



Water Quality Monitoring for the Escalante River and Coyote Gulch in Glen Canyon National Recreation Area

2014 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2017/1134



ON THE COVER

Water quality monitoring site ESC02 on the Escalante River in Glen Canyon National Recreation Area.
Photography by SCPN

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The National Park Service, Natural Resource Stewardship and Science office in Fort Collins, Colorado, publishes a range of reports that address natural resource topics. These reports are of interest and applicability to a broad audience in the National Park Service and others in natural resource management, including scientists, conservation and environmental constituencies, and the public.

The Natural Resource Data Series is intended for the timely release of basic data sets and data summaries. Care has been taken to assure accuracy of raw data values, but a thorough analysis and interpretation of the data has not been completed. Consequently, the initial analyses of data in this report are provisional and subject to change. Please direct any data requests to the water resources project manager or the SCPN data manager.

All manuscripts in the series receive the appropriate level of peer review to ensure that the information is scientifically credible, technically accurate, appropriately written for the intended audience, and designed and published in a professional manner. Data in this report were collected and analyzed using methods based on established, peer-reviewed protocols and were analyzed and interpreted within the guidelines of the protocols.

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Abstract

Water-related vital signs are fundamental components defining overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified water quality as one of seven key vital signs used to determine the condition and long-term status of aquatic ecosystems in park streams. This report summarizes water quality core parameter data and bacteria, nutrient, major element, and trace metal data for water quality samples collected from the Escalante River and Coyote Gulch in Glen Canyon National Recreation Area in 2014. In addition, it reports data on Contaminants of Emerging Concern found in water quality samples for an agreement with the U.S. EPA. The data presented in this report represent a snapshot of the water quality in these systems in 2014.

1 Introduction

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a scientific foundation for making decisions and working with other agencies and the public to protect park ecosystems. Hydrologic vital signs are the fundamental components that define overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified seven vital signs pertaining to riparian ecosystems: 1) aquatic macroinvertebrates, 2) stream water quality, 3) stream flow and depth to groundwater, 4) spring water quality, 5) fluvial geomorphology, 6) riparian vegetation, composition, and structure, and 7) spring ecosystems. These vital signs are closely related and are all included in the Vital Signs Monitoring Plan for the Southern Colorado Plateau Network (Thomas et al. 2006). The context and ecological significance of these vital signs are further explained in Scott et al. (2005). In this report we focus on stream water quality.

Specific objectives for monitoring stream water quality in SCPN parks are

- Determine status and trends for selected core water quality parameters (water temperature, pH, specific conductance, dissolved oxygen, turbidity and discharge) at selected sites in priority streams within SCPN parks.
- Determine status and trends of selected water quality constituents, including bacteria, nutrients, major elements, and trace metals at selected sites in priority streams within SCPN parks.
- Compare water quality data against state standards for chronic exceedances. Multiple exceedances in a year typically indicate non-compliance.

1.1 Selecting potential water quality monitoring sites

We targeted SCPN streams and springs in SCPN parks with potential for water quality monitoring by reviewing (1) water quality data inventory and analysis reports prepared by the Water Resources Division (WRD) of the National Park Service (NPS); (2) a USGS summary and review of available water quality data from streams in SCPN parks (Brown 2008); (3) data collected during a Level 1 water quality inventory of streams in SCPN parks (Macy and Monroe 2006); and (4) results of water quality monitoring planning meetings with park staff.

SCPN water bodies were selected for water quality monitoring based on the following criteria:

- 303(d) listed waters¹ — where previous sampling indicates one or more parameters regularly approach or exceed established water quality standards or recommended levels
- waters with demonstrated threat levels—where an analysis of existing data indicate that measured conditions regularly approach or exceed standards or recommended levels, but where the frequency of exceedances or the quality of the database do not support a 303(d) listing
- pristine waters—where there is no direct impact of human activities (provides baseline data)
- ecological significance—presence of unique species or species of concern
- waters of management concern—where past sampling may not indicate constituent values of concern, but where anthropogenic activities indicate that contamination is a significant threat
- historic data—waters identified as important, for which substantial historic water quality data are available
- data gaps—waters identified as important, but where little or no water quality information exists

Whenever possible, SCPN water quality monitoring sites are located where a history of water quality data collection exists, and co-located with SCPN aquatic macroinvertebrate monitoring sites.

¹ Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters—waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes (EPA 2011).

1.2 Water quality monitoring at Glen Canyon National Recreation Area

The Escalante River watershed covers 5,244 km² in southern Utah, with 97% of the watershed managed by the U.S. Forest Service, Bureau of Land Management (BLM), and the National Park Service (NPS) (Macfarlane and Wheaton 2013). The river is primarily fed by several perennial tributaries originating on the Aquarius Plateau north of Boulder, Utah. The mainstem of the river flows northwest to southeast, from outside of Escalante and through the arid canyonlands of Grand Staircase-Escalante National Monument and Glen Canyon National Recreation Area (GLCA) for approximately 145 km before emptying into Lake Powell. The small towns of Escalante and Boulder lie within the northern portion of the watershed.

Coyote Gulch is a perennial tributary in the southeastern tip of the Escalante Watershed that flows into the Escalante River near Lake Powell. It is a popular hiking destination. The upper portion of the Coyote Gulch watershed is located in the Grand Staircase-Escalante National Monument and is managed for multiple uses by the BLM. However, most of the canyon and stream lies within GLCA and is managed by the NPS for recreational use.

In 2013 SCPN implemented long-term monitoring of water quality at two sites in GLCA (Figure 1, Appendix A):

- Escalante River above Coyote Gulch (GLCAESC02), identified in this report as ESC02, is located just upstream from the confluence with Coyote Gulch.
- Coyote Gulch above Crack-in-the-Wall Trail (GLCACOY01) is identified in this report as COY01. The site is located in the lower portion of Coyote Gulch, approximately 1.6 km upstream from the confluence of the Escalante River. This site is co-located with an SCPN aquatic macroinvertebrate monitoring site (now discontinued), where limited water quality data has been collected since 2008.

SCPN collects core water quality data and water quality samples at regular intervals throughout the year. Water quality samples are analyzed by SCPN staff and by a qualified contract laboratory. In 2014, SCPN staff made four water quality monitoring site visits to ESC02 and COY01. This report documents all SCPN water quality monitoring activities at GLCA in 2014 and summarizes the data collected.

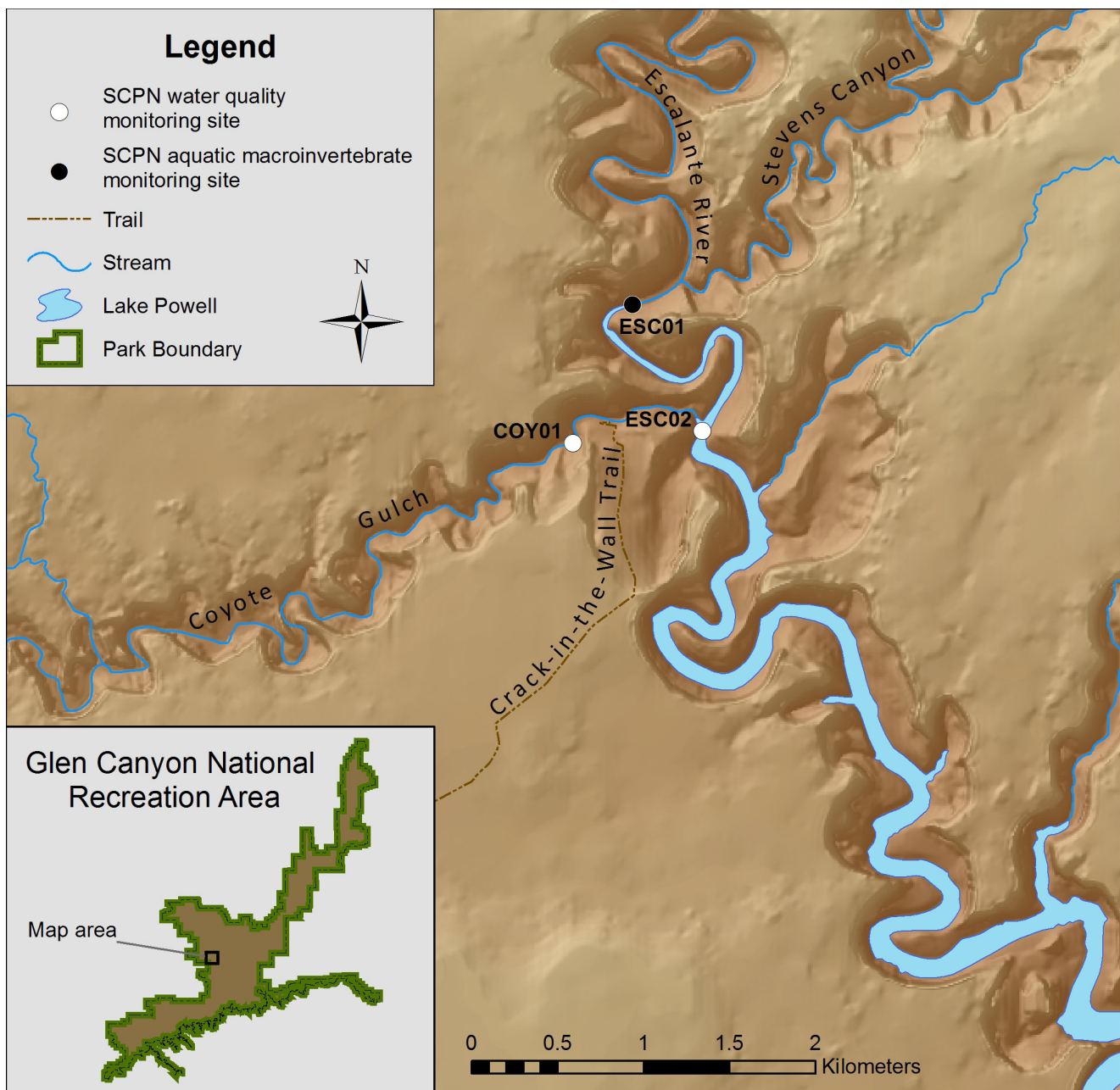


Figure 1. SCPN water quality monitoring sites in the Escalante River and Coyote Gulch at Glen Canyon NRA, 2014.

2 Methods

A brief description of water quality data collection and processing procedures followed by SCPN staff at GLCA during 2014 is presented here. Detailed descriptions of these procedures are available in the Water Quality Monitoring Protocol for Streams and Springs in the Southern Colorado Plateau Network (Monroe et al. 2016).

2.1 Water quality core parameters

National Park Service core water quality parameters include water temperature, pH, specific conductance, dissolved oxygen, turbidity, and discharge. During each site visit, the SCPN Water Resources field crew noted the hydrologic conditions, and collected water quality core parameter data using the following methods:

- As soon as possible after arriving at the site, SCPN water resources crew calibrated and deployed a multi-parameter sonde (Hydrolab-MS5; Hach Inc.) in a well-mixed part of the stream channel, logging temperature, pH, specific conductance, and dissolved oxygen data at 5-second intervals. The sonde was left stationary in the stream for the entire site visit.
- Turbidity samples were collected and kept on ice for a maximum time of 24 hours, then analyzed with a HACH 2100P Portable Turbidimeter (Hach Inc.).
- Discharge was measured using a Hach FH950 (Hach Inc.).

2.2 Water quality sample collection and analysis

SCPN collects water quality samples at GLCA to analyze for bacteria, nutrients, major elements, and trace metals, during each quarterly site visit. Bacteria samples were collected by dipping a sample bottle into the center of flow. SCPN staff then analyzed the sample for total coliforms and *E. coli* using the Quanti-Tray® 2000 system (IDEXX Inc.). The Utah water quality standards state that this procedure is approved as a method for water quality assessment. Samples for nutrients, major elements, and trace metals were filtered directly from the stream. Sample water was then acid-treated (as required), kept on ice, and shipped to the contract laboratory.

In 2014 SCPN continued an Interagency Agreement with the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado for analysis of water samples for selected water quality constituents: nutrients, major elements and trace metals (Table 1). Sample collection methods and NWQL methods are described SOP #8 of the SCPN water quality monitoring protocol (Monroe et al. 2016).

In 2014 SCPN continued its partnership with the U.S. Environmental Protection Agency (EPA) to sample for Contaminants of Emerging Concern (CECs) in water sources in selected SCPN parks. The contaminants include pharmaceuticals, personal care products, waste indicators, and pesticides (see Appendix C). The purpose of the sampling was to develop a baseline dataset documenting the occurrence of these contaminants within selected SCPN parks. We began CEC sampling at GLCA in 2011 and followed the procedures described in NPS 2013. In 2014, we collected two samples at ESC02 and two at COY01. The samples were kept on ice and analyzed at the EPA Region 8 Laboratory in Golden, Colorado within seven days of collection, as required.

Table 1. USGS National Water Quality Laboratory and U.S. Environmental Protection Agency Laboratory sample analytes.

Analytical group	Analytes
Nutrients	ammonia, nitrite, nitrite + nitrate, orthophosphate
Major elements	calcium, chloride, fluoride, magnesium, potassium, silica, sodium, sulfate, acid neutralizing capacity (ANC; as CaCO ₃), total dissolved solids
Trace metals	aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium, zinc
Contaminants of emerging concern	pharmaceuticals, personal care products, waste water indicators, pesticides

2.3 Data handling and reporting

All water quality data are entered into SCPN's water quality database. All multiparameter sonde electronic data and discharge files are stored on the SCPN server. In this report, we include the median values of a subset of seven consecutive multiparameter sonde measurements. Similarly, only the median values for each set of turbidity samples are presented. For total coliforms and *E. coli* samples, most-probable numbers (MPN/100 mL) are reported; MPN is a statistical estimate of the number of bacteria per unit volume of a sample, determined by using a lookup table provided by the manufacturer of Quanti-Tray 2000, the method used by SCPN to analyze bacteria in stream samples (IDEXX Inc.).

All results from the NWQL and EPA are presented as they were reported from the lab. In cases where analytes were not detected, we presented the applicable laboratory reporting level, which is the lowest concentration that can be reliably measured by a given analytical method. For the NWQL data, results which are below the laboratory reporting level but above the method detection level are flagged to indicate that the analyte was detected, but the concentration was not high enough to report.

Where applicable, we compared our results against the state of Utah's Department of Environmental Quality 2016 water quality standards (Utah DEQ 2016). We noted any exceedances of the applicable standards.

2.4 Understanding water quality data and standards

The NPS Natural Resource Challenge (NRC) provides funding for water quality monitoring in NPS park units. This funding is intended to advance NPS's long-term goals to protect pristine water quality and improve impaired water quality in parks by supporting Clean Water Act protections and provisions for designated unimpaired and impaired waters. Preliminary analysis of data available through the water quality data synthesis (Brown 2008), a Level 1 water quality inventory (Macy and Monroe 2006), and SCPN monitoring indicate that water quality conditions at many SCPN parks exceed established USEPA, state or Tribal standards.

The SCPN water quality monitoring program collects samples quarterly to document the range of hydrologic conditions that occur in network parks. Thus, rare and short-term events may not be captured. These "grab" samples represent conditions at the point and time of sampling; they do not represent the condition of the entire water body, spatially or temporally.

The Utah DEQ has developed water quality standards and criteria to meet requirements of the Federal Clean Water Act. This report includes water quality standards and criteria applicable to the Escalante River and Coyote Gulch. A water quality standard refers to a specific parameter and its associated beneficial use, in conjunction with a criterion, which is the numeric component against which a result is compared. For example, the standard for dissolved selenium (parameter) for warm water aquatic life (beneficial use) is a one-hour average of 18.4 µg/L (numeric criterion) (UDEQ 2014).

All SCPN sample results are for the dissolved concentration, meaning that samples are filtered through a 0.45 µm filter to remove the particulate component of the sample before it is shipped for analysis of the dissolved fraction. All aquatic life criteria for metals are based on the dissolved fraction. This method more accurately addresses the form of metals that is most toxic to aquatic life while excluding less toxic forms. However, for some analytes, such as ammonia, the Utah water quality standards are based on the total concentration, which includes the portion of the analyte bound to particulates. Because our samples exclude the particulate component, our data are not necessarily comparable to criteria based on the total sample. Therefore, only the criteria for dissolved parameters are listed in the Results section of this report. However, we note when dissolved concentrations exceed the criteria for total concentrations.

As tributaries to Lake Powell, the Escalante River and Coyote Gulch have the following beneficial uses: infrequent primary contact recreation, warm water aquatic life, and agriculture. The aquatic life criteria are often

dependent upon water hardness, which varies at each site visit. In these cases, the criteria are expressed as a range encompassing the lowest and highest values for the year.

2.4.1 Chronic and acute standards

Numeric criteria for aquatic life water quality standards address potential effects of both chronic exposure to a parameter over an extended period of time and acute exposure over a short period of time. In Utah, the criteria are expressed as either 4-day average or 1-hour average concentrations. Criteria are much lower for chronic exposure than for acute exposure and are not directly comparable to the results obtained from a single sample due to the multiple samples required over a 4-day period. From a compliance standpoint, the acute criteria afford the only direct comparison for such data because they apply to a single sample. However, from a resource conservation standpoint, instantaneous grab-sample data, when compared against more stringent chronic criteria, can provide a means of early warning and an indication of a problem that may require more attention. Therefore, we have identified when results are outside the chronic criteria in the results section of this report.

2.4.2 Regulatory authority

The National Park Service does not have regulatory authority over waters in the U.S., or even the authority to make assessments for designated use. This report compares water quality data to designated use criteria without stating whether a designated use was attained. Those designations are reported by the states or tribes in their triennial 305(b) reports to Congress. However, the NPS cooperates with states and tribes in collecting data used in the protection of water bodies under state jurisdiction.

3 Results

This section summarizes data collected by SCPN from the Escalante River and Coyote Gulch in 2014. Data collected in 2013 for core parameters and bacteria are also summarized here for comparison. We conducted site visits to ESC02 and COY01 on 29 March, 22 May, 24 Sept, and 9 December. All data collected during the four site visits are presented in Appendix B.

3.1 Escalante River above Coyote Gulch

3.1.1 Water quality core parameter data

Table 2 presents medians and ranges for the core parameter data from four site visits to ESC02, along with the applicable Utah water quality criteria.

Water temperature at ESC02 in 2014 ranged from 5.9–20.7°C. Values for pH ranged from 8.1–8.6, and specific conductance ranged from 300–544 $\mu\text{S}/\text{cm}$. Dissolved oxygen measurements were all near 100% saturation, ranging from 8.0–10.0 mg/L. Turbidity was highly variable, from a low of 26 NTU (measured during the winter) to a high of 26,000 NTU (measured during summer monsoon season). We were unable to get discharge readings on 29 March because the flow was too high, and on 9 December because it was too cold. None of the results for temperature, pH, and dissolved oxygen exceeded the Utah water quality criteria.

Table 2. Summary of water quality core parameter data from ESC02 on the Escalante River in Glen Canyon NRA, 2014 ($n=4$). Data for 2013 ($n=3$) is included for comparison. The associated Utah water quality criteria are indicated for each parameter, “nc” indicates that no criteria exist for a specific parameter. An “nd” indicates that data was not collected.

Core parameter	2013		2014		UT State aquatic life criteria
	Median	Range	Median	Range	
Water temperature (°C)	16.8	15.1–22.4	14.1	5.9–20.7	≤ 27.0
pH	8.6	8.3–8.6	8.4	8.1–8.6	$> 6.5 - < 9.0$
Specific conductance ($\mu\text{S}/\text{cm}$)	534	502–673	395	300–544	nc
Dissolved oxygen (mg/L)	8.3	6.8–9.1	8.8	8.0–10.0	> 5.0
Dissolved oxygen (%)	99.1	90.4–103	99.5	97.3–103	nc
Turbidity (NTU)	13	5.2–300	71	26–26,000	nc
Discharge (cfs)	64.6	14.3–81.3	65.8	51.9–79.8	nc

3.1.2 Precipitation

The National Oceanic and Atmospheric Administration/National Climatic Data Center operates weather stations in the upper Escalante watershed in the town of Escalante (#422592, 63 km away) and Boulder, Utah (#481930, 67 km away) (NOAA/NCDC 2016). Daily precipitation for 2014 is plotted in Figure 2 for both stations. The Escalante station recorded 18.9 cm of precipitation in 2014; the Boulder station recorded 24.2 cm.

A third NOAA weather station (421020, NOAA/NCDC 2016), located near Lake Powell at Bullfrog, Utah, is 24 km northeast of ESC02 and COY01. This is the closest active weather station to the monitoring sites; however the station is not located within the Escalante watershed. In 2014, 11.8 cm of precipitation was recorded (Figure 3).

3.1.3 Total coliforms and *E. coli*

Four samples for total coliforms and *E. coli* were collected from ESC02 in 2014. Results are presented in Figure 4 and the 2013 data are included for comparison. The numeric results are in Appendix B. The Escalante River is protected for infrequent primary contact recreation (UDEQ 2016), meaning that recreational use of the stream is

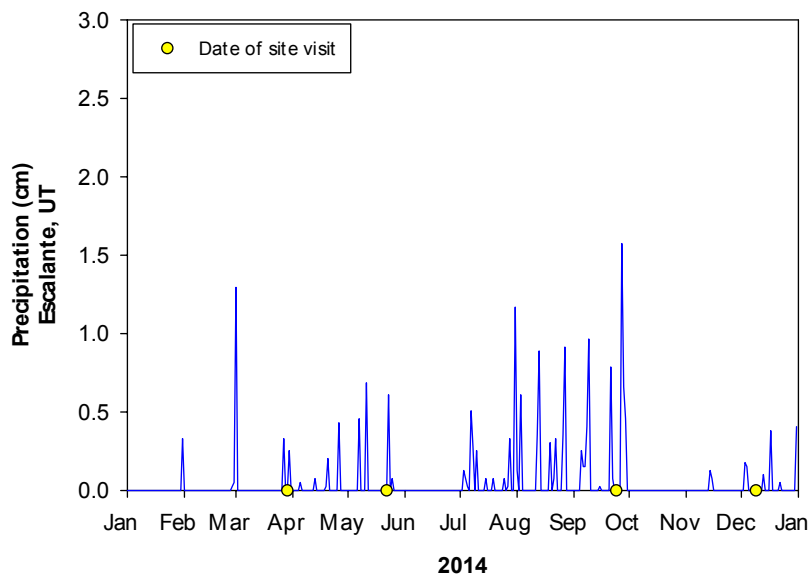


Figure 2. Daily precipitation from the NOAA/NCDC weather stations 422592 in Escalante, UT (top) and 481930 in Boulder, UT (bottom), located in the upper Escalante watershed, 2014.

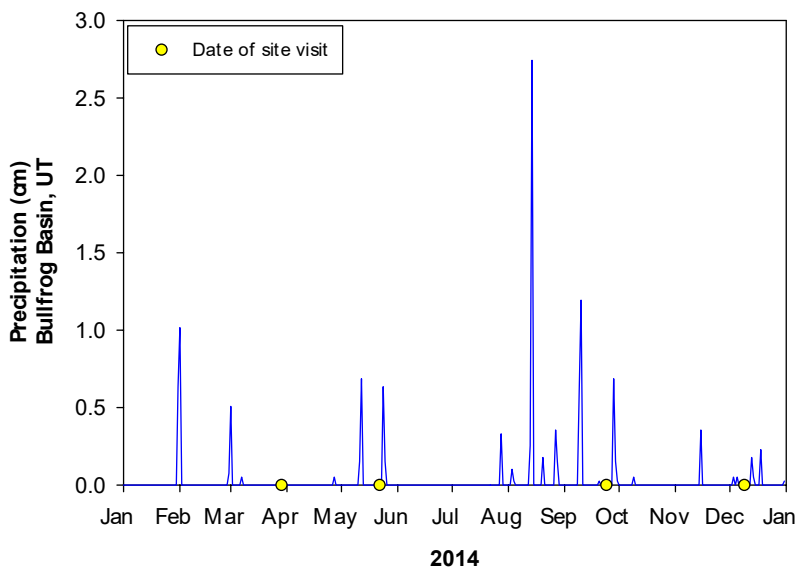
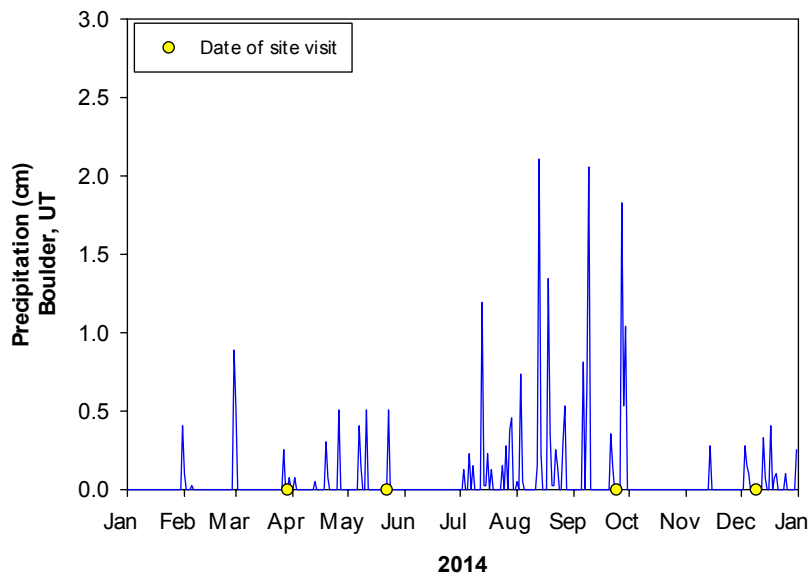


Figure 3. Daily precipitation from the NOAA/NCDC weather stations 421020 in Bullfrog Basin, UT, located 24 km northeast of ESC02 and COY01, 2014.

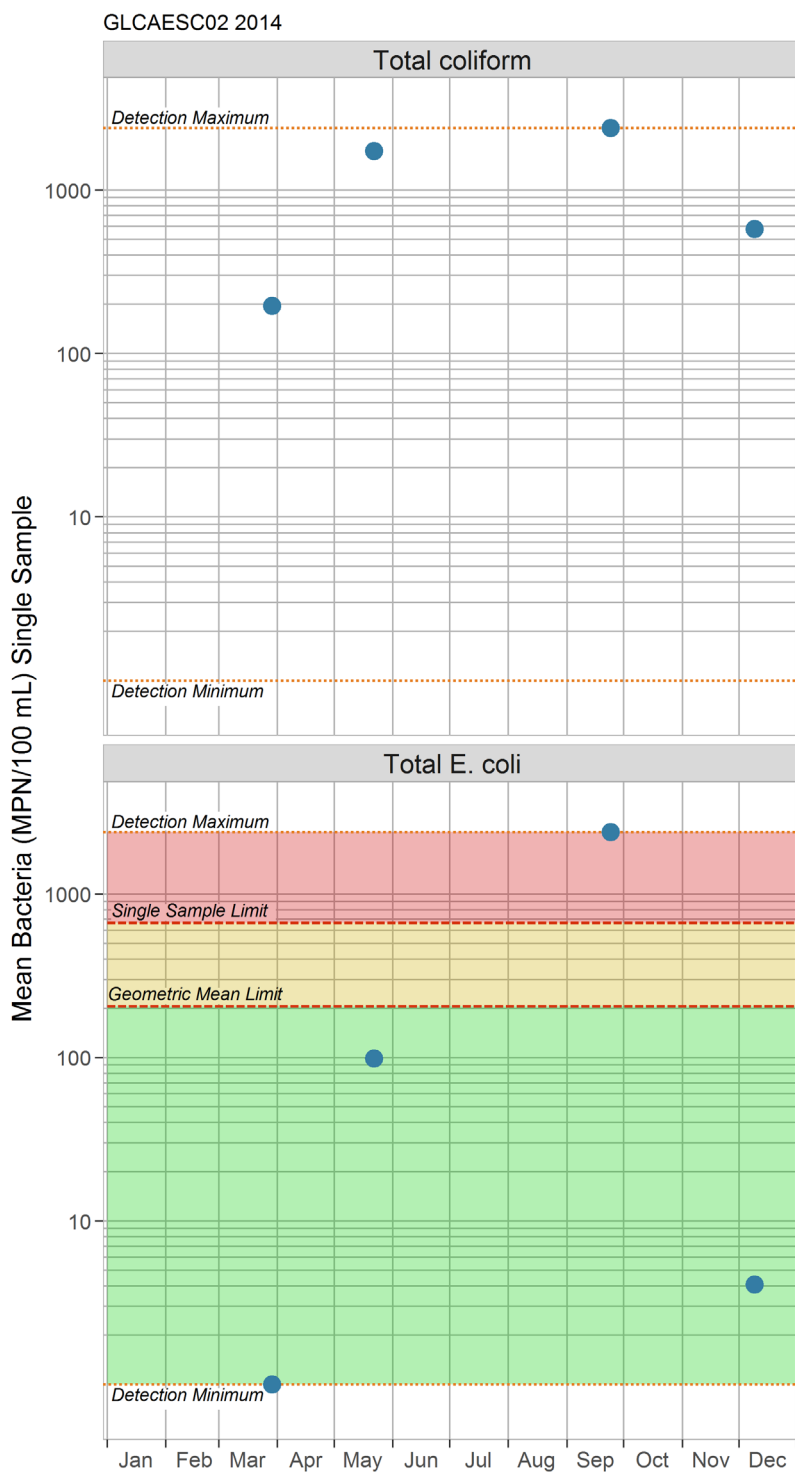


Figure 4. Total coliform (top) and *E. coli* (bottom) results from samples collected at ESC02, 2013–2014. The *E. coli* results from 4/4/13 and 3/29/14 were <1 MPN/100 mL.

presumed to be primarily through secondary contact recreation, such as wading or fishing, and there is a low likelihood that water will be ingested through activities such as swimming or rafting. For the Escalante River, Utah's criteria for *E. coli* is a single-sample maximum of 668 MPN/100 mL or a 5-sample monthly geometric mean of 206 MPN/100 mL. None of the samples exceeded these criteria; the results were <1, 99, >2400, and 4 MPN/100 mL in the March, May, September, and December samples.

Total coliforms, which include *E. coli* and many other types of bacteria, are also included in the analyses. They are indicators of the presence of all coliform groups of bacteria, both vegetative and fecal in origin. Total coliforms are used in drinking water testing because their presence indicates contamination of a water supply by an outside source. There are no water quality criteria for total coliforms. At ESC02, total coliform levels were 200, 1700, >2400, and 580 MPN/100 mL in the March, May, September, and December 2014 samples.

3.1.4 Water quality laboratory data

Nutrients, major element, and trace metal results from the three water samples collected at ESC02 on 29 March, 22 May, 24 September, and 9 December 2014 are presented in Tables 3–5. All results are compared to the Utah water quality standards applicable to ESC02 (UDEQ 2016).

Nutrient data are presented in Table 3. Ammonia was not detected in the samples above the laboratory reporting limit of 0.0200 mg/L. Nitrite concentrations were low and only detected in one sample just above the reporting level of 0.00200 mg/L. Nitrite+nitrate was also not detected above the reporting level in three samples, and well below the water quality criterion for nitrate, which is 4 mg/L. Orthophosphate concentrations were also very low, ranging from <0.00800 to 0.0101 mg/L.

Major element data are summarized in Table 4. Total dissolved solids ranged from 198–346 mg/L and did not exceed the 1200 mg/L water quality criterion for agriculture. Acid neutralizing capacity ranged from 120–168 mg/L in three samples; a sample collected on 24 September 2014 could not be analyzed.

Major ions are plotted in Figure 5 as a percentage of total milliequivalents per liter. Only three of the four samples are shown because bicarbonate plus carbonate could not be calculated due to the missing acid neutralizing capacity result. The plot shows that cations in the three ESC02 samples were primarily dominated by calcium, but magnesium and sodium plus potassium also play significant roles in the water chemistry. Cations were also very similar in the three samples. Anions were dominated by bicarbonate plus carbonate.

Trace metal data are presented in Table 5, along with the water quality criteria applicable to ESC02. Trace metal concentrations were similar in three of the samples; but several trace metals, particularly aluminum, iron, and manganese, were much higher in the September sample. Of the 21 analytes, four were not detected above the reporting level in the four samples: cadmium, chromium, mercury, and silver. There were no exceedances of the water quality criteria.

Table 3. Nutrient data from ESC02 at Glen Canyon NRA, 2014. An “nc” indicates that no criteria have been developed for a particular nutrient, and a “ndc” indicates that there is no dissolved criterion. Results that were lower than the National Water Quality Laboratory reporting levels are noted as “<[reporting level]”.

Sampling date and time	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 9:50	12/9/2014 11:32	Lowest criterion (mg/L)	# of exceedances	Beneficial use
Nutrients (mg/L)							
Ammonia as N	<0.0200	<0.0200	<0.0200 ^a	<0.0200	ndc	ndc	ndc
Nitrite + nitrate as N	<0.080	<0.080	0.273	<0.080 ^a	4 (nitrate only)	0	warm water aquatic life
Nitrite as N	<0.00200	<0.00200	0.00259	<0.00200	nc	nc	nc
Orthophosphate as P	<0.00800 ^a	<0.00800 ^a	<0.00800	0.0101	ndc	ndc	ndc

^a Result is below the Laboratory Reporting Level, but above the method detection level.

Table 4. Major element data from ESC02 at Glen Canyon NRA, 2014. All analytes are dissolved except for acid neutralizing capacity, which was measured in unfiltered samples. There are no Utah water quality criteria for these analytes. An “nd” indicates not data were available.

Sampling date and time	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 9:50	12/9/2014 11:32	Lowest criterion (mg/L)	# of exceedances	Beneficial use
Major elements (mg/L)							
Calcium	55.2	29.8	45.5	47.0	nc	nc	nc
Chloride	31.4	12.6	9.77	25.4	nc	nc	nc
Fluoride	0.207	0.153	0.207	0.180	nc	nc	nc
Magnesium	22.5	11.7	14.2	17.9	nc	nc	nc
Potassium	3.10	2.34	7.64	2.68	nc	nc	nc
Silica	17.5	13.7	9.39	18.8	nc	nc	nc
Sodium	28.1	12.6	18.3	22.0	nc	nc	nc
Sulfate	85.0	34.1	54.1	64.7	nc	nc	nc
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	168	120	nd	142	nc	nc	nc
Total dissolved solids	346	198	213	288	1200	0	agriculture

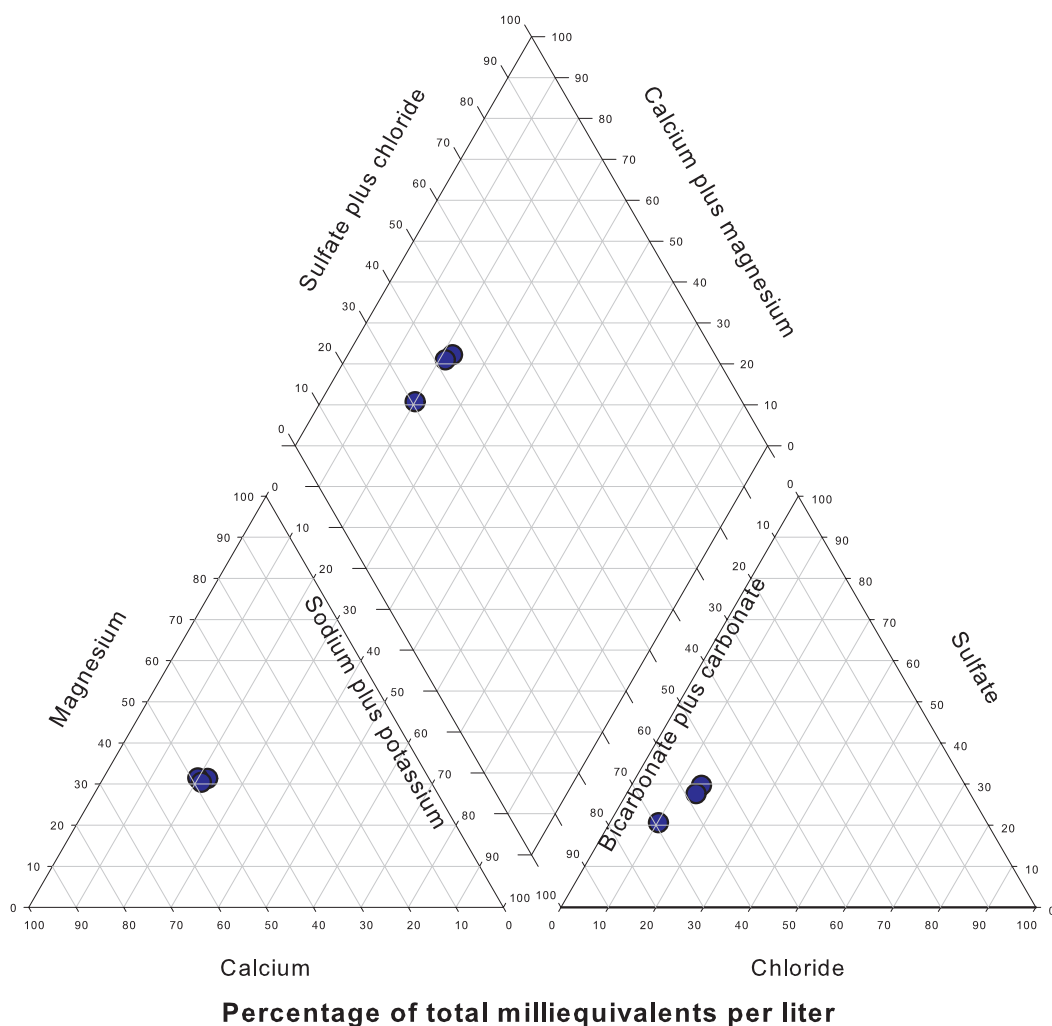


Figure 5. Major ion composition at ESC02 in Glen Canyon NRA, 2014.

3.1.5 Contaminants of emerging concern

In 2014, two samples were collected at ESC02 to be analyzed for contaminants of emerging concern by the USEPA Region 8 lab. Pesticide/PPCP samples were collected on 22 May and 24 September. No waste indicator samples were collected at this site in 2014. Three contaminants were detected: caffeine and the herbicides tri-clopyr and imazethapyr (Table 6). The complete list of Pesticide/PPCP analytes is in Appendix C.

Table 5. Dissolved trace metal data from samples collected at ESC02 on the in Glen Canyon NRA, 2014, and number of times that the samples were outside the applicable water quality criteria. An "nc" indicates that no criteria have been developed for a particular trace metal, and an "ndc" indicates that no dissolved criteria exist. Results that were lower than the NWQL reporting levels are noted as "<[reporting level]".

Trace metal, dissolved (µg/L)	Sampling date and time				Lowest criterion (mg/L)	# of exceedances	Beneficial use
	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 9:50	12/9/2014 11:32			
Aluminum	<4.40 ^a	19.0	513	<6.00 ^a	ndc	ndc	human health - organism only
Antimony	0.0910	0.176	0.381	<0.0540	640	0	

Table 5. Dissolved trace metal results for ESC02 in 2014 (*continued*)

Sampling date and time	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 9:50	12/9/2014 11:32	Lowest criterion (mg/L)	# of exceedances	Beneficial use
Arsenic	2.97	2.62	2.58	2.43	100	0	agriculture
Barium	90.4	58.6	167	79.3	nc	nc	nc
Beryllium	<0.040	<0.040	0.167	<0.040	nc	nc	nc
Boron	40.4	26.7	69.1	36.5	750	0	agriculture
Cadmium	<0.060	<0.060	<0.060 ^a	<0.060	0.28–0.44	0	warm water aquatic life
Chromium	<0.60	<0.60	<0.60	<0.60 ^a	Cr (III) 87.6–147, Cr (VI) 11	0	warm water aquatic life
Cobalt	0.431	0.280	4.76	<0.100 ^a	nc	nc	nc
Copper	<1.60	<1.60 ^a	3.91	<1.60	10.7–18.3	0	warm water aquatic life
Iron	<8.00a	31.4	374	16.2	1000	0	warm water aquatic life
Lead	<0.080	0.199	1.30	<0.080	3.14–6.17	0	warm water aquatic life
Manganese	5.90	5.04	142	3.65	nc	nc	nc
Mercury	<0.010	<0.010	<0.010	<0.010	0.012	0	warm water aquatic life
Molybdenum	0.692	0.529	0.566	0.625	nc	nc	nc
Nickel	0.866	1.27	2.63	0.948	61.8–105	0	warm water aquatic life
Selenium	0.234	0.186	0.884	0.174	4.6	0	warm water aquatic life
Silver	<0.040	<0.040	<0.040	<0.040	4.57–13.5	0	warm water aquatic life
Uranium	1.28	0.630	2.27	1.01	nc	nc	nc
Vanadium	1.4	1.99	4.31	1.24	nc	nc	nc
Zinc	<4.00	<4.00	5.57	<4.00	140–240	0	warm water aquatic life

^a Result is below the Laboratory Reporting Level, but above the Method Detection Level.

Table 6. Summary of contaminants of emerging concern detections in 4 samples collected at ESC02 in Glen Canyon NRA, 2014. An “nd” indicates that the contaminant was not detected.

Contaminant	Use	Number of detections
Pesticides		
Triclopyr	herbicide	2
Imazethapyr	herbicide	1
Pharmaceuticals and personal care products		
Caffeine	Stimulant drug	1
Waste indicators		Not collected

3.2 Coyote Gulch above Crack-in-the-Wall Trail

3.2.1 Water quality core parameter data

Core parameter measurements at COY01 were collected during four site visits in 2014. Medians and ranges for these measurements are displayed in Table 7, along with the Utah water quality criteria for aquatic life. The 2013 data are also summarized for comparison. The complete results, along with dates of site visits, are in Appendix B.

Temperature ranged from 5.2–26.1°C, below the water quality criterion of 27°C. Values for pH ranged from 8.4–8.6, within the water quality criteria of 6.5–9.0. Dissolved oxygen ranged from 6.8–10.7 mg/L, above the water quality criterion of 5.0 mg/L.

Specific conductance measurements were fairly consistent between site visits and ranged from 302–341 µS/cm. Turbidity ranged from 22–250 NTU, and discharge ranged from 1.4–2.8 cfs.

All measurements for water temperature, pH, and dissolved oxygen were within the Utah DEQ water quality criteria.

3.2.2 Total coliforms and *E. coli*

Four samples were collected and analyzed for total coliforms and *E. coli* in 2014. The results are plotted in Figure 6 and the numeric results are in Appendix B. In three of the four samples, total coliforms exceeded the maximum limit of the IDEXX test, which is 2400 MPN/100 mL. There are no water quality criteria for total coliforms.

As a tributary to Lake Powell, Coyote Gulch is to be protected for infrequent primary contact recreation (UDEQ 2016). The water quality criteria for *E. coli* are a single-sample maximum of 668 MPN/100 mL, or a 5-sample monthly geometric mean of 206 MPN/100 mL. None of the four samples exceeded these criteria; the range was 1–66 MPN/100 mL.

3.2.3 Water quality laboratory data

Nutrient, major element, and trace metal results from the four samples collected at COY01 in 2014 are presented in Tables 8–10, along with the Utah water quality standards applicable to COY01 (UDEQ 2016).

Nutrient data are presented in Table 8. Ammonia was not detected in any of the samples above the laboratory reporting limit of 0.0200 mg/L. Nitrite was detected twice, but results were near the reporting level of 0.00200 mg/L. Nitrite+nitrate was detected only once, and this result was just above the reporting level as well, and far below the water quality criterion of 4 mg/L. Orthophosphate was not detected in any of the samples; the reporting level was 0.00800 mg/L.

Table 7. Summary of water quality core parameter data from COY01 on Coyote Gulch in Glen Canyon NRA, 2014 ($n=4$). Data for 2013 ($n=4$) is included for comparison. The associated Utah water quality criteria are indicated for each parameter. An "nc" indicates that no criteria exist for a specific parameter. An "nd" indicates that no data are available.

Core parameter	2013		2014		UT State aquatic life criteria
	Median	Range	Median	Range	
Water temperature (°C)	15.9	0.1–21.1	12.6	5.2–26.1	≤ 27.0
pH	8.4	8.2–8.5	8.5	8.4–8.6	>6.5 – <9.0
Specific conductance (µS/cm)	360	282–513	323	302–341	nc
Dissolved oxygen (mg/L)	8.7	7.1–12.6	9.2	6.8–10.7	>5.0
Dissolved oxygen (%)	98.8	91.9–104	100	95.8–104	nc
Turbidity (NTU)	39	4.3–450	67	22–250	nc
Discharge (cfs)	2.5	0.2–3.0	2.2	1.4–2.8	nc

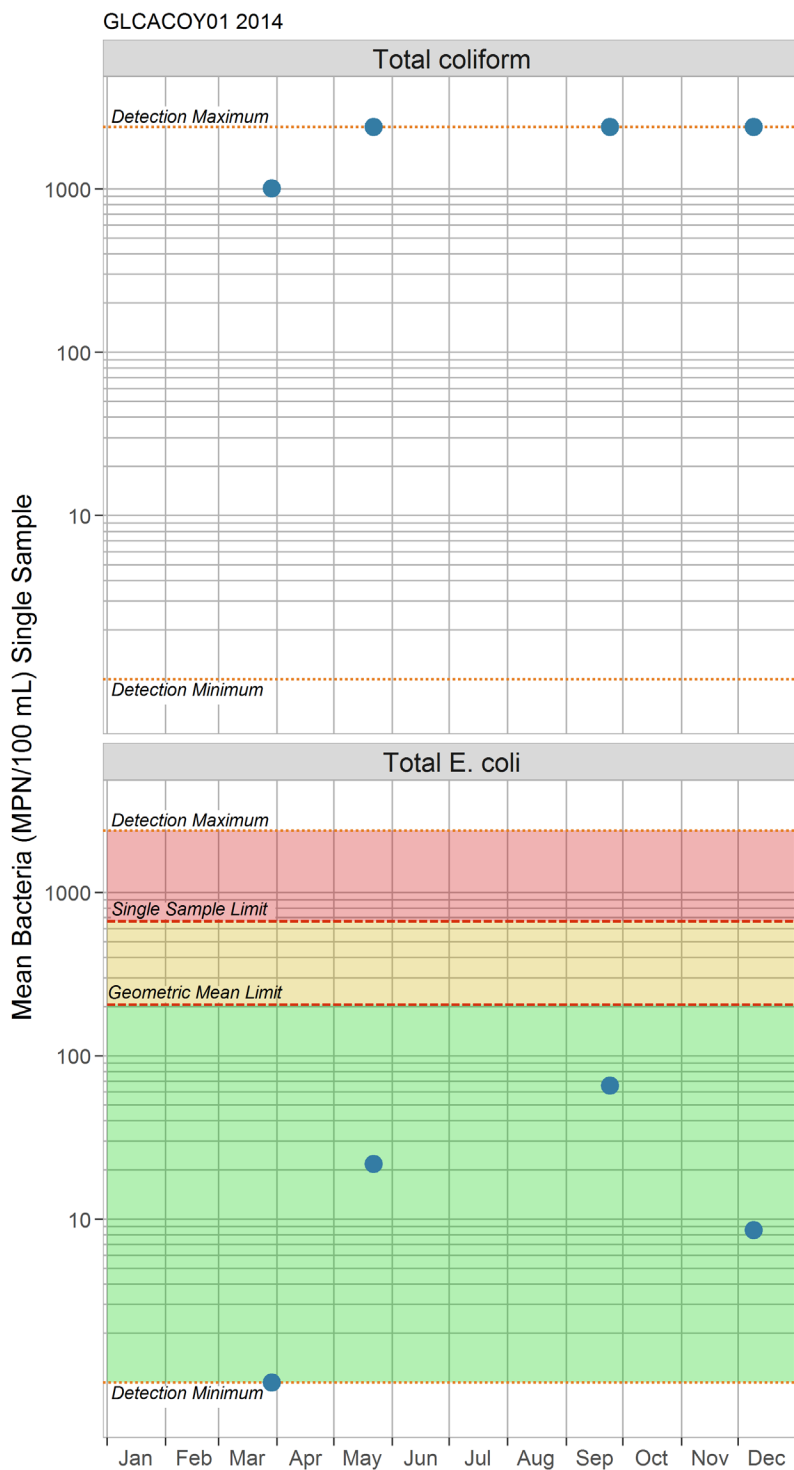


Figure 6. Total coliforms (top) and *E. coli* (bottom) results from samples collected at COY01 in Glen Canyon NRA, 2013–2014. The *E. coli* result from 4/4/13 was <1 MPN/100 mL.

Major element data are summarized in Table 9. These include the major ions, silica, acid neutralizing capacity, and total dissolved solids. Silica concentrations were similar between samples and ranged from 9.92–11.1 mg/L. Acid neutralizing capacity also did not vary much between samples and ranged from 159–190 mg/L. Total dissolved solids ranged from 179–210 mg/L and all samples were below the water quality criterion of 1200 mg/L. Major ions are plotted in Figure 7, showing that anions in these samples were almost entirely dominated by bicarbonate plus carbonate. Cations mostly consisted of calcium and, to a lesser extent, magnesium.

Trace metal data are presented in Table 10, along with the water quality criteria applicable to COY01. Trace metal concentrations were similar between samples. Eight of the 21 trace metals included in the analyses were not detected in the four samples: beryllium, cadmium, chromium, copper, lead, mercury, silver, and zinc. There were no exceedances of the water quality criteria; metals that were detected in these samples were present at levels well below these criteria.

Continued on page 16...

Table 8. Nutrient data (mg/L) from COY01 on Coyote Gulch in Glen Canyon NRA, 2014. An “nc” indicates that no criteria have been developed for a particular nutrient, and an “ndc” indicates that there is no dissolved criterion. Results that were lower than the National Water Quality Laboratory reporting levels are noted as “<[reporting level]”.

	Sampling date and time						
	3/29/2014 11:30	5/22/2014 16:25	9/24/2014 11:15	12/9/2014 13:23	Lowest crite- rion (mg/L)	# of exceedances	Beneficial use
Nutrients (mg/L)							
Ammonia as N	<0.0200	<0.0200	<0.0200	<0.0200 ^a	ndc	ndc	ndc
Nitrite + nitrate as N	0.086	<0.080 ^a	<0.080	<0.080 ^a	4 (nitrate only)	0	warm water aquatic life
Nitrite as N	<0.00200 ^a	0.00284	<0.00200	0.00202	nc	nc	nc
Orthophosphate as P	<0.00800	<0.00800	<0.00800	<0.00800	ndc	ndc	ndc

^a Result is below the Laboratory Reporting Level, but above the Method Detection Level.

Table 9. Major element data from COY01 at Glen Canyon NRA, 2014. All analytes are dissolved except for acid neutralizing capacity, which was measured in unfiltered samples. There are no Utah state water quality criteria (nc) for these analytes, except for total dissolved solids

Major element (mg/L)	Sample collection date and time				Lowest criterion (mg/L)	# of exceedances	Beneficial use
	3/29/2014 11:30	5/22/2014 16:25	9/24/2014 11:15	12/9/2014 13:23			
Calcium	50.3	41.8	50.8	48.0	nc	nc	nc
Chloride	2.92	2.13	2.08	2.17	nc	nc	nc
Fluoride	0.171	0.186	0.177	0.150	nc	nc	nc
Magnesium	14.7	11.8	11.7	12.2	nc	nc	nc
Potassium	1.77	1.91	2.71	1.61	nc	nc	nc
Silica	10.2	9.96	11.1	9.92	nc	nc	nc
Sodium	3.74	2.93	3.06	2.59	nc	nc	nc
Sulfate	15.5	8.98	16.3	8.81	nc	nc	nc
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	180	159	190	172	nc	nc	nc
Total dissolved solids	210	179	199	187	1200	0	agriculture

Table 10. Trace metal data from samples collected at COY01 in Glen Canyon NRA, 2014, and the water quality criteria for each trace metal. An “ndc” indicates that there is no dissolved criterion for a particular trace metal. Results that were lower than the National Water Quality Laboratory reporting levels are noted as “<[reporting level]”.

Trace metal (µg/L)	Sample collection date and time				Lowest criterion (mg/L)	# of exceedances	Beneficial use
	4/4/2013 15:00	6/13/2013 6:40	9/26/2013 13:30	12/11/2013 13:45			
Aluminum	5.64	15.1	8.27	6.16	ndc	0	warm water aquatic life
Antimony	0.0697	0.152	0.190	0.0590	640	0	human health - organism only
Arsenic	0.916	1.67	1.93	0.721	100	0	agriculture

Table 10. (continued) Trace metal data (mg/L) from samples collected at COY01 in Glen Canyon NRA, 2014.

Trace metal	Sample collection date and time				Most stringent criterion (mg/L)	# of exceedances	Beneficial use
	4/4/2013 15:00	6/13/2013 6:40	9/26/2013 13:30	12/11/2013 13:45			
Barium	247	261	161	226	nc	nc	nc
Beryllium	<0.040	<0.040	<0.040	<0.040	nc	nc	nc
Boron	26.0	24.8	30.0	21.8	750	0	agriculture
Cadmium	<0.060	<0.060	<0.060	<0.060	0.33–0.38	0	warm water aquatic life
Chromium	<0.60	<0.60	<0.60	<0.60	Cr (III) 105–123, Cr (VI) 11	0	warm water aquatic life
Cobalt	0.534	0.237	0.906	0.216	nc	nc	nc
Copper	<1.60	<1.60 ^a	<1.60 ^a	<1.60	12.9–15.2	0	warm water aquatic life
Iron	10.3	11.5	<8.00 ^a	12.9	1000	0	warm water aquatic life
Lead	<0.080	<0.080	<0.080 ^a	<0.080	3.99–4.92	0	warm water aquatic life
Manganese	6.40	1.79	4.81	8.23	nc	nc	nc
Mercury	<0.010	<0.010	<0.010	<0.010	0.012	0	warm water aquatic life
Molybdenum	0.641	0.708	1.42	0.653	nc	nc	nc
Nickel	0.955	1.36	1.45	1.08	74.6–88.0	0	warm water aquatic life
Selenium	0.138	0.157	0.172	<0.100 ^a	4.6	0	warm water aquatic life
Silver	<0.040	<0.040	<0.040	<0.040	6.69–9.37	0	warm water aquatic life
Uranium	0.394	0.292	0.577	0.343	nc	nc	nc
Vanadium	.547	1.28	2.26	.440	nc	nc	nc
Zinc	<4.00	<4.00	<4.00	<4.00	169–200	0	warm water aquatic life

a Results were below the laboratory reporting level but above the minimum detection level.

Continued from page 14

3.2.4 Contaminants of emerging concern

Table 11 contains the contaminant of emerging concern detections found in two samples collected at COY01 in 2014. Both samples were analyzed for pesticides, pharmaceuticals, and personal care products. One sample was also analyzed for waste indicators. The complete list of over 250 analytes is in Appendix C; four of these analytes were detected in the COY01 samples. Pesticides were not found in either sample. Caffeine and DEET were detected in both samples. In the waste indicator sample, Bisphenol A (a component of some plastics and of metal can coatings) and the flame retardant tri(2-butoxyethyl) phosphate were detected. There are no water quality criteria for these analytes.

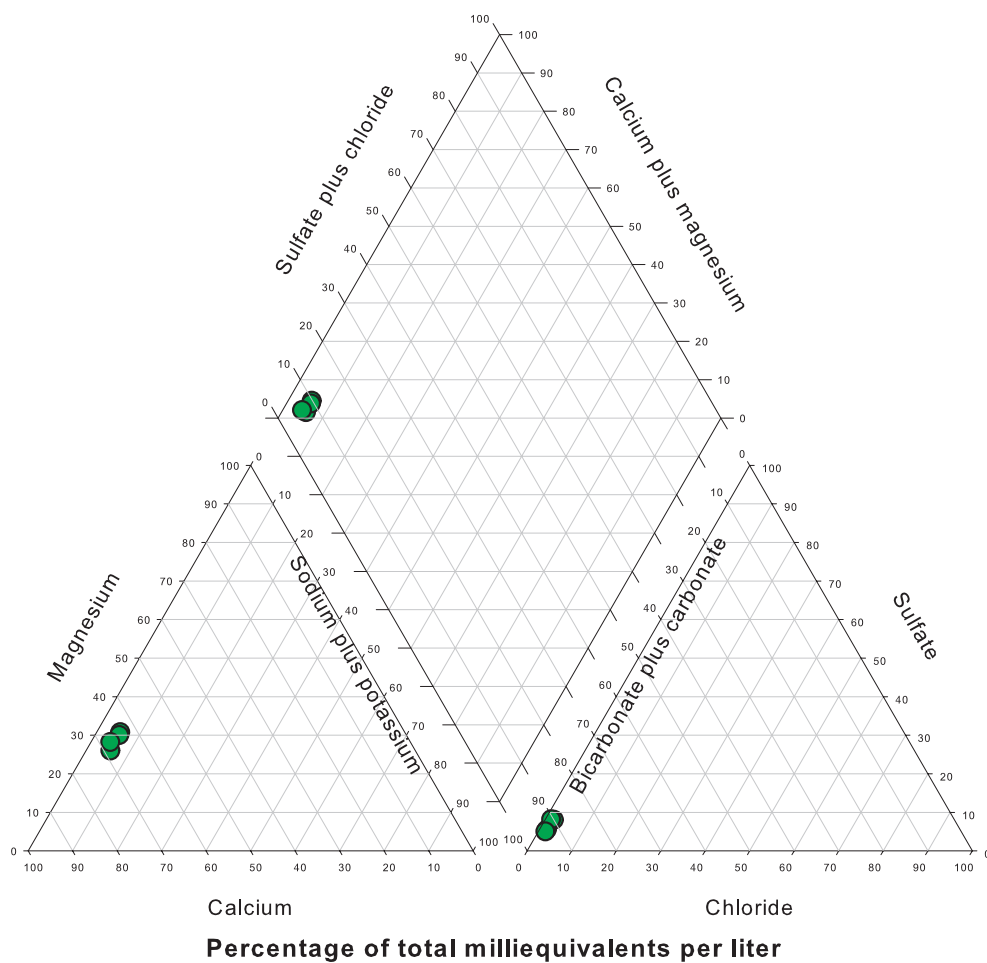


Figure 7. Major ion composition at COY01 in Glen Canyon NRA, 2014.

Table 11. Summary of detections of contaminants of emerging concern in 2 samples collected at COY01 on Coyote Gulch in Glen Canyon NRA, 2014.

Contaminant	Use	No. of detections
Pesticides		0
Pharmaceuticals and personal care products		
Caffeine	Stimulant drug	2
DEET	Insect repellent	2
Waste indicators		
Bisphenol A		1
Tri(2-butoxyethyl) Phosphate		1

4 Quality Assurance/Quality Control

We followed the quality assurance/quality control procedures described in Monroe et al. (2016) and in National Park Service (2013). To ensure accuracy of the instruments, we calibrated and performed maintenance on the multiparameter sondes in an indoor laboratory four times per year. We checked the current meters according to manufacturer recommendations to determine that they were in working order, and calibrated the turbidimeter quarterly in the lab. The turbidimeter was also checked for drift in the field prior to each measurement.

In 2014, five duplicate bacteria samples were collected at several SCPN monitoring sites by filling two sample bottles in succession and comparing tray results after the incubation period. In addition, two blank samples were processed using sterile water provided by IDEXX.

To verify the cleanliness of both the sampling equipment and the sample filtration process for nutrients, major elements, and trace metals, NWQL analyzed two sample sets of certified inorganic blank water. The results were compared against the 2014 reporting levels.

In 2014, SCPN did not collect field blank or field duplicate samples for the Contaminants of Emerging Concern at GLCA. Laboratory quality control information such as laboratory method blanks, blank spikes, matrix spikes, and other QA/QC checks were included in the EPA reports to SCPN; this information was considered when evaluating data quality.

5 Summary

This report summarizes water quality monitoring activities at the Escalante River and Coyote Gulch in GLCA during 2014 and compares the results to the data collected in 2013 and to the Utah water quality standards (UDEQ 2014). Prior to 2012, limited water quality data was collected at these streams, but in 2013 ESC02 and COY01 became regular SCPN water quality monitoring sites to be visited on a quarterly basis.

NPS core parameter measurements for water temperature, pH, specific conductance, dissolved oxygen, turbidity and discharge were recorded at all site visits. Measurements for temperature, pH, and dissolved oxygen were within the Utah state water quality criteria.

Starting in 2013, samples for *E. coli* and total coliform bacteria were collected during each of the quarterly site visits. Results for *E. coli* were well below the Utah state water quality criteria at ESC02 and COY01.

Nutrient and trace metal concentrations were low at both sites, and also below the Utah water quality criteria. “A total of three contaminants of emerging concern were detected at the Escalante River, and a total of four were detected at Coyote Gulch.” These chemicals included herbicides, DEET, caffeine, endocrine disruptors, and flame retardants.

The data in this report should be viewed as a snapshot of water quality conditions existing at the time that the data was collected. Data and analyses in this report are provisional and are subject to change. When sufficient data are available, SCPN plans to produce an interpretive report which will include trend analysis of water quality data for the Escalante River and Coyote Gulch in Glen Canyon NRA.

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Appendix A: Southern Colorado Plateau Network Water Quality Monitoring Sites in Glen Canyon National Recreation Area

Table A1. Southern Colorado Plateau Network (SCPN) water quality monitoring sites for Glen Canyon NRA, 2011–2013.

Site code	Common name	Report name	Easting (m) ^a	Northing (m) ^a	Elevation (m) ^a
GLCACOY01 ^b	Coyote Gulch above Crack-in-the-Wall Trail	COY01	500945	4142251	1147
GLCAESC02 ^b	Escalante River at Coyote Gulch	ESC02	501698	4142320	1129

^a Horizontal coordinates are reported in Universal Transverse Mercator (UTM) projection, Zone 12 North, North American Datum of 1983 (NAD 83). Vertical coordinates are referenced to the North American Vertical Datum of 1988 (NAVD 88).

^b SCPN long-term water quality monitoring sites.

Appendix B. Water quality monitoring results for the Escalante River and Coyote Gulch at Glen Canyon National Recreation Area, 2014

Table B1. Water quality core parameter data from ESC02 on the Escalante River in Glen Canyon NRA, 2013–2014. An "nd" indicates no data are available.

Parameter	Sampling date and time			
	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 13:35	12/9/2014 11:32
Water temperature (°C)	10.0	20.7	18.3	5.9
pH	8.5	8.4	8.1	8.6
Specific conductance (µS/cm)	544	300	348	442
Dissolved oxygen (mg/L)	10.0	8.0	8.1	9.5
Dissolved oxygen (% saturation)	101	103	98.3	97.3
Turbidity (NTU)	34	110	26,000 ^a	26
Discharge cfs	nd	79.8	51.9	nd
a This is an estimated result				

Table B2. Total coliforms and *E. coli* in samples collected at ESC02 on the Escalante River in Glen Canyon NRA, 2013.

Parameter	Sampling date and time			
	3/29/2014 9:56	5/22/2014 14:30	9/24/2014 13:35	12/9/2014 11:32
Total coliforms, MPN/100mL	200	1700	>2400 ^a	580 ^b
<i>E. coli</i> , MPN/100mL	<1	99	>2400 ^a	4 ^b

a Exceeded the maximum detection level of the IDEXX system, which is 2400 MPN/100 mL

b Two packages of colilert accidentally applied to sample

Table B3. Contaminants of Emerging Concern data for samples taken from ESC02 on the Escalante River in Glen Canyon NRA in 2014. An "nd" indicates that no data are available.

Contaminant (ng/L)	Use	Reporting limit (ng/L)	Sampling date and time	
			5/22/2014 16:30	9/24/2014 9:50
Pesticides				
Imazethapyr	Herbicide	20		55.6
Triclopyr	Herbicide	20	80.5 ^a	102
Pharmaceuticals and personal care products			nondetect	
Caffeine	Stimulant drug	25		30.2
Waste indicators			Not collected	

a Analyzed outside holding time; method blank spike yield was low

Table B4. Water quality core parameter data from COY01 on Coyote Gulch in Glen Canyon NRA, 2013–2014.

Parameter	Sampling date and time			
	3/29/2014 10:30	5/22/2014 16:25	9/24/2014 11:15	12/9/2014 13:23
Water temperature (°C)	7.9	26.1	17.2	5.2
pH	8.4	8.6	8.4	8.6
Specific conductance (µS/cm)	340	305	341	302
Dissolved oxygen (mg/L)	10.7	6.8	8.8	9.6
Dissolved oxygen (% saturation)	103	95.8	104	96.7
Turbidity (NTU)	51	22	250	83
Discharge cfs	2.8	1.4	1.5	2.8

a This is an estimated result

Table B5. Total coliforms and *E. coli* in samples collected at COY01 on the Escalante River in Glen Canyon NRA, 2013–2014.

Parameter	Sampling date and time			
	3/29/2014 10:30	5/22/2014 16:25	9/24/2014 11:15	12/9/2014 13:23
Total coliforms, MPN/100mL	1000	>2400 ^a	>2400 ^a	>2400 ^a
<i>E. coli</i> , MPN/100mL	1	22	66	9

a Exceeded the maximum detection level of the IDEXX system, which is 2400 MPN/100 mL

Table B6. Contaminants of Emerging Concern data for samples taken from COY01 in Coyote Gulch in Glen Canyon NRA in 2014.

Contaminant (ng/L)	Use	Reporting limit (ng/L)	Sampling date and time	
			5/22/2014 16:25	9/24/2014 11:15
Pesticides			nondetect	nondetect
Pharmaceuticals and personal care products				
Caffeine	Stimulant drug	25	27.1 ^a	48.6
Deet	Insect repellent	10	53.5 ^a	15.7
Waste indicators				Not collected
Bisphenol A		50	77.1 ^a	
Tri(2-butoxyethyl) Phosphate		50	162 ^{a,b}	

a Analyzed outside holding time; method blank spike yield was low

b Method blank spike result was out of range (133%, should be 70-130%), result may be biased high.

Appendix C: List of analytes and reporting limits for contaminants of emerging concern

Table C-1. Target analytes and U.S. Environmental Protection Agency reporting limits for pesticides

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
2,4,5-T	10.0	Ethoprop	10.0
2,4,5-TP	10.0	Fipronil	20.0
2,4-D	10.0	Fipronil sulfide	10.0
3-Hydroxycarbofuran	10.0	Fipronil sulfone	10.0
Acetochlor	20.0	Foramsulfuron	20.0
Acetochlor OA	20.0	Hexazinone	10.0
Alachlor	20.0	Imazaquin	20.0
Alachlor OA	50.0	Imazethapyr	20.0
Aldicarb	10.0	Imidacloprid	20.0
Aldicarb sulfone	20.0	Linuron	20.0
Aldicarb sulfoxide	10.0	Malathion	10.0
Atraton	10.0	MCPP	20.0
Atrazine	10.0	Metalaxyl	10.0
Atrazine de-ethyl	20.0	Methiocarb	20.0
Atrazine de-isopropyl	20.0	Methomyl	20.0
Azoxystrobin	20.0	Metolachlor	10.0
Bentazon	10.0	Metolachlor ESA	20.0
Bromacil	50.0	Metribuzin	20.0
Bromoxynil	10.0	Monuron	10.0
Butachlor ESA	10.0	Neburon	50.0
Carbaryl	10.0	Oryzalin	20.0
Carbofuran	10.0	Oxamyl	10.0
Chlorimuron ethyl	20.0	Prometon	20.0
Chlorsulfuron	20.0	Propachlor	10.0
Clothianidin	20.0	Propachlor ESA	20.0
Cyanazine	10.0	Propachlor OA	10.0
Dacthal monoacid	20.0	Propazine	20.0
Diazinon	20.0	Propiconazole	50.0
Dichloroprop	10.0	Propoxur	10.0
Dimethachlor	10.0	Simazine	20.0
Dimethenamid	10.0	Sulfometuron methyl	20.0
Dimethenamid ESA	20.0	Tebuconazole	50.0
Disulfoton sulfone	20.0	Tebuthiuron	10.0
Diuron	20.0	Terbuthylazine	10.0
Diuron Metabolite	20.0	Thiamethoxam	20.0
EPTC	20.0	Triclopyr	20.0

Table C-2. Target analytes and U.S. Environmental Protection Agency reporting limits for pharmaceuticals and personal care products

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
(+/-)11-nor-9-carboxy-delta-THC	10.0	Duloxetine	25.0
10,11-dihydro-10-hydroxycarbamazepine	10.0	Ecgonine Methyl Ester	10.0
6-Acetylmorphine	10.0	EDDP	10.0
Acebutolol	10.0	Erythromycin	10.0
Acetaminophen	10.0	Erythromycin-anhydro	10.0
Albuterol	10.0	Escitalopram	10.0
Amitriptyline	10.0	Famotidine	10.0
Amitriptyline (+/-)-E-10-hydroxylated	10.0	Fenbufen	25.0
Amphetamine	10.0	Fentanyl	10.0
Aripiprazole	10.0	Fluoxetine	10.0
Atenolol	10.0	Fluticasone propionate	10.0
Atorvastatin	10.0	Furosemide	10.0
Atrazine	10.0	Gabapentin	10.0
Benzoylecgonine	10.0	Gemfibrozil	10.0
Bezafibrate	10.0	Glyburide	10.0
Buprenorphine	10.0	Hydrochlorothiazide	10.0
Bupropion	10.0	Hydrocodone	10.0
Caffeine	25.0	Hydromorphone	10.0
Carbamazepine	10.0	Hydroxybupropion	10.0
Carbamazepine 10,11 epoxide	10.0	Ibuprofen	25.0
Carisoprodol	10.0	Ketoprofen	10.0
Celecoxib	10.0	Lamotrigine	10.0
Chloramphenicol	10.0	Levorphanol	10.0
Chlorpheniramine	10.0	Lidocaine	10.0
Clenbuterol	10.0	Loratadine	10.0
Clopidogrel carboxylic acid	10.0	Lorazepam	25.0
Cocaethylene	10.0	MDA	10.0
Cocaine	10.0	MDEA	10.0
Codeine	10.0	MDMA	10.0
Cotinine	10.0	Mefenamic acid	10.0
DEET	10.0	Meperidine	10.0
Dehydroaripiprazole	10.0	Meprobamate	10.0
Desmethylcitalopram	10.0	Metformin	10.0
Desmethylvenlafaxine	10.0	Methadone	10.0
Dextromethorphan	10.0	Methamphetamine	10.0
Diclofenac	10.0	Methotrexate	10.0
Diclofenac 4-hydroxy	25.0	Methylparaben	25.0
Diltiazem	10.0	Methylphenidate	10.0
Diphenhydramine	10.0	Metoprolol	10.0
Disopyramide	10.0	Mevastatin	10.0
Donepezil	10.0	m-Hydroxybenzoylecgonine	10.0

Table C-2. Target analytes and U.S. Environmental Protection Agency reporting limits for pharmaceuticals and personal care products, *continued*

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
Modafinil	10.0	Pregabalin	10.0
Modafinil acid	25.0	Primidone	25.0
Monoethylglycinexylidide	10.0	Propranolol	10.0
Montelukast	10.0	Pseudoephedrine	10.0
Morphine	10.0	Quetiapine	10.0
Naproxen	25.0	Ritalinic acid	10.0
n-Butylparaben	25.0	Sertraline	10.0
Nifedipine	10.0	Sildenafil	10.0
Nifedipine oxidized	10.0	Simvastatin	10.0
Norfentanyl	10.0	Sotalol	10.0
Norfluoxetine	10.0	Sulfamethazine	10.0
Normeperidine	10.0	Sulfamethoxazole	10.0
Norquetiapine	10.0	Sumatriptan	10.0
Norsertaline	10.0	Tadalafil	25.0
Norverapamil	10.0	Temazepam	10.0
Omeprazole	10.0	Thiabendazole	10.0
Oxazepam	10.0	Tramadol	10.0
Oxcarbazepine	10.0	Trazodone	10.0
Oxycodone	10.0	Triamterene	10.0
Oxymorphone	10.0	Triclocarban	10.0
Oxymorphone glucuronide	10.0	Triclosan	25.0
Paroxetine	10.0	Trimethoprim	10.0
Phenmetrazine	10.0	Tylosin	25.0
Phenobarbital	25.0	Valsartan	10.0
Phentermine	25.0	Venlafaxine	10.0
Phenylpropanolamine	10.0	Verapamil	10.0
Phenytoin	10.0	Warfarin	10.0
Pioglitazone	10.0	Zolpidem	10.0
Pravastatin	25.0	Zolpidem phenyl-4-carboxylic acid	10.0

Table C-3. Target analytes and U.S. Environmental Protection Agency reporting limits for wastewater indicators

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
1,4-Dichlorobenzene	50.0	Galaxolide	50.0
17beta-Estradiol	100	Indole	50.0
1-Methylnaphthalene	50.0	Isoborneol	50.0
2,6-Dimethylnaphthalene	50.0	Isophorone	50.0
2-Methylnaphthalene	50.0	Isoquinoline	50.0
3-Methyl Indole	50.0	Menthol	50.0
4-Cumylphenol	50.0	Methyl Salicylate	50.0
4-n-Octylphenol	50.0	Metolachlor	50.0
4-tert-Octylphenol	50.0	Musk ketone	50.0
Acetophenone	50.0	Naphthalene	50.0
Benzophenone	50.0	Nonylphenol	50.0
Bisphenol A	50.0	p-Cresol	50.0
Bromacil	50.0	Pentachlorophenol	100
Butylated Hydroxyanisole	100	Phantolide	50.0
Caffeine	50.0	Phenanthrene	50.0
Camphor	50.0	Phenol	50.0
Carbaryl	50.0	Prometon	50.0
Carbazole	50.0	Pyrene	50.0
Celestolide	50.0	Tonalide	50.0
Chlorpyrifos	50.0	Tri(2-butoxyethyl) Phosphate	50.0
Dacthal	50.0	Tri(2-chloroethyl) Phosphate	50.0
Diazinon	50.0	Tri(dichloroisopropyl) Phosphate	50.0
Dichlorvos	50.0	Tributyl Phosphate	50.0
Equilenin	100	Triclosan	50.0
Estrone	100	Triethyl Citrate	50.0
Ethinylestradiol	100	Triphenyl phosphate	50.0
Fluoranthene	50.0		

Appendix D. Abbreviations, chemical formulas, and symbols used in this report

Term	Definition
ANC	acid neutralizing capacity of solutes plus particulates in an unfiltered water sample
CaCO_3	chemical formula for calcium carbonate
cfs	cubic feet per second
cfu/100 ml	colony forming units, for bacteria sampling, a measure of the number of viable bacteria per 100 mL
LRL	laboratory reporting level
MDL	method detection level
$\mu\text{g/L}$	micrograms per liter
$\mu\text{S/cm}$	microsiemens per centimeter at 25°C, a measure of specific conductance
mg/L	milligrams per liter
Milliequivalents per liter	an expression of the concentration of substances that is chemically equivalent in terms atomic weight and electrical charge
MPN/100 mL	most probable number, for sampling bacteria, a statistical estimation of the number of coliform that would give the results shown by the laboratory examination
N	chemical symbol for the element nitrogen
ng/L	nanograms per liter
NTU	nephelometric turbidity unit, a measure of turbidity
P	chemical symbol for the element phosphorous

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