



Water Quality Monitoring for Chinle Wash and Tsaile Creek in Canyon de Chelly National Monument

2014 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2017/1131



ON THE COVER
Tsaile Creek, Canyon de Chelly National Monument
Photography by SCPN

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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 Tsaile Creek and Chinle Wash in Canyon de Chelly National Monument 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 this system 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 7 vital signs pertaining to riparian and spring 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 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 (USEPA 2011).

1.2 Water quality monitoring at Canyon de Chelly National Monument

Chinle Wash is an intermittent stream that drains a 1655 km² watershed, which includes Canyon de Chelly and a major tributary canyon, Canyon del Muerto. This canyon network was formed by streams originating in the Chuska Mountains along the Arizona/New Mexico border. Located entirely on the Navajo Nation, these canyon bottoms are used extensively for grazing, farming, and tourism, and the broad and sandy streambed of Chinle Wash is used as the main road through the canyon.

Tsaile Creek is a perennial stream that drains a 424 km² area on the western flank of the Chuska Mountains. It is the headwater stream to Canyon del Muerto, and eventually joins Chinle Wash in Canyon de Chelly. Flow in Tsaile Creek is heavily influenced by Tsaile Dam, which was built in 1963 to form Tsaile Lake. The dam has reduced base flows in the stream and moderated high flows that normally would result from spring snowmelt (NRCS 2000). Due to several safety issues with the dam, Tsaile Lake was drained starting in 2013 in order to facilitate repairs. The lake was dry by the summer of 2014.

In 2010 SCPN implemented water quality monitoring at the following sites along Chinle Wash and Tsaile Creek in Canyon de Chelly NM (CACH) (Figure 1):

- Chinle Wash at Chinle (CACHCHI01) is identified in this report as CHI01. The site is located downstream of the mouth of Canyon de Chelly near a streamflow gaging station (Chinle Wash at Chinle, station number 09379025 NN 07), operated by the Navajo Nation Department of Water Resources, Water Management Branch.
- Tsaile Creek below Tsaile Dam (CACHTSA01), identified in this report as TSA01, is co-located with SCPN's aquatic macroinvertebrate monitoring site. TSA01 is located in Canyon del Muerto, 0.95 km downstream of Tsaile Dam.

Water quality monitoring by SCPN occurs on a quarterly basis in CACH. In 2014, SCPN staff made three site visits to TSA01 on February 18, May 5, and October 30. A site visit on July 26 was skipped because the creek was dry just downstream of the dam. Two site visits were made to CHI01 on February 18 and May 5; the wash was dry on July 26 and October 30. This report summarizes all data obtained from these site visits in 2014.

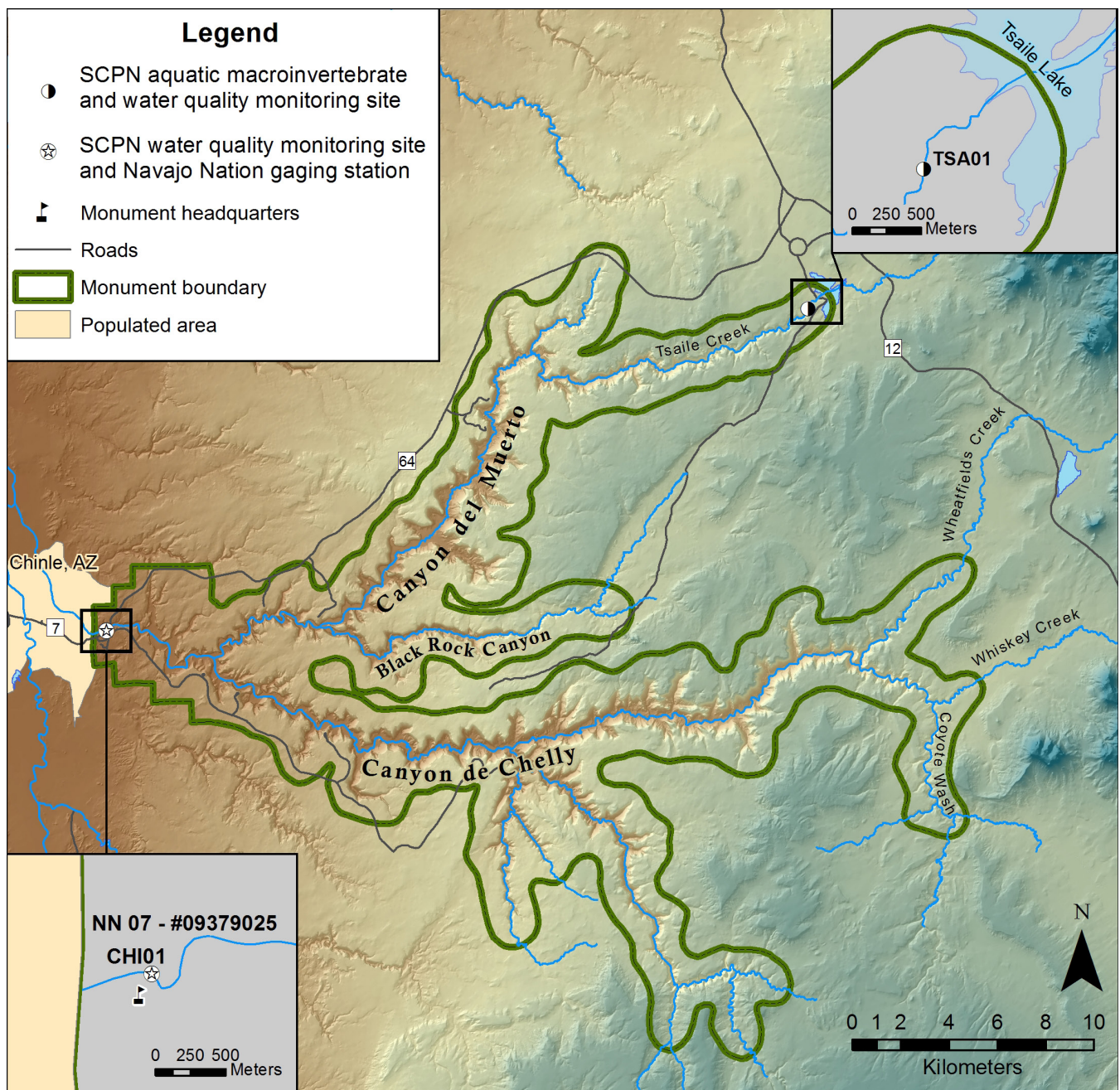


Figure 1. Locations of SCPN water quality monitoring sites, CHI01 and TSA01 in Canyon de Chelly NM.

2 Methods

A brief description of water quality data collection and processing procedures followed by SCPN staff at CACH during 2014 is presented here. Detailed descriptions of these procedures are available in the Standard Operating Procedures for the Water Quality Monitoring Protocol for Streams and Springs in the Southern Colorado Plateau Network (Monroe et al. 2016; available at <https://irma.nps.gov/DataStore/Reference/Profile/2233293>).

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, we noted the hydrologic conditions and collected water quality core parameter data using the following methods:

- As soon as possible after arrival at the site, a multiparameter sonde (Hydrolab-MS5; Hach Inc.) was calibrated and deployed 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 duration of the site visit.
- Turbidity samples were collected and kept on ice for no longer than 24 hours, and analyzed with a Hach 2100P Portable Turbidimeter (Hach Inc.).
- Discharge was measured using a Hach FH950 (Hach Inc.).

2.2 Water quality samples

During each site visit to TSA01, SCPN crew collected samples to analyze for bacteria, nutrients, major elements, and trace metals. We collected bacteria samples by dipping a sample bottle into the center of flow. SCPN staff analyzed the bacteria sample for total coliforms and *E. coli* using the Quanti-Tray® 2000 system (IDEXX Inc.). Sample water for nutrient, major element, and trace metal analysis was filtered and/or acid-treated (as required), kept on ice, and shipped to the contract laboratory. Samples for CHI01 were only analyzed for bacteria.

In 2014 SCPN continued an Interagency Agreement with the USGS National Water Quality Laboratory (NWQL) in Denver, Colorado for analysis of water samples from TSA01 for selected water quality constituents (Table 1). These analyses fall into three categories: nutrients, major elements and trace metals (Table 1). Information documenting NWQL methods is included in SOP #8 of the SCPN water quality monitoring protocol (Monroe et al. 2016).

In 2011, SCPN entered into a partnership with the US Environmental Protection Agency (EPA) to sample at selected network parks for a suite of Contaminants of Emerging Concern (CECs), which include pharmaceuticals, personal care products, waste water indicators, and pesticides (Appendix C). The procedures described in NPS 2013 were followed. The purpose is to develop a baseline dataset documenting the occurrence of these contaminants within SCPN parks. One CEC sample was collected at TSA01 on May 5. The sample was kept on ice and analyzed at the EPA Region 8 Laboratory in Golden, Colorado within seven days of collection, as

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

required.

2.3 Data handling and reporting

All SCPN water quality data are stored in a Microsoft Access database created by SCPN and stored on the SCPN server, along with all multiparameter sonde and discharge data files. 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.). We compared our results against the Navajo Nation Environmental Protection Agency (NNEPA) criteria for primary and secondary human contact. Although the NNEPA criteria are expressed as colony forming units per 100 mL (cfu/100 mL) and do not assume an estimation, it is comparable to MPN as reported by SCPN.

All results from the NWQL and EPA are presented as they were reported from the lab. In cases where analytes were not detected, we present the applicable laboratory reporting level. 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 Navajo Nation EPA water quality standards applicable to CHI01 and TSA01 (NNEPA 2008). We noted any exceedances of these 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 NNEPA 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 waters on the Navajo Nation (NNEPA 2008). A water quality standard refers to a specific parameter and its associated beneficial use, in conjunction with a criterion. The criterion is the numeric component against which a result is compared. For example, the standard for chronic selenium (parameter) for aquatic and wildlife habitat (use designation) is 2 µg/L (numeric criterion). This criterion is for the total selenium concentration in the sample.

All of SCPN's sample results are for the dissolved concentration, meaning the samples are filtered through a 0.45µm filter to remove the particulate component of the sample before it is shipped for analysis of the dissolved fraction. Most Navajo Nation 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, not all Navajo Nation water quality criteria are based on dissolved samples. Many are based on the total sample 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.

In this report results for each parameter are evaluated against applicable water quality standards as defined for each stream by the Navajo Nation EPA. Navajo Nation surface waters can have up to eight beneficial uses; most are applicable to the streams discussed in this report. Each use designation may have different criteria for one parameter. Also, aquatic life criteria are often dependent upon water hardness, which varies for 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 (months) and acute exposure over a short period of time (hours or days). Acute criteria apply to any single sample and are not to be exceeded at any time. Criteria are much lower for chronic exposure than for acute exposure and are not directly comparable to the results obtained from a single sample because chronic standards are based on the arithmetic mean of samples collected during four consecutive days (NNEPA 2008). From a compliance standpoint, the acute instantaneous 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 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 presents data collected by SCPN from Chinle Wash (CHI01) and Tsaille Creek (TSA01) in 2014. Summaries of the 2013 core parameters and bacteria data are included for comparison. Because Chinle Wash only flows intermittently, core parameter measurements and bacteria samples could only be collected at CHI01 on two monitoring visits when water was flowing in the wash— 18 February and 5 May. Samples for the laboratory analytes were not collected at CHI01.

At TSA01, water quality core parameter data, bacteria, and samples for nutrients, major elements and trace metals were collected during each of three site visits—18 February, 5 May, and 30 October. A fourth site visit was made on 26 July, but there was no flowing water in the creek below the reservoir, therefore sampling was not conducted. Complete results for TSA01, along with dates and sample times, are in Appendix B.

3.1 Chinle Wash at Chinle

3.1.1 Water quality core parameter data

NPS core parameter data collected during two site visits in 2014 are presented in Table 2; the results from the 2013 site visit are included for comparison. Water temperature was 15.7°C on February 18 and 24.6°C on May 5. The pH measurements were similar for the two site visits: 8.4 and 8.5, which is within the water quality criteria for aquatic and wildlife habitat. Specific conductance was 372 and 469 $\mu\text{S}/\text{cm}$, respectively. Dissolved oxygen was 6.6 and 8.0 mg/L (99.1 and 97.1% saturation), which is above the 6.0 mg/L water quality criterion for aquatic and wildlife habitat. Turbidity was 610 and 500 NTU, and discharge was 12.0 and 6.6 cfs. There are no water quality criteria for water temperature, specific conductance, turbidity, and discharge.

3.1.2 Total coliforms and *E. coli*.

Bacteria results for total coliforms and *E. coli* collected during two site visits in 2014 are presented in Table 2 and Figure 2, with 2013 data plotted for comparison. There are no NNEPA water quality criteria for total coliforms, which are a diverse group of bacteria used in water quality sampling as indicators of the likely presence of pathogenic bacteria, such as *E. coli*. Total coliforms were 1200 MPN/100 mL in February and exceeded 2400 MPN/100 mL in May, which is the maximum limit of the IDEXX test.

Table 2. Water quality core parameter and bacteria data from CHI01 on Chinle Wash in Canyon de Chelly NM during 2014 (n=2). Data from 2013 (n=1) are included for comparison, along with the Navajo Nation Environmental Protection Agency (NNEPA) water criteria. A “nc” indicates that no criteria exist for a specific parameter.

Core parameter	Sample date and time			NNEPA criteria
	8/12/2013 14:20	2/18/2014 14:00	5/5/2014 13:45	
Water temperature (°C)	31.9	15.7	24.6	nc
pH	7.9	8.4	8.5	6.5–9.0
Specific conductance ($\mu\text{S}/\text{cm}$)	216	372	469	nc
Dissolved oxygen (mg/L)	5.8	8.0	6.6	>6.0
Dissolved oxygen (%)	97.4	99.1	97.1	>90%
Turbidity (NTU)	48500 ^a	610	500	nc
Discharge (cfs)	9.5	12.0	6.6	nc
Total coliforms (MPN/100 mL)	>2400	1200	>2400	nc
<i>E. coli</i> (MPN/100 mL)	>2400	16	110	nc

^a Turbidity exceeded the instrument maximum detection limit of 1000 NTU. The value is an estimate based on diluted samples.

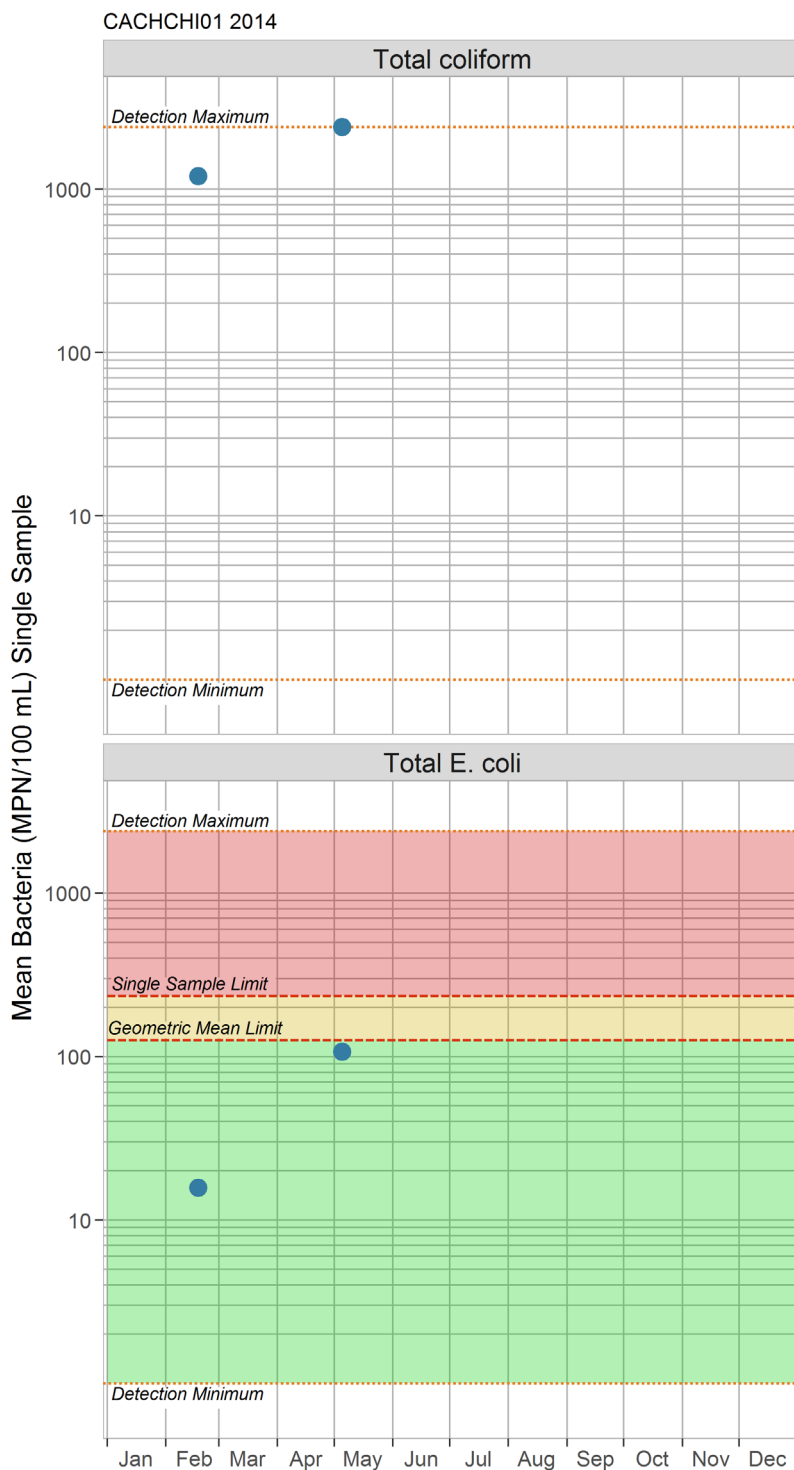


Figure 2. Total coliforms (top) and *E. coli* (bottom) results from samples collected at CHI01 in Canyon de Chelly NM, 2013–2014.

E. coli are a type of coliform bacteria that originate from animal feces, and are of concern because some strains can cause illness upon entering the human digestive system. Two NNEPA *E. coli* standards apply to CHI01: primary (swimming) and secondary (incidental) contact. These standards can be evaluated as either a geometric mean of four samples collected in 30 days, or as a single-sample maximum. The primary contact criteria are a geometric mean of 126 cfu/100 mL, or a single-sample maximum of 235 cfu/100 mL. The secondary contact criteria are a geometric mean of 126 cfu/100 mL, or a single-sample maximum of 575 cfu/100 mL (NNEPA 2008). In 2014, *E. coli* results from the samples collected on February 18 and May 5 were 16 and 110 MPN/100 mL, and did not exceed any of these criteria.

3.2 Tsaile Creek below Tsaile Dam

3.2.1 Water quality core parameter data

Core parameter data for three site visits made to TSA01 in 2014 are summarized in Table 3; the 2013 data are also included for comparison. Numeric results for 2014 are provided in Appendix B. A fourth site visit was attempted on July 26, but the reservoir had been emptied and the creek was dry just downstream from the dam. No data were collected on this site visit.

Water flow in the creek is highly dependent on releases from Tsaile Dam. Early in 2014, stream discharge was higher because the reservoir was being emptied. Later in 2014, the reservoir was empty and water from Tsaile Creek was free to pass beyond the dam. On our July 26 site visit, there was not enough water flowing beyond the dam to maintain consistent flows in the creek, which was dry a short distance downstream from the dam. On our October 30 site visit, much more water was observed and the creek was flowing well downstream of the dam.

Water temperature averaged 5.4 °C over

Table 3. Summary of water quality core parameter data from TSA01 on Tsaile Creek in Canyon de Chelly NM, 2014 (n=3). Data from 2013 (n=4) are included for comparison, along with the Navajo Nation Environmental Protection Agency (NNEPA) water criteria. An “nc” indicates that no criteria exist for a specific parameter; “nd” indicates that data were not collected.

Core parameter	2013		2014		NNEPA criteria
	Median	Range	Median	Range	
Water temperature (°C)	6.1	(-)0.3–24.8	5.0	4.0–15.5	nc
pH	8.4	8.1–8.6	8.4	8.3–8.5	6.5–9.0
Specific conductance (µS/cm)	377	299–489	307	253–309	nc
Dissolved oxygen (mg/L)	9.6	7.4–10.6	8.8	7.8–10.3	>6.0
Dissolved oxygen (%)	94.2	82.7–143	101	86.2–104	>90%
Turbidity (NTU)	18.7	7.8–42	126	31–290	nc
Discharge (cfs)	<0.1	0.0–16.9	5.7	0.9–6.3	nc

the three visits, and ranged from 4.0 to 15.5 °C. Measurements for pH ranged from 8.3–8.5, within the criteria of 6.5–9.0; specific conductance ranged from 253–308 µS/cm, Dissolved oxygen measurements ranged from 7.8–10.4 mg/L, which meets the 6.0 mg/L criterion. However, the % saturation for dissolved oxygen ranged from 86.2–106; and the October 30 measurement did not meet this criterion. Turbidity ranged from 31–290 NTU; and discharge ranged from 0.9–6.3 cfs, with the lowest measurement in October and the highest in May. Only pH and dissolved oxygen have NNEPA water quality criteria (NNEPA 2008).

3.2.2 Total coliforms and *E. coli*

SCPN collected three bacteria samples at TSA01 in 2014 and analyzed them for total coliforms and *E. coli*. The results are plotted in Figure 3. The numeric results are in Appendix B. The 2013 data are included for comparison. Total coliforms in 2014 ranged from 147 to greater than 2400 MPN/100 mL, which is the maximum detection limit of the IDEXX test.

E. coli levels at TSA01 ranged from 6–260 MPN/100 mL. Despite the small size of the stream, primary contact is a beneficial use on this reach of Tsaile Creek (NNEPA 2008). The October 30 sample was 260 MPN/100 mL, which exceeded the NNEPA primary contact criteria (single sample maximum of 235 cfu/100 mL or a geometric mean of 126 cfu/100 mL). This sample, however, did not exceed the secondary contact single sample maximum (575 cfu/100 mL).

3.2.3 Water quality laboratory data

Nutrient, major element, and trace metal data from three samples collected at TSA01 in 2014 are presented in Tables 4–6. Where applicable, results are compared against NNEPA water quality standards (NNEPA 2008).

Levels for the nutrients ammonia, nitrite +nitrate, and nitrite were very low (Table 4). There are no water quality criteria for the dissolved fraction of these analytes, which is what SCPN submits for analysis. Of the three samples, ammonia, nitrite+nitrate, and nitrite were only detected in the October 30 sample at concentrations of 0.0453, 0.361, and 0.0170 mg/L, respectively. Orthophosphate was detected in two of the samples at 0.0477 and 0.0626 mg/L. There are no water quality criteria for orthophosphate.

Major element data for TSA01 are presented in Table 5, and show that the concentrations of ions, silica, acid neutralizing capacity, and total dissolved solids did not change much between site visits. Acid neutralizing capacity ranged from 163–175 mg/L and total dissolved solids ranged from 178–220 mg/L. Major ions for the three samples are plotted relative to one another in terms of milliequivalents per liter in Figure 4. This plot shows that cations at TSA01 mostly consist of calcium, followed distantly by magnesium. Anions are almost entirely

Table 4. Dissolved nutrient data for samples collected from TSA01 at Canyon de Chelly NM, 2014. There are no Navajo Nation Environmental Protection Agency criteria for these analytes. Results that were lower than the National Water Quality Laboratory (NWQL) reporting levels are noted as "<[reporting level]".

Nutrients (mg/L)	2/18/2014 16:30	5/5/2014 16:35	10/30/2014 11:45
Ammonia as N	<0.0200	<0.0200 ^a	0.0453
Nitrite + nitrate as N	<0.080	<0.080	0.361
Nitrite as N	<0.00200 ^a	<0.00200	0.0170
Orthophosphate as P	<0.00800	0.0477	0.0626

^a Result is above the Method Detection Level and below the NWQL Reporting Level.

Table 5. Dissolved major element data for samples collected from TSA01 in Canyon de Chelly NM, 2014. Acid neutralizing capacity was measured from unfiltered samples. There are no Navajo Nation Environmental Protection Agency criteria for these analytes.

Major elements (mg/L)	2/18/2014 16:30	5/5/2014 16:35	10/30/2014 11:45
Calcium	52.2	49.7	45.6
Chloride	2.97	2.68	2.51
Fluoride	0.107	0.123	0.105
Magnesium	7.35	6.92	6.33
Potassium	2.40	1.98	1.57
Silica	23.1	23.2	22.4
Sodium	6.71	6.57	6.31
Sulfate	5.02	5.41	5.96
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	175	164	163
Total dissolved solids	220	197	178

dominated by bicarbonate plus carbonate. The proportions of major ions did not change between site visits.

Trace metal data are presented in Table 6, along with the most stringent water quality standards applicable for each analyte at TSA01. There were no exceedances for trace metals in the three samples collected at TSA01, however the mercury criterion for aquatic and wildlife habitat (0.001 µg/L) is set below the laboratory reporting level (0.010 µg/L), so compliance with this standard could not be assessed. There were eight trace metals that were not detected above the corresponding laboratory reporting levels: beryllium, cadmium, chromium, copper, lead, mercury, silver, and zinc. As was the case with the other analytes, trace metal concentrations did not vary greatly between samples.

3.2.4 Contaminants of Emerging Concern

On May 5, we collected a sample at TSA01 to be analyzed by the EPA Region 8 Laboratory for pesticides, pharmaceuticals and personal care products, and waste indicators. The complete list of over 250 analytes considered to be Contaminants of Emerging Concern is in Appendix C. None of the analytes were detected in this sample.

CACHTSA01 2014

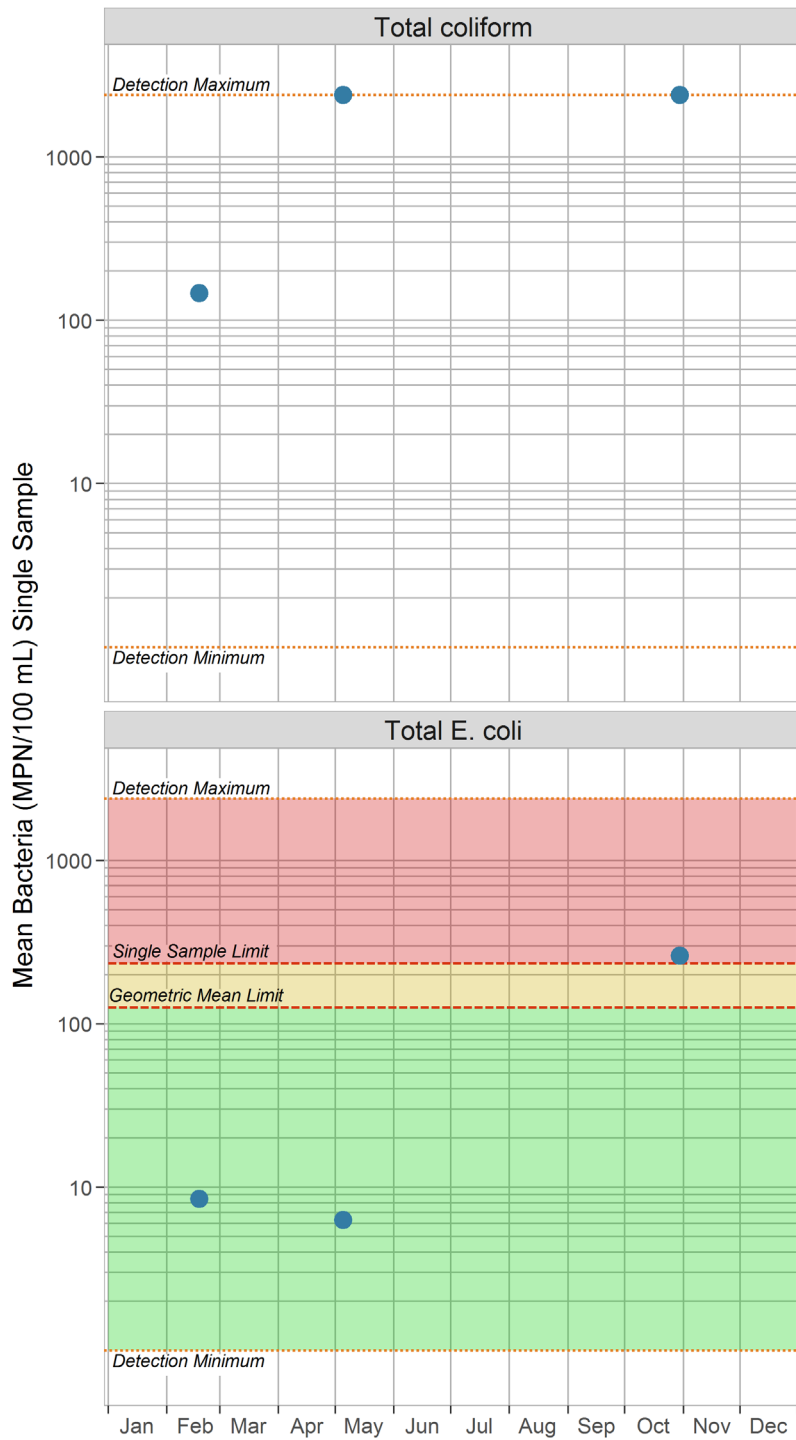


Figure 3. Total coliform (top) and *E. coli* (bottom) results for samples collected at TSA01 in Canyon de Chelly NM in 2013 and 2014. The *E. coli* result from TSA01 on 5/24/13 was <1 MPN/100 mL.

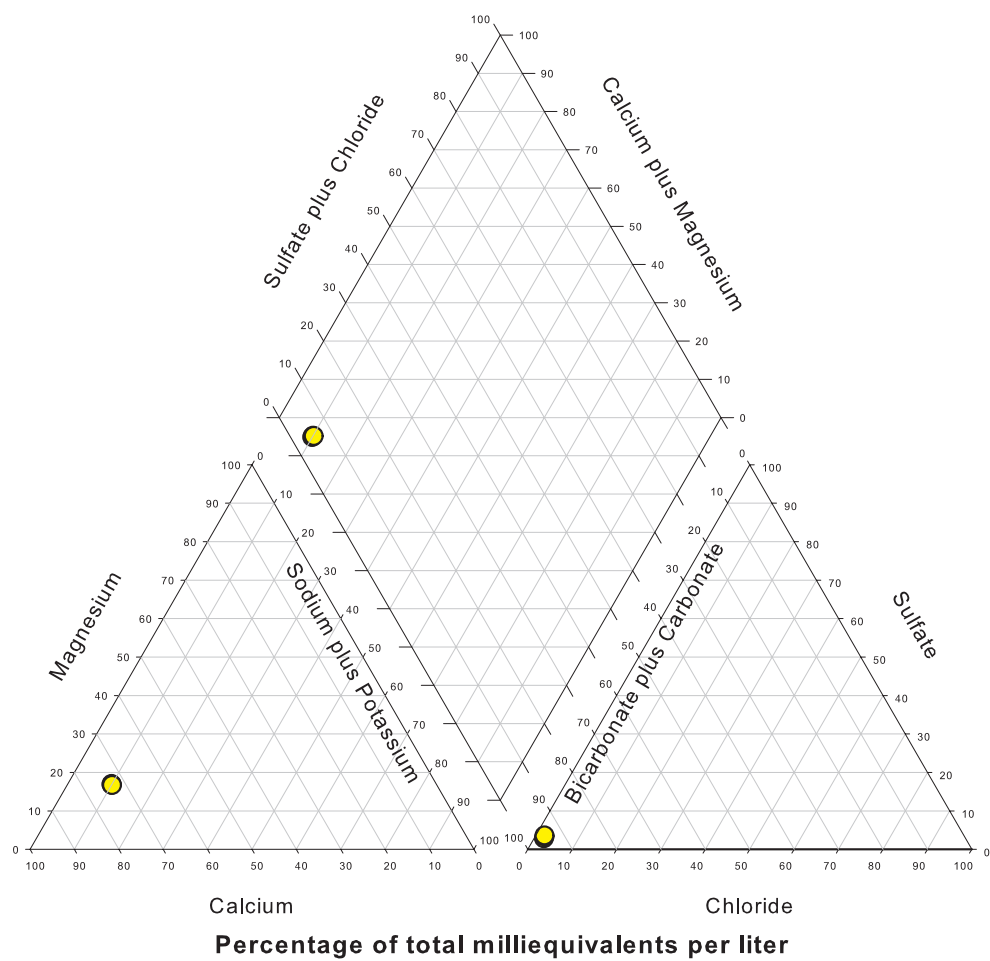


Figure 4. Major ion composition from samples collected at TSA01 on Tsaile Creek in Canyon de Chelly NM, 2014.

Table 6. Dissolved trace metal data for samples collected from TSA01 in Canyon de Chelly NM, 2014, the most stringent Navajo Nation Environmental Protection Agency (NNEPA) criteria that apply to TSA01, and the number of times that the samples were outside those criteria. An “nc” indicates that no criteria have been developed for a particular metal, and an “ndc” indicates there is no dissolved criterion. Results that were lower than the National Water Quality Laboratory (NWQL) reporting levels are noted as “<[reporting level]”.

Trace metal (µg/L)	2/18/2014 16:30	5/5/2014 16:35	10/30/2014 11:45	NNEPA criterion (mg/L)	# of exceedances	Beneficial use ^a
Aluminum	7.97	15.5	32.1	5000	0	AgWS
Antimony	0.115	0.114	0.112	30	0	A&WHbt, chronic
Arsenic	1.68	1.95	1.59	150	0	A&WHbt, chronic
Barium	149	152	135	ndc	ndc	ndc
Beryllium	<0.040	<0.040	<0.040	ndc	ndc	ndc
Boron	22.5	21.5	17.7	5000	0	LW
Cadmium	<0.060	<0.060	<0.060	0.31–0.34	0	A&WHbt, chronic
Chromium	<0.600	<0.600	<0.600	Cr (III) 97.7–109, Cr (VI) 11	0	A&WHbt, chronic
Cobalt	1.11	0.403	1.37	50	0	AgWS
Copper	<1.60	<1.60 ^b	<1.60	11.9–13.4	0	A&WHbt, chronic
Iron	<8.00 ^b	12.8	24.7	nc	nc	nc
Lead	<0.080	<0.080	<0.080	3.62–4.20	0	A&WHbt, chronic
Manganese	55.2	17.5	71.9	nc	nc	nc
Mercury	<0.010	<0.010	<0.010	0.001	unknown	A&WHbt, chronic
Molybdenum	0.455	0.443	0.535	1000	0	AgWS
Nickel	1.04	1.09	0.999	69.2–77.7	0	A&WHbt, chronic
Selenium	0.145	0.184	0.112	ndc	ndc	ndc
Silver	<0.040	<0.040	<0.040	5.74–7.28	0	A&WHbt, acute
Uranium	1.30	1.32	1.56	ndc	ndc	ndc
Vanadium	3.04	6.22	4.90	100	0	AgWS, LW
Zinc	<4.00 ^a	<4.00	<4.00	157–177	0	A&WHbt, chronic

a Beneficial use codes: A&WHbt - aquatic and wildlife habitat; AgWS - agricultural water supply; LW - livestock watering

b Result is above the Method Detection Level and below the NWQL Reporting Level.

4 Quality Assurance/Quality Control

We followed the Quality Assurance/Quality Control (QA/QC) 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. 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. We collected five duplicate bacteria samples at several SCPN monitoring sites by filling two sample bottles in succession and comparing tray results after the incubation period. 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, and the results were compared against the 2014 reporting levels.

In reporting results for Contaminants of Emerging Concern, SCPN considered the QA/QC results provided by the EPA lab such as method blanks, blank spikes, matrix spikes, and other instrument checks when making decisions whether to flag or exclude data.

5 Summary

In 2010, SCPN implemented long-term water quality monitoring at CHI01 on Chinle Wash and at TSA01 on Tsaille Creek in CACH, and continued this work through 2014. This report summarizes data collected during site visits to CHI01 and TSA01 during 2014, and compares these results against applicable NNEPA water quality standards (Navajo Nation Environmental Protection Agency 2008).

CHI01 was visited on the same days as TSA01 but was only sampled on February 18 and May 5 when water was flowing there. At this site, only NPS core parameter measurements and bacteria samples were collected. Dissolved oxygen, pH, and *E. coli* results were within the NNEPA water quality criteria.

TSA01 was visited four times in 2014, but water was flowing in the creek on only three of those site visits: February 18, May 5, and October 30. During each of these visits, NPS core parameter measurements were made and samples for bacteria, nutrients, major elements, and trace metals were collected. All core parameters were in compliance with applicable NNEPA water quality standards for each site visit, except the dissolved oxygen measurements on October 30, which were below 90% saturation. Also on October 30, the *E. coli* result exceeded the NNEPA primary contact criterion for this stream, but not the secondary contact criterion. Laboratory-measured results for nutrients and trace metals were below the NNEPA water quality criteria.

The data in this report should be viewed as a snapshot of water quality conditions existing at the time data were collected. Data and analyses in this report are provisional and subject to change. When sufficient data are available, SCPN will prepare an in-depth trend analysis report of water quality data for Chinle Wash and Tsaille Creek in CACH.

6 Literature Cited

- Brown, J. B. 2008. Review of available water-quality data for the Southern Colorado Plateau Network and characterization of water quality in five selected park units in Arizona, Colorado, New Mexico, and Utah, 1925 to 2004: U.S. Geological Survey Scientific Investigations Report 2008-5130.
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Appendix A. Southern Colorado Plateau Network Water Quality Monitoring Sites at Canyon de Chelly National Monument, 2014

Table A1. Southern Colorado Plateau Network water quality monitoring sites for Canyon de Chelly National Monument, 2014.

Site code	Common name	Report name	Easting ¹	Northing ¹	Elevation (m) ¹
CACHCHI01	Chinle Wash at Chinle	CHI01	631525	4002062	1689
CACHTSA01	Tsaile Creek below Tsaile Dam	TSA01	660576	4015393	2125

¹ 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)

Appendix B. Water quality monitoring results for Tsaile Creek at Canyon de Chelly National Monument, 2014

Table B-1. Water quality core parameter and bacteria data from TSA01 on Tsaile Creek in Canyon de Chelly National Monument, 2014 (*n*=3).

Parameter	Unit	Sample collection date and time			NNEPA criteria
		2/19/2014 16:30	5/5/2014 15:35	10/30/2014 11:45	
Water temperature	°C	5.0	15.5	4.0	nc
pH	none	8.3	8.5	8.4	6.5–9.0
Specific conductance	μS/cm	309	307	253	nc
Dissolved oxygen	mg/L	10.3	7.8	8.8	>6.0
Dissolved oxygen	%	104	101	86.2	>90%
Turbidity	NTU	31	130	290	nc
Discharge	cfs	5.7	6.3	0.9	nc
Total coliforms	MPN/100 mL	147	>2400	>2400	nc
<i>E. coli</i>	MPN/100 mL	9	6	260	nc

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	MCP	20.0
Atrazine	10.0	Metolachlor	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	Terbutylazine	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
Desmethylocitalopram	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
µg/L	micrograms per liter
µS/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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