0.06	0.04e	0.02
Feb 03, 1999	10:45	0.045	0.021	0.02
Jun 15, 1999	10:45	0.18	0.091	0.01

**Spring at Dancing Marsh near Wakefield, VA - 55PS1
(381108076551101)**

Oct 06, 1998	11:00	0.09	<0.05	0.04
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	0.06	0.02	0.02
Jun 15, 1999	13:30	--	--	--

Table 5. Major-element data.

[mg/l, milligrams per liter, <, less than; --, no data]

Date	Time	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity (mg/L as CaCO ₃)	Sulfate, dissolved (mg/L as SO ₄)
Popes Creek at Point of Point near Wakefield, VA (0166087750)							
Oct 07, 1998	11:00	130	370	3,100	110	78	720
Dec 16, 1998	12:15	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--
Jun 14, 1999	11:45	--	--	--	--	--	--
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)							
Oct 07, 1998	08:05	130	380	3,100	110	76	740
Dec 16, 1998	09:00	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--
Jun 14, 1999	10:30	--	--	--	--	--	--
Bridges Creek at Mouth near Wakefield, VA (01660860)							
Oct 06, 1998	12:00	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--
Feb 03, 1999	08:20	37	76	620	26	49	150
Jun 15, 1999	09:35	--	--	--	--	--	--
Dancing Marsh near Wakefield, VA (0166087770)							
Oct 06, 1998	13:00	11	16	120	5.5	29	23
Dec 15, 1998	13:00	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--
Jun 15, 1999	10:45	--	--	--	--	--	--
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)							
Oct 06, 1998	11:00	42	3.1	11	1.2	65	22
Dec 15, 1998	14:40	--	--	--	--	--	--
Feb 03, 1999	12:30	33	2.6	8.1	1.0	54	22
Jun 15, 1999	13:30	--	--	--	--	--	--

Table 5. Major-element data--Continued.
[mg/l, milligrams per liter, <, less than; --no data]

Date	Time	Chloride, dissolved (mg/l as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO ₂)
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Popes Creek at Point of Point near Wakefield, VA (0166087750)

Oct 07, 1998	11:00	5,500	0.5	3.9
Dec 16, 1998	12:15	--	--	--
Feb 02, 1999	09:20	--	--	--
Jun 14, 1999	11:45	--	--	--

Popes Creek at Burnt House Point near Wakefield, VA (0166087760)

Oct 07, 1998	08:05	5,500	0.5	4.1
Dec 16, 1998	09:00	--	--	--
Feb 02, 1999	08:30	--	--	--
Jun 14, 1999	10:30	--	--	--

Bridges Creek at Mouth near Wakefield, VA (01660860)

Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	--	--	--
Feb 03, 1999	08:20	1,100	0.2	13
Jun 15, 1999	09:35	--	--	--

Dancing Marsh near Wakefield, VA (0166087770)

Oct 06, 1998	13:00	220	<0.1	11
Dec 15, 1998	13:00	--	--	--
Feb 03, 1999	10:45	--	--	--
Jun 15, 1999	10:45	--	--	--

Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)

Oct 06, 1998	11:00	25	<0.1	13
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	20	<0.1	14
Jun 15, 1999	13:30	--	--	--

Table 6. Trace-element data.

[ug/L, micrograms per liter; <, less than; --, no data]

Date	Time	Aluminum, total (ug/L as Al)	Arsenic, total (ug/L as As)	Barium, total (ug/L as Ba)	Beryllium, total (ug/L as Be)	Cadmium, total (ug/L as Cd)	Chromium, total (ug/L as Cr)	Cobalt, total (ug/L as Co)	Copper, total (ug/L as Cu)	Iron, total (ug/L as Fe)
Popes Creek at Point of Point near Wakefield, VA (0166087750)										
Oct 07, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 16, 1998	12:15	--	--	--	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--	--	--	--
Jun 14, 1999	11:45	502	<1	60.1	<20.0	<4	<1.0	<4	10	1,390
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)										
Oct 07, 1998	08:05	--	--	--	--	--	--	--	--	--
Dec 16, 1998	09:00	--	--	--	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--	--	--	--
Jun 14, 1999	10:30	322	<1	51.7	<20.0	<4	<1.0	<4	5	766
Bridges Creek at Mouth near Wakefield, VA (01660860)										
Oct 06, 1998	12:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	08:20	--	--	--	--	--	--	--	--	--
Jun 15, 1999	09:35	<140	1	72.5	<20.0	<4	<1.0	<4	<4	651
Dancing Marsh near Wakefield, VA (0166087770)										
Oct 06, 1998	13:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	13:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--	--	--	--
Jun 15, 1999	10:45	99.8	<1	51.7	<4.0	<1	<1.0	<1	<1	2,230
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)										
Oct 06, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	14:40	--	--	--	--	--	--	--	--	--
Feb 03, 1999	12:30	--	--	--	--	--	--	--	--	--
Jun 15, 1999	13:30	113	<1	12.6	<4.0	<1	<1.0	<1	5	152

Table 6. Trace-element data—Continued.

[ug/L, micrograms per liter; <, less than; e, estimated value; --, no data,

*, minimum reporting limit is above chronic toxicity standard]

Date	Time	Lead, total (ug/L as Pb)	Lithium, total (ug/L as Li)	Manganese total (ug/L as Mn)	Mercury, total (ug/L as Hg)	Molyb- denum, total (ug/L as Mo)	Nickel, total (ug/L as Ni)	Selenium, total (ug/L as Se)	Silver, total (ug/L as Ag)	Zinc, total (ug/L as Zn)
Popes Creek at Point of Point near Wakefield, VA (0166087750)										
Oct 07, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 16, 1998	12:15	--	--	--	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--	--	--	--
Jun 14, 1999	11:45	<4	41.9e	94.6	<0.1 *	4.0	<4	<1	<4	<200
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)										
Oct 07, 1998	08:05	--	--	--	--	--	--	--	--	--
Dec 16, 1998	09:00	--	--	--	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--	--	--	--
Jun 14, 1999	10:30	<4	60.5	37.5	<0.1 *	4.0	<4	<1	<4	<200
Bridges Creek at Mouth near Wakefield, VA (01660860)										
Oct 06, 1998	12:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	08:20	--	--	--	--	--	--	--	--	--
Jun 15, 1999	09:35	<4	54.9e	295	<0.1 *	4.0	<4	<1	<4	<200
Dancing Marsh near Wakefield, VA (0166087770)										
Oct 06, 1998	13:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	13:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--	--	--	--
Jun 15, 1999	10:45	<1	6.2e	219	<0.1 *	<1.0	<1	<1	<1	<40
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)										
Oct 06, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	14:40	--	--	--	--	--	--	--	--	--
Feb 03, 1999	12:30	--	--	--	--	--	--	--	--	--
Jun 15, 1999	13:30	<1	<12	3.6	<0.1 *	<1.0	3	<1	<1	<40

GENERAL CLIMATIC AND HYDROLOGIC CONDITIONS

The period of study occurred within the 1999 water year, October 1, 1998, through September 30, 1999. Published statistics (White and others, 1998, 1999) show that across Virginia low streamflows in the summer of 1998 continued to decrease during the autumn to levels below the normal range for that time of year. Normal precipitation in the winter of 1999 generally increased streamflows to levels in the normal range, but below median monthly flow. In the spring and summer of 1999, streamflows continued to decline to levels comparable to the four most severe drought periods since the early 1900's: the droughts of 1930-32, 1938-42, 1962-71, and 1980-82.

Analysis of streamflow records provided by the Virginia Department of Environmental Quality for an indicator gage located near the GEWA study area shows that for Cat Point Creek near Montross, Va., the annual mean streamflow for water year 1999 is 57 percent of the 56-year annual mean. Drought conditions at the gage were somewhat relieved in mid-September by precipitation from Hurricane Floyd, but were unaffected by an earlier storm, Hurricane Dennis. Gage records for Cat Point Creek (01668500) beginning in 1944 show that drought conditions in water year 1999 were comparable to the droughts of 1962-71 and 1980-82.

EXCEEDENCES OF STATE WATER-QUALITY STANDARDS

In the GEWA study area, all water-quality measurements are within the surface water standards established by the Virginia State Water Control Board (1997), except as noted below.

Fecal coliform: Of 20 measurements of fecal coliform bacteria made in the study area, 7 measurements exceeded the standard of 1,000 bacteria per 100 milliliters (ml.). Bacteria counts of 2,700 bacteria per 100 ml. and 1,080 bacteria per 100 ml. were measured at station 01660860 (Bridges Creek) on December 15, 1998, and June 15, 1999, respectively. Counts of 1,188 bacteria per 100 ml. and 2,200 bacteria per 100 ml. were measured at station 0166087770 (Dancing Marsh) on October 6, 1998 and June 15, 1999, respectively. Counts greater than 10,000 bacteria per 100 ml. were measured at station 381108076551101 (Spring at Dancing Marsh) on October 6, 1998 and also on February 3, 1999. One count of 1,125 bacteria per 100 ml. was measured at station 0166087750 (Popes Creek) on October 7, 1998.

Dissolved oxygen: Of 20 measurements of dissolved oxygen concentration made in the study area, 3 measurements are less than the minimum standard of 4.0 milligrams per liter (mg/L) for tidal waters in the coastal zone east of the Fall Line. Dissolved oxygen concentrations of 3.17 mg/L and 2.48 mg/L were measured at station 381108076551101 (Spring at Dancing Marsh) on February 3, 1999 and June 15, 1999, respectively; and a dissolved oxygen concentration of 2.53 mg/L was measured at station 01660860 (Bridges Creek) on June 15, 1999.

Mercury: Of 5 measurements of total mercury concentration made in the study area, 5 are reported as less than 0.1 micrograms per liter (ug/L), the minimum reporting level. The most restrictive standard limiting mercury concentration is the chronic toxicity limit for saltwater aquatic life, 0.025 ug/L. No inferences can be made about exceedence of this standard because the analytical determination is not meaningful in this concentration range. None of the samples, however, exceeded the acute toxicity limit for saltwater aquatic life, 2.1 ug/L.

Zinc: Of 5 measurements of total zinc concentration made in the study area, 3 measurements may have exceeded both the chronic and the acute toxicity standards for saltwater aquatic life: 86 ug/L and 95 ug/L, respectively. Total zinc concentrations for three stations are reported as less than 200 ug/L, with a minimum reporting limit of 40 ug/L for station: 0166087750 (Popes Creek at Point of Point), station 0166087760 (Popes Creek at Burnt House Point), both collected on June 14, 1999, and station 01660860 (Bridges Creek) collected on June 15, 1999.

Organic ammonia: Of 17 measurements of total ammonia plus organic nitrogen made in the study area, 2 measurements at station 01660860 (Bridges Creek) are unusually high: 2.62 mg/L on December 15, 1998, and 2.16 mg/L on February 3, 1999. Both concentrations are below the chronic and acute toxicity standards for saltwater, about 77 mg/L and

79 mg/L, respectively, but both values approach the chronic toxicity standard for freshwater, 2.82 mg/L. Specific conductances of 1,211 microsiemens per centimeter (uS/cm) and 4,000 uS/cm, respectively, indicate a brackish water system.

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- Virginia State Water Control Board, 1997, Surface water standards with general, statewide application: Code of Virginia, 9 VAC 25-260-5 et seq. Water Quality Standards.
- White, R.K., Hayes, D.C., Eckenwiler, M.R., and Herman, P.E., 1998, Water resources data, Virginia, water year 1998: U.S. Geological Survey Water-Data Report VA-98-1, 577 p.
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TABLE 1. SITES AT GEWA

Station Name	Station ID	Station Type	Description	Purpose	Latitude	Longitude	Method of Determining Lat/Long
Bridges Creek at Mouth nr Wakefield, VA	01660860	Stream	Station is in GEWA. Stream width is typically less than 20 feet. Surrounding area includes beach at mouth to Potomac River, lightly wooded banks, and upstream swamp land. Access is via GEWA tour road, approximately 1.25 miles NNW of park entrance. Station is less than 50 feet above Potomac River and is influenced by tides.	Station is monitored as it is one of the park's key water bodies.	38°12'05"	76°56'01"	Manual map interpolation
Dancing Marsh nr Wakefield, VA	0166087770	Stream	Station is in GEWA. Stream width is typically less than 10 feet. Surrounding area includes swamp edged by woodland and upgradient pasture. Foot bridge passes near station. Access is via Private Residence and 600 feet streamward on trail. Station is approximately 1000 feet above Popes Creek and is influenced by tides.	Station is monitored as it is one of the park's key water bodies.	38°11'09"	76°55'11"	Manual map interpolation GPS
Spring at Dancing Marsh nr Wakefield, VA	0381108076 551101	Spring	Station is in GEWA. Surrounding area includes swamp edged by woodland and upgradient pasture. Access is via Private Residence and approximately 200 feet upstream of foot bridge at Dancing Marsh. Station is approximately 1100 feet above Popes Creek.	Station is monitored as a contributor to one of the park's key water bodies.	38°11'08"	76°55'11"	Manual map interpolation GPS

TABLE 1. SITES AT GEWA

Map Scale	Referenced Datum	State	County	HUC	Elevation	Elevation Source	Elevation Datum	Secondary Name(s)
					feet			
1:24000	NAD1927	Virginia	Westmoreland	02070011	1	Topographic map	Gage	
1:24000 Rockwell	NAD1927	Virginia	Westmoreland	02070011	5	Topographic map GPS	Gage	
1:24000 Rockwell	NAD1927	Virginia	Westmoreland	02070011	5	Topographic map GPS	Gage	55PS1

TABLE 1. SITES AT GEWA

Popes Creek at Burnt House Point nr Wakefield, VA	0166087760	Stream	Station is in GEWA. Stream width is approximately 2000 feet. Surrounding areas include woodland, swamp, and pasture. Access is via canoe. Location is approximately 0.25 miles downstream from Visitor Center and 0.75 miles upstream from Potomac River. Station is influenced by tides.	Station is monitored as it is one of the park's key water bodies.	38°10'59"	76°54'44"	Manual map interpolation
Popes Creek at Point of Point nr Wakefield, VA	166087750	Stream	Station is in GEWA. Stream width is approximately 200 feet. Surrounding areas include woodland, swamp, and pasture. Access is via canoe. Location is approximately 0.4 miles upstream from Visitor Center and 1.5 miles upstream from Potomac River. Station is influenced by tides.	Station is monitored as it is one of the park's key water bodies.	38°10'35"	76°55'16"	Manual map interpolation
Digwood Swamp Creek nr Wakefield, VA	0+B5166086 2	Intermittent Stream	Station is in GEWA. Stream is intermittent. Surrounding area is moderately wooded, with light agricultural practices occurring upgradient. Access is via Maintenance Road and approximately 400 feet north of maintenance area. Station is approximately 2000 feet above Potomac River.	Station is monitored as it is one of the park's key water bodies.	38°11'45"	76°55'29"	Manual map interpolation GPS

TABLE 1. SITES AT GEWA

1:24000	NAD1927	Virginia	Westmoreland	02070011	0	Topographic map	Gage
1:24000	NAD1927	Virginia	Westmoreland	2070011	0	Topographic map	Gage
1:24000 Rockwell	NAD1927	Virginia	Westmoreland	2070011	5	Topographic map GPS	Gage

TABLE 3. WQ PARAMETERS AT GEWA

PARAMETER NAME	Discharge (Q)
SAMPLE FRACTION	total
MEASUREMENT UNITS	cubic feet per second (cfs)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	calculated
PREPARATION PROCEDURES	spin test
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	current meter method; USGS
FIELD/LAB EQUIPMENT OR PROCEDURE	Wading rod and pygmy(P90267) or Price AA(A91114) velocity meter
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)
PARAMETER NAME	Water Temperature (WT)
SAMPLE FRACTION	total
MEASUREMENT UNITS	degrees Celsius (°C)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	actual
PREPARATION PROCEDURES	calibration check w/ ASTM thermometer
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	--
FIELD/LAB EQUIPMENT OR PROCEDURE	thermometer (YSI50B DO W#496703)
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)
PARAMETER NAME	Hydrogen Ion Activity (pH)
SAMPLE FRACTION	total

TABLE 3. WQ PARAMETERS AT GEWA

MEASUREMENT UNITS	pH units
FIELD/LAB MEASUREMENT	field
VALUE TYPE	actual
PREPARATION PROCEDURES	calibration w/ pH buffers 4, 7, 10
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	--
FIELD/LAB EQUIPMENT OR PROCEDURE	Beckman 12 pH meter (W#563868)
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)

PARAMETER NAME	Hydrogen Ion Activity (pH)
SAMPLE FRACTION	total
MEASUREMENT UNITS	pH units
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	electrometric electrode, pH, lab
DETECTION LIMIT	0.100
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Specific Conductance (SC)
SAMPLE FRACTION	total
MEASUREMENT UNITS	microsiemens per centimeter (uS/cm)
FIELD/LAB MEASUREMENT	field

TABLE 3. WQ PARAMETERS AT GEWA

VALUE TYPE	actual
PREPARATION PROCEDURES	calibration with SC standards 50 - 500
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	--
FIELD/LAB EQUIPMENT OR PROCEDURE	Orion 122 SC meter (W#593055)
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)
PARAMETER NAME	Specific Conductance (SC)
SAMPLE FRACTION	total
MEASUREMENT UNITS	microsiemens per centimeter (uS/cm)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Wheatstone Bridge, Specific conductance, lab, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory
PARAMETER NAME	Dissolved Oxygen (DO)
SAMPLE FRACTION	total
MEASUREMENT UNITS	milligrams per liter (mg/L)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	actual

TABLE 3. WQ PARAMETERS AT GEWA

PREPARATION PROCEDURES	zero DO check, atmospheric calibration in water
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	--
FIELD/LAB EQUIPMENT OR PROCEDURE	YSI 50B DO meter (W#496703)
DETECTION LIMIT	0.0
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)

PARAMETER NAME	Alkalinity
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as CaCO ₃ (mg/L as CaCO ₃)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	calculated
PREPARATION PROCEDURES	filtration of water samples, 0.45 microns
TRANSPORT/PRESERVATION	--
LAB ANALYTICAL PROCEDURE; SOURCE	titration with H ₂ SO ₄
FIELD/LAB EQUIPMENT OR PROCEDURE	Hach alkalinity kit
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)

PARAMETER NAME	Acid Neutralizing Capacity (ANC)
SAMPLE FRACTION	total
MEASUREMENT UNITS	milligrams per liter as CaCO ₃ (mg/L as CaCO ₃)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	calculated
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	untreated, cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Electrometric Titration, Acid Neutralizing Capacity as CaCO ₃ , lab, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Nitrogen, ammonia
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as nitrogen (mg/L as N)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; Salicylate-hypochlorite
DETECTION LIMIT	0.02
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory
PARAMETER NAME	Nitrogen, ammonia + organic nitrogen
SAMPLE FRACTION	total
MEASUREMENT UNITS	milligrams per liter as nitrogen (mg/L as N)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	whole water sample
TRANSPORT/PRESERVATION	acidified to pH<2 with H ₂ SO ₄ , cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; microkjeldahl digestion
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Nitrogen, ammonia + organic nitrogen
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as nitrogen (mg/L as N)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; microkjeldahl digestion
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Nitrogen, nitrite
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as nitrogen (mg/L as N)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry
DETECTION LIMIT	0.01
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Nitrogen, nitrite + nitrate
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as nitrogen (mg/L as N)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry, cadmium reduction-diazotization
DETECTION LIMIT	0.05
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Phosphorous
SAMPLE FRACTION	total
MEASUREMENT UNITS	milligrams per liter as phosphorous (mg/L as P)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	whole water sample
TRANSPORT/PRESERVATION	acidified to pH<2 with H ₂ SO ₄ , cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; microkjeldahl digestion
DETECTION LIMIT	0.01
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Phosphorous
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as phosphorous (mg/L as P)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; microkjeldahl digestion
DETECTION LIMIT	0.01
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Phosphorous, phosphate, ortho
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as phosphorous (mg/L as P)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	untreated, cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S2702 NAWQA, Nutrients + Microkjeldahl P and N; Inorganics: Nutrients; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry; phosphomolybdate
DETECTION LIMIT	0.01
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Boron
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	micrograms per liter as boron (ug/L as B)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
MAX/MIN QUANTIFICATION LIMITS	
DETECTION LIMIT	16
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Calcium
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as calcium (mg/L as Ca)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
DETECTION LIMIT	0.02
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Chloride
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as chloride (mg/L as Cl)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Ion chromatography (IC)
MAX/MIN QUANTIFICATION LIMITS	
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Fluoride
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as fluoride (mg/L as F)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF), ion selective electrode
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Iron
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	micrograms per liter as iron (ug/L as Fe)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
DETECTION LIMIT	10
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory
PARAMETER NAME	Magnesium
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as magnesium (mg/L as Mg)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics:

TABLE 3. WQ PARAMETERS AT GEWA

	Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
MAX/MIN QUANTIFICATION LIMITS	
DETECTION LIMIT	0.004
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory
PARAMETER NAME	Manganese
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	micrograms per liter as manganese (ug/L as Mn)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
DETECTION LIMIT	4
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory
PARAMETER NAME	Potassium
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as potassium (mg/L as K)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Atomic absorption (AA), flame
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Silica
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter is silica dioxide (mg/L as SiO ₂)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Automated-segmented flow (ASF) colorimetry, molybdate blue
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Sodium
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as sodium (mg/L as Na)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ , cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Inductively Coupled Plasma (ICP)
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Sulfate
SAMPLE FRACTION	dissolved
MEASUREMENT UNITS	milligrams per liter as sulfate (mg/L as SO ⁴)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S11 USGS National Water-Quality Laboratory Major Ions + Trace (Swapper); Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	Ion chromatography (IC)
DETECTION LIMIT	0.1
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Chromium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as chromium (ug/L as Cr)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, chromium, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Arsenic
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as arsenic (ug/L as As)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, arsenic, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Cadmium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as cadmium (ug/L as Cd)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, cadmium, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Molybdenum
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as molybdenum (ug/L as Mo)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, molybdenum, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Zinc
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as zinc (ug/L as Zn)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C

TABLE 3. WQ PARAMETERS AT GEWA

LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	ZINC WWR-ICP
MAX/MIN QUANTIFICATION LIMITS	
DETECTION LIMIT	40
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Nickel
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as nickel (ug/L as Ni)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, nickel, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Lithium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as lithium (ug/L as Li)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw

TABLE 3. WQ PARAMETERS AT GEWA

TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	LITHIUM WWR-ICP
DETECTION LIMIT	12
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Selenium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as selenium (ug/L as Se)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, selenium, water, WWR
DETECTION LIMIT	1.0
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Silver
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as silver (ug/L as Ag)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw

TABLE 3. WQ PARAMETERS AT GEWA

TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, silver, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Lead
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as lead (ug/L as Pb)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, lead, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Iron
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as iron (ug/L as Fe)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw

TABLE 3. WQ PARAMETERS AT GEWA

TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	IRON WWR-ICP
DETECTION LIMIT	14
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Mercury
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as mercury (ug/L as Hg)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ +K ₂ Cr ₂ O ₇ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	AA, manual cold vapor, mercury, WWR
DETECTION LIMIT	0.100
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Barium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as barium (ug/L as Ba)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw

TABLE 3. WQ PARAMETERS AT GEWA

TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	BARIUM WWR-ICP
DETECTION LIMIT	1.2
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Beryllium
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as beryllium (ug/L as Be)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	BERYLLIUM WWR-ICP
DETECTION LIMIT	4
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Copper
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as copper (ug/L as Cu)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual

TABLE 3. WQ PARAMETERS AT GEWA

PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, copper, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Cobalt
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as cobalt (ug/L as Co)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	GFAA, cobalt, WWR
DETECTION LIMIT	1.000
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Aluminum
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as aluminum (ug/L as Al)
FIELD/LAB MEASUREMENT	lab

TABLE 3. WQ PARAMETERS AT GEWA

VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	ALUMINUM WWR-ICP
DETECTION LIMIT	28
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Manganese
SAMPLE FRACTION	total
MEASUREMENT UNITS	micrograms per liter as manganese (ug/L as Mn)
FIELD/LAB MEASUREMENT	lab
VALUE TYPE	actual
PREPARATION PROCEDURES	raw
TRANSPORT/PRESERVATION	acidified to pH<2 with HNO ₃ ; cooled to 4°C
LAB ANALYTICAL PROCEDURE; SOURCE	S197 USGS National Water-Quality Laboratory Trace Metals, WWR; Inorganics: Major Ions and Trace Metals; USGS National Water-Quality Laboratory
FIELD/LAB EQUIPMENT OR PROCEDURE	MANGANESE WWR-ICP
DETECTION LIMIT	3
PERSON/AGENCY THAT ANALYZED	USGS National Water-Quality Laboratory

PARAMETER NAME	Total Coliform (TC)
SAMPLE FRACTION	total
MEASUREMENT UNITS	colonies per 100 milliliters (col/100mL)
FIELD/LAB MEASUREMENT	field

TABLE 3. WQ PARAMETERS AT GEWA

VALUE TYPE	calculated
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	incubated, 24 hours at 35 °C
LAB ANALYTICAL PROCEDURE; SOURCE	membrane/vacuum filtration
FIELD/LAB EQUIPMENT OR PROCEDURE	hand-dip method
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)

PARAMETER NAME	Fecal Coliform (FC)
SAMPLE FRACTION	total
MEASUREMENT UNITS	colonies per 100 milliliters (col/100mL)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	calculated
PREPARATION PROCEDURES	filtered, 0.65 microns
TRANSPORT/PRESERVATION	incubated, 24 hours at 44.5 °C
LAB ANALYTICAL PROCEDURE; SOURCE	membrane/vacuum filtration
FIELD/LAB EQUIPMENT OR PROCEDURE	hand-dip method
DETECTION LIMIT	--
PERSON/AGENCY WHO ANALYZED	Mike Gearheart (USGS)

PARAMETER NAME	Fecal Streptococcus (FS)
SAMPLE FRACTION	total
MEASUREMENT UNITS	colonies per 100 milliliters (col/100mL)
FIELD/LAB MEASUREMENT	field
VALUE TYPE	calculated
PREPARATION PROCEDURES	filtered, 0.45 microns
TRANSPORT/PRESERVATION	incubated, 48 hours at 35 °C
LAB ANALYTICAL PROCEDURE; SOURCE	membrane/vacuum filtration

TABLE 3. WQ PARAMETERS AT GEWA

FIELD/LAB EQUIPMENT OR PROCEDURE	hand-dip method
DETECTION LIMIT	--
PERSON/AGENCY THAT ANALYZED	Mike Gearheart (USGS)

TABLE 2. WQ DATA AT GEWA

[--, no data available]

Station Name	Station ID	Date		Time	Medium	Sampling Depth
		mm/dd/yy		hh:mm:ss		feet
Bridges Creek at Mouth nr Wakefield, VA	01660860	10/06/98	did not collect samples/measurements	12:00:00	Water	
Bridges Creek at Mouth nr Wakefield, VA	01660860	12/15/98		10:00:00	Water	1.0
Bridges Creek at Mouth nr Wakefield, VA	01660860	02/03/99		8:20:00	Water	1.0
Bridges Creek at Mouth nr Wakefield, VA	01660860	06/15/99		9:35:00	Water	0.7
Dancing Marsh nr Wakefield, VA	0166087770	10/06/98		13:00:00	Water	0.3
Dancing Marsh nr Wakefield, VA	0166087770	12/15/98		13:00:00	Water	0.7
Dancing Marsh nr Wakefield, VA	0166087770	02/03/99		10:45:00	Water	0.3
Dancing Marsh nr Wakefield, VA	0166087770	06/15/99		10:45:00	Water	0.2
Spring at Dancing Marsh nr Wakefield, VA (55PS1)	0381108076551101	10/06/98		11:00:00	Water	0.3
Spring at Dancing Marsh nr Wakefield, VA (55PS1)	0381108076551101	12/15/98	did not collect samples	14:40:00	Water	--
Spring at Dancing Marsh nr Wakefield, VA (55PS1)	0381108076551101	02/03/99		12:30:00	Water	0.3
Spring at Dancing Marsh nr Wakefield, VA (55PS1)	0381108076551101	06/15/99		13:30:00	Water	0.2
Popes Creek at Burnt House Point nr Wakefield, VA	0166087760	10/07/98		8:05:00	Water	4.5
Popes Creek at Burnt House Point nr Wakefield, VA	0166087760	12/16/98		9:00:00	Water	3.0
Popes Creek at Burnt House Point nr Wakefield, VA	0166087760	02/02/99		8:30:00	Water	4.0
Popes Creek at Burnt House Point nr Wakefield, VA	0166087760	06/14/99		10:30:00	Water	3.5
Popes Creek at Point of Point nr Wakefield, VA	0166087750	10/07/98		11:00:00	Water	3.5
Popes Creek at Point of Point nr Wakefield, VA	0166087750	12/16/98		12:15:00	Water	4.0
Popes Creek at Point of Point nr Wakefield, VA	0166087750	02/02/99		9:20:00	Water	3.5
Popes Creek at Point of Point nr Wakefield, VA	0166087750	06/14/99		11:45:00	Water	3.0
Digwood Swamp Creek nr Wakefield, VA	01660862	10/06/98	site dry	12:05:00	Water	--
Digwood Swamp Creek nr Wakefield, VA	01660862	12/15/98	site dry	9:00:00	Water	--
Digwood Swamp Creek nr Wakefield, VA	01660862	02/03/99	site dry	14:00:00	Water	--
Digwood Swamp Creek nr Wakefield, VA	01660862	06/15/99	site dry	8:00:00	Water	--

TABLE 2. WQ DATA AT GEWA

Station ID	Sample Collector	Discharge	Specific Conductance - field	pH - field
		cu ft per sec	microsiemens per centimeter at 25 degrees Celsius	standard pH units
01660860	J. Michael Gearheart (USGS)	0 creek did not outflow to Potomac River	--	--
01660860	J. Michael Gearheart (USGS)	0 creek did not outflow to Potomac River	1,210	7.4
01660860	J. Michael Gearheart (USGS)	2.9 outgoing tides	4,000	6.9
01660860	J. Michael Gearheart (USGS)	4.95 outgoing tides	16,300	6.6
0166087770	J. Michael Gearheart (USGS)	0.07 outgoing tides	655	6.8
0166087770	J. Michael Gearheart (USGS)	0.063 high/incoming tides	2,050	7.1
0166087770	J. Michael Gearheart (USGS)	0.17 outgoing tides	550	6.7
0166087770	J. Michael Gearheart (USGS)	0.05 outgoing tides	3,000	6.5
0381108076551101	J. Michael Gearheart (USGS)	0.05 estimated	311	6.6
0381108076551101	J. Michael Gearheart (USGS)	<0.01 estimated	296	--
0381108076551101	J. Michael Gearheart (USGS)	0 measured with rated flume	240	6.5
0381108076551101	J. Michael Gearheart (USGS)	0 measured with rated flume	220	6.5
0166087760	J. Michael Gearheart (USGS)	-- outgoing tides	17,400	7.1
0166087760	J. Michael Gearheart (USGS)	-- incoming tides	20,000	7.4
0166087760	J. Michael Gearheart (USGS)	-- outgoing tides	16,800	7.4
0166087760	J. Michael Gearheart (USGS)	-- outgoing tides	14,300	7.8
0166087750	J. Michael Gearheart (USGS)	-- outgoing tides	17,100	7.4
0166087750	J. Michael Gearheart (USGS)	-- incoming tides	18,800	7.3
0166087750	J. Michael Gearheart (USGS)	-- outgoing tides	15,000	7.2
0166087750	J. Michael Gearheart (USGS)	-- low tides	15,700	7.4
01660862	J. Michael Gearheart (USGS)	--	--	--
01660862	J. Michael Gearheart (USGS)	--	--	--
01660862	J. Michael Gearheart (USGS)	--	--	--
01660862	J. Michael Gearheart (USGS)	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Water Temperature	Dissolved Oxygen
	degrees Celsius	milligrams per liter
01660860	--	--
01660860	5.8 1/4" ice across entire section	9.1
01660860	6.2	5.0
01660860	23.0	2.5
0166087770	18.7	9.3
0166087770	7.4	9.9
0166087770	8.0	10.6
0166087770	21.4	4.7
0381108076551101	17.0	8.7 measurement taken approx 10' downstream of spring
0381108076551101	11.0	--
0381108076551101	12.6	3.2
0381108076551101	16.5	2.5
0166087760	18.8	7.0
0166087760	6.7	7.5
0166087760	5.9	11.4
0166087760	25.1	--
0166087750	18.4	6.0
0166087750	6.7	9.4
0166087750	6.1	10.8
0166087750	26.8	--
01660862	--	--
01660862	--	--
01660862	--	--
01660862	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Total Coliform		Fecal Coliform	Fecal Streptococcus
	colonies per 100 milliliters		colonies per 100 milliliters	colonies per 100 milliliters
01660860	--		--	--
01660860	4,000		2,700	1,800
01660860	1,700		660	740
01660860	1,500		1,080	1,440
0166087770	2,800		1,200	1,300
0166087770	380		200	460
0166087770	310		73 non-ideal colony count	170
0166087770	10,455		2,200	4,600
0381108076551101	>10,000		>10,000	>10,000
0381108076551101	--		--	--
0381108076551101	>10,000		>10,000	>10,000
0381108076551101	310		26 non-ideal colony count	64
0166087760	310		150 non-ideal colony count	170
0166087760	160 non-ideal colony count		76 non-ideal colony count	97
0166087760	100 non-ideal colony count		20 non-ideal colony count	67
0166087760	300		130	16
0166087750	>1300		1,100	580
0166087750	180		67 non-ideal colony count	94
0166087750	>250		200	220
0166087750	500		260	100
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID		Calcium - Dissolved	Magnesium - Dissolved	Sodium - Dissolved
		<i>detection limit = 0.020</i> milligrams per liter as calcium	<i>detection limit = 0.004</i> milligrams per liter as magnesium	<i>detection limit = 0.06</i> milligrams per liter as sodium
01660860		--	--	--
01660860		--	--	--
01660860		37	76	620
01660860		--	--	--
0166087770		11	16	120
0166087770		--	--	--
0166087770	non-ideal colony count	--	--	--
0166087770		--	--	--
0381108076551101		42	3.1	11
0381108076551101		--	--	--
0381108076551101		33	2.6	8.1
0381108076551101	non-ideal colony count	--	--	--
0166087760		130	380	3,100
0166087760	non-ideal colony count	--	--	--
0166087760	non-ideal colony count	--	--	--
0166087760	non-ideal colony count	--	--	--
0166087750		130	370	3,100
0166087750	non-ideal colony count	--	--	--
0166087750		--	--	--
0166087750		--	--	--
01660862		--	--	--
01660862		--	--	--
01660862		--	--	--
01660862		--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Potassium - Dissolved <i>detection limit = 0.100</i> milligrams per liter as potassium	Alkalinity - field milligrams per liter as calcium carbonate	Alkalinity - lab <i>detection limit = 1</i> milligrams per liter as calcium carbonate	Sulfate - Dissolved <i>detection limit = 0.100</i> milligrams per liter as sulfate
01660860	--	--	--	--
01660860	--	159	--	--
01660860	26	109	49	150
01660860	--	89	--	--
0166087770	5.5	26	29	23
0166087770	--	60	--	--
0166087770	--	13	--	--
0166087770	--	39	--	--
0381108076551101	1.2	65	65	22
0381108076551101	--	--	--	--
0381108076551101	1.0	44	54	22
0381108076551101	--	36	--	--
0166087760	110	83	76	740
0166087760	--	56	--	--
0166087760	--	67	--	--
0166087760	--	68	--	--
0166087750	110	84	78	720
0166087750	--	61	--	--
0166087750	--	48	--	--
0166087750	--	66	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Chloride - Dissolved <i>detection limit = 0.100</i> milligrams per liter as chloride	Fluoride - Dissolved <i>detection limit = 0.100</i> milligrams per liter as fluoride	Silica - Dissolved <i>detection limit = 0.100</i> milligrams per liter as silica dioxide	Nitrogen, Nitrite - Dissolved <i>detection limit = 0.010</i> milligrams per liter as nitrogen
01660860	--	--	--	--
01660860	--	--	--	0.01
01660860	1,100	0.2	13	0.01
01660860	--	--	--	<0.01
0166087770	220	<0.1	11	<0.01
0166087770	--	--	--	0.01
0166087770	--	--	--	0.01
0166087770	--	--	--	<0.01
0381108076551101	25	<0.1	13	0.04
0381108076551101	--	--	--	--
0381108076551101	20	<0.1	14	0.01
0381108076551101	--	--	--	--
0166087760	5,500	0.5	4.1	<0.01
0166087760	--	--	--	0.01
0166087760	--	--	--	0.01
0166087760	--	--	--	<0.01
0166087750	5,500	0.5	3.9	<0.01
0166087750	--	--	--	<0.01
0166087750	--	--	--	0.01
0166087750	--	--	--	<0.01
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	NO2 + NO3 - Dissolved <i>detection limit = 0.050</i> milligrams per liter as nitrogen	Nitrogen Ammonia - Dissolved <i>detection limit = 0.10</i> milligrams per liter as nitrogen	Nitrogen, Amn & Org - Total <i>detection limit = 0.10</i> milligrams per liter as nitrogen	Nitrogen, Amn & Org - Dissolved <i>detection limit = 0.10</i> milligrams per liter as nitrogen
01660860	--	--	--	--
01660860	0.05	0.04	2.6	1.3
01660860	0.12	0.56	2.2	1.5
01660860	<0.05	<0.02	0.8	0.4
0166087770	0.39	0.18	0.8	0.4
0166087770	0.07	0.07	0.6	0.4
0166087770	0.32	0.06	0.5	0.4
0166087770	<0.05	<0.02	1.1	1.1
0381108076551101	4.9	0.03	0.7	0.2
0381108076551101	--	--	--	--
0381108076551101	3	0.03	0.6	0.2
0381108076551101	--	--	--	--
0166087760	<0.05	0.02	1	0.3
0166087760	0.05	0.03	0.5	0.3
0166087760	0.36	0.12	0.5	0.4
0166087760	<0.05	<0.02	0.7	0.2
0166087750	0.05	0.03	0.6	0.3
0166087750	0.06	0.03	0.4	0.3
0166087750	0.22	0.09	0.5	0.3
0166087750	<0.05	<0.02	0.8	0.1
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Phosphorous - Total	Phosphorous - Dissolved
	<i>detection limit = 0.005</i> milligrams per liter as phosphorous	<i>detection limit = 0.005</i> milligrams per liter as phosphorous
01660860	--	--
01660860	1.4	0.85
01660860	0.69	0.56
01660860	0.19	0.13
0166087770	0.10	<0.05
0166087770	0.06	0.04 estimated value
0166087770	0.045	0.021
0166087770	0.18	0.091
0381108076551101	0.09	<0.05
0381108076551101	--	--
0381108076551101	0.06	0.02
0381108076551101	--	--
0166087760	0.17	0.03 estimated value
0166087760	0.05	<0.05
0166087760	0.028	0.012
0166087760	0.076	0.011
0166087750	0.09	<0.05
0166087750	0.04 estimated value	<0.05
0166087750	0.034	0.0110
0166087750	0.097	0.012
01660862	--	--
01660862	--	--
01660862	--	--
01660862	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Orthophosphate - Dissolved <i>detection limit = 0.010</i> milligrams per liter as phosphorous	Aluminum - Total <i>detection limit = 28</i> micrograms per liter as aluminum	Arsenic - Total <i>detection limit = 1.000</i> micrograms per liter as arsenic	Barium - Total <i>detection limit = 1.2</i> micrograms per liter as barium
01660860	--	--	--	--
01660860	0.78	--	--	--
01660860	0.51	--	--	--
01660860	0.01	<140	1	72.5
0166087770	0.05	--	--	--
0166087770	0.02	--	--	--
0166087770	0.02	--	--	--
0166087770	0.01	99.8	<1	51.7
0381108076551101	0.04	--	--	--
0381108076551101	--	--	--	--
0381108076551101	0.02	--	--	--
0381108076551101	--	113	<1	12.6
0166087760	0.03	--	--	--
0166087760	0.01	--	--	--
0166087760	<0.01	--	--	--
0166087760	0.01	322	<1	51.7
0166087750	0.03	--	--	--
0166087750	0.01	--	--	--
0166087750	0.01	--	--	--
0166087750	0.01	502	<1	60.1
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Beryllium - Total <i>detection limit = 4</i> micrograms per liter as beryllium	Boron - Dissolved <i>detection limit = 16</i> micrograms per liter as boron	Cadmium - Total <i>detection limit = 1.000</i> micrograms per liter as cadmium
01660860	--	--	--
01660860	--	--	--
01660860	--	232	--
01660860	<20.0	--	<4
0166087770	--	64.1	--
0166087770	--	--	--
0166087770	--	--	--
0166087770	<4	--	<1
0381108076551101	--	13.6 estimated value (lab)	--
0381108076551101	--	--	--
0381108076551101	--	14.3 estimated value (lab)	--
0381108076551101	<4	--	<1
0166087760	--	1,330	--
0166087760	--	--	--
0166087760	--	--	--
0166087760	<20.0	--	<4
0166087750	--	1,210	--
0166087750	--	--	--
0166087750	--	--	--
0166087750	<20.0	--	<4
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Chromium - Total <i>detection limit = 1.000</i> micrograms per liter as chromium	Cobalt - Total <i>detection limit = 1.000</i> micrograms per liter as cobalt	Copper - Total <i>detection limit = 1.000</i> micrograms per liter as copper	Iron - Total <i>detection limit = 14</i> micrograms per liter as iron
01660860	--	--	--	--
01660860	--	--	--	--
01660860	--	--	--	--
01660860	<1.0	<4	<4	651
0166087770	--	--	--	--
0166087770	--	--	--	--
0166087770	--	--	--	--
0166087770	<1.0	<1	<1	2230
0381108076551101	--	--	--	--
0381108076551101	--	--	--	--
0381108076551101	--	--	--	--
0381108076551101	<1.0	<1	5	152
0166087760	--	--	--	--
0166087760	--	--	--	--
0166087760	--	--	--	--
0166087760	<1.0	<4	5	766
0166087750	--	--	--	--
0166087750	--	--	--	--
0166087750	--	--	--	--
0166087750	<1.0	<4	10	1390
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Iron - Dissolved <i>detection limit = 10.000</i> micrograms per liter as iron	Lead - Total <i>detection limit = 1.000</i> micrograms per liter as lead	Lithium - Total <i>detection limit = 12</i> micrograms per liter as lithium
01660860	--	--	--
01660860	--	--	--
01660860	550	--	--
01660860	--	<4	54.9 estimated value
0166087770	190	--	--
0166087770	--	--	--
0166087770	--	--	--
0166087770	--	<1	6.2 estimated value
0381108076551101	<10	--	--
0381108076551101	--	--	--
0381108076551101	<10	--	--
0381108076551101	--	<1	<12
0166087760	<200	--	--
0166087760	--	--	--
0166087760	--	--	--
0166087760	--	<4	60.5
0166087750	<200	--	--
0166087750	--	--	--
0166087750	--	--	--
0166087750	--	<4	41.9 estimated value
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Manganese - Total <i>detection limit = 3</i> micrograms per liter as manganese	Manganese - Dissolved <i>detection limit = 3.0</i> micrograms per liter as manganese	Mercury - Total <i>detection limit = 0.100</i> micrograms per liter as mercury
01660860	--	--	--
01660860	--	--	--
01660860	--	610	--
01660860	295	--	<0.1
0166087770	--	65	--
0166087770	--	--	--
0166087770	--	--	--
0166087770	219	--	<0.1
0381108076551101	--	9	--
0381108076551101	--	--	--
0381108076551101	--	4	--
0381108076551101	3.6	--	<0.1
0166087760	--	30 estimated value (lab)	--
0166087760	--	--	--
0166087760	--	--	--
0166087760	37.5	--	<0.1
0166087750	--	55 estimated value (lab)	--
0166087750	--	--	--
0166087750	--	--	--
0166087750	94.6	--	<0.1
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--
01660862	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Molybdenum - Total <i>detection limit = 1.000</i> micrograms per liter as molybdenum	Nickel - Total <i>detection limit = 1.000</i> micrograms per liter as nickel	Selenium - Total <i>detection limit = 1.0</i> micrograms per liter as selenium	Silver - Total <i>detection limit = 1.000</i> micrograms per liter as silver
01660860	--	--	--	--
01660860	--	--	--	--
01660860	--	--	--	--
01660860	4.0	<4	<1	<4
0166087770	--	--	--	--
0166087770	--	--	--	--
0166087770	--	--	--	--
0166087770	<1.0	<1	<1	<1
0381108076551101	--	--	--	--
0381108076551101	--	--	--	--
0381108076551101	--	--	--	--
0381108076551101	<1.0	3	<1	<1
0166087760	--	--	--	--
0166087760	--	--	--	--
0166087760	--	--	--	--
0166087760	4.0	<4	<1	<4
0166087750	--	--	--	--
0166087750	--	--	--	--
0166087750	--	--	--	--
0166087750	4.0	<4	<1	<4
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--
01660862	--	--	--	--

TABLE 2. WQ DATA AT GEWA

Station ID	Zinc - Total
	<i>detection limit = 40</i> micrograms per liter as zinc
01660860	--
01660860	--
01660860	--
01660860	<200
0166087770	--
0166087770	--
0166087770	--
0166087770	<40
0381108076551101	--
0381108076551101	--
0381108076551101	--
0381108076551101	<40
0166087760	--
0166087760	--
0166087760	--
0166087760	<200
0166087750	--
0166087750	--
0166087750	--
0166087750	<200
01660862	--
01660862	--
01660862	--
01660862	--