EMID-701253

DEPARTMENT OF ENERGY

Environmental Management Los Alamos Field Office (EM-LA)
Los Alamos, New Mexico 87544

EMLA-2021-0167-02-001 March 3, 2021

Mr. Kevin Pierard
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6313

Subject: Submittal of the 2020 Sandia Wetland Performance Report

Dear Mr. Pierard:

Enclosed please find two hard copies with electronic files of the "2020 Sandia Wetland Performance Report." The U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA) and Newport News Nuclear BWXT-Los Alamos, LLC (N3B) have prepared this report in response to requirements set forth in the "Work Plan and Final Design for Stabilization of the Sandia Canyon Wetland." The requirement to design a Sandia wetland monitoring program was previously set forth in the New Mexico Environment Department's (NMED's) "Approval with Modification, Interim Measures Work Plan for Stabilization of the Sandia Canyon Wetland," in response to the previously submitted "Interim Measures Work Plan for Stabilization of the Sandia Canyon Wetland." The "2019 Sandia Wetland Performance Report" was approved by NMED on May 6, 2020.

Pursuant to Section XXIII.C of the Compliance Order on Consent, a pre-submission review meeting was held with EM-LA, N3B, and NMED on December 9, 2020, to discuss changes in monitoring requirements for 2021.

If you have any questions, please contact Amanda White at (505) 309-1366 (amanda.white@em-la.doe.gov) or Cheryl Rodriguez at (505) 414-0450 (cheryl.rodriguez@em.doe.gov).

Sincerely,

Arturo Q. Duran

Digitally signed by Arturo Q. Duran
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Arturo Q. Duran
Compliance and Permitting Manager
Environmental Management
Los Alamos Field Office

Enclosures:

1. Two hard copies with electronic files – 2020 Sandia Wetland Performance Report (EM2021-0053)

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March 2021
EM2021-0053

2020 Sandia Wetland Performance Report

N3B Los Alamos

EM2021-0053

2020 Sandia Wetland Performance Report

March 2021

Responsible project director:

Printed Name	Signature	Title	Organization	Date
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Responsible N3B representative:

Printed Name	Signature	Title	Organization	Date
Kim Lebak	Kimberly D Lebak	Program Manager	N3B Environmental Remediation Program	2/23/21

Responsible DOE EM-LA representative:

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EXECUTIVE SUMMARY

The 2020 Sandia wetland performance report is the seventh annual performance report following the 2012 to 2014 baseline that assessed the overall condition of the wetland at the head of Sandia Canyon. Canyon wetland monitoring was performed in the context of the wetland's ability to mitigate migration of contaminants of concern (i.e., chromium, polychlorinated biphenyls [PCBs], and polycyclic aromatic hydrocarbons) detected in wetland sediments as a result of historical releases at Los Alamos National Laboratory (the Laboratory). The geochemistry and physical stability of wetland sediments, along with the extent of wetland vegetation, are the key indicators of wetland conditions. The condition of the wetland is assessed to evaluate the effectiveness of the grade-control structure (GCS) completed in 2013 at the terminus of the wetland and to monitor changes to the Laboratory's operational practices that have affected outfall volumes discharging to the wetland. This report presents the results of monitoring conducted for surface water, alluvial groundwater, vegetation, and geomorphology between January and December 2020, in the context of the baseline conditions presented in the "Sandia Wetland Performance Report, Baseline Conditions 2012–2014."

The monitoring conducted during the performance period indicates the Sandia wetland remains stable following the installation of the GCS, even with generally lower, but variable, effluent volumes entering the wetland. The GCS continues to be effective in arresting headcutting at the terminus of the wetland. Groundwater within the shallow alluvium remains in a reducing condition, with no obvious detrimental temporal trends in chemistry observed. Sampling of hexavalent chromium indicates concentrations at or below the method detection limit within the wetland. Water levels in the wetland remained similar over the last 7 yr, with temporary drops in the easternmost transect during summer months. Despite the observed decreases after the Sanitary Effluent Reclamation Facility came online in 2012, water levels remained sufficiently high to sustain obligate wetland vegetation, and analytical results of iron and manganese indicate alluvial groundwater remained in strongly reducing conditions in most wells upgradient of the GCS. Chloride, generally considered a conservative tracer and highly mobile, nonreactive chemical species, indicates similar trends in import (E121) and export (E123) at gaging stations along the wetland. Storm-water data also indicate that the GCS has had a positive effect in reducing contaminant mobility, and this trend continued through 2020. Storm-flow suspended sediment and chromium concentrations have decreased compared with pre- and post-GCS data immediately downgradient of the wetland at gaging station E123, presumably from eliminating headcutting at the terminus of the wetland and from sediment-trapping efficiency of the dense vegetation within the wetland. Historically, PCB concentrations in base flow and storm flow have been lower post-GCS, but in 2020, PCB concentrations appear to be more varied in both flow conditions. Small sample numbers make it difficult to detect trends, but this will remain a focused interest of future PCB data.

Past geomorphic-change detection studies indicate the wetland remains stable, with no significant geomorphic change experienced between post-2018 and post-2019 monsoon bank and thalweg surveys. Beginning in 2019, ground-based survey techniques were replaced by aerial-based survey techniques, which provide a more accurate and robust baseline data set for both geomorphic and vegetation data. The next surveys of geomorphology and vegetation will be conducted in 2021 and 2022, respectively.

Surface water and alluvial groundwater analytical data collected in 2020 were compared with New Mexico surface water quality criteria (20.6.4 New Mexico Administrative Code [NMAC]) and groundwater standards (20.6.2 NMAC), respectively. Exceedances of water quality criteria are presented in this report and are determined to be associated with historical Laboratory releases, runoff from developed areas in the upper watershed, naturally occurring chemicals, and/or the natural reducing conditions of the wetland within the alluvial system.

The 2020 monitoring year was affected by the COVID-19 pandemic. A partial stop-work order was issued by the U.S. Department of Energy (DOE) Environmental Management Los Alamos Field Office (EM-LA) to Newport News Nuclear BWXT-Los Alamos, LLC on March 24, 2020, for all fieldwork except essential mission critical activities, as described in the March 31, 2020, letter from DOE EM-LA to New Mexico Environment Department (NMED) Hazardous Waste Bureau. Fieldwork was limited to only the activities necessary to ensure the safety of the public, the workers, and the environment.

Email updates on the status of compliance activities were sent to NMED biweekly until October 2020, when the frequency switched to monthly. Section 2.2.2 provides further detail on how COVID-19 impacted the monitoring season.

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1.0 INTRODUCTION

This report addresses performance of the Sandia wetland for calendar year (CY) 2020. Section 1 of this report describes the Sandia wetland and contaminants in the wetland sediment and discusses Sandia wetland monitoring goals. Section 2 discusses Sandia wetland monitoring methods and summarizes monitoring conducted in 2020. Section 3 discusses monitoring results, and section 4 presents conclusions. Appendixes include acronyms, a metric conversion table, and definitions of data qualifiers (Appendix A), a summary of watershed mitigation inspections in 2020 (Appendix B), and analytical data and 5-min stage, discharge, and precipitation data (Appendix C, on CD and included with this document).

The Sandia wetland, located at the head of Sandia Canyon, has expanded from a relatively small footprint in the early 1950s to its current size in response to liquid effluent released by the Los Alamos National Laboratory (LANL or the Laboratory). Throughout the course of Laboratory operations, the wetland has been perpetuated by sustained effluent releases to the canyon from outfalls located in Technical Area 03 (TA-03). Contaminants, namely chromium, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs), are present in wetland sediments because of historical releases from Laboratory operations (LANL 2009, 107453). Ensuring the stability of the wetland has become an important aspect of managing the inventory of contaminants entrained in wetland sediments.

Through monitoring and reporting, the performance of the wetland has been studied since 2014, following initial baseline monitoring that occurred between 2012 and 2014. Monitoring efforts have been designed to evaluate the physical and chemical stability of the wetland that provide insight regarding the ability of the wetland to contain contaminants of concern and prevent migration past the grade-control structure (GCS) that was installed in 2013 (Figure 1.0-1).

1.1 Wetland Description

The Sandia wetland is a cattail-dominated wetland primarily sustained by effluent from the National Pollutant Discharge Elimination System (NPDES permit no. NM002835)-permitted outfalls 001 and 03A199. An additional NPDES-permitted outfall, 03A027, discharged effluent from 2012 to 2016 (EPA 2014, 600257; EPA 2015, 701237). Operational changes occurring at the Sanitary Effluent Reclamation Facility (SERF) since mid-2012 have influenced the outfall volumes and the chemical makeup of the effluent (Figures 1.1-1 to 1.1-5). The wetland has experienced generally decreased liquid outfall effluent volumes (both daily and annually) from NPDES-permitted Outfalls 001 and 03A027 as part of the SERF expansion project and water reuse programs at the Laboratory. However, total effluent volumes discharged to Outfall 001 have actually increased 27% since 2017 (Figure 1.1-1). As part of the SERF expansion, a portion of the effluent previously released to Sandia Canyon is now being rerouted to cooling towers at various facilities, including the Strategic Computing Complex (SCC) and the Trinity supercomputer. In September 2019, a temperature limit of 20°C was imposed on all discharges to Outfall 001. In the warmer months, this requirement necessitates rerouting some of the water to the power plant cooling towers before being discharged, to ensure compliance with the temperature limit (Griffin 2021, 701199). Descriptions of earlier operational changes at SERF can be found in previous years' Sandia Wetland performance reports (LANL 2015, 600399; LANL 2016, 601432; LANL 2017, 602341; LANL 2018, 603022; N3B 2019, 700415).

The 2019 draft discharge permit, NPDES Permit No. NM0028355, contemplated additional reuse by the SCC, rerouting cooling tower blowdown, and recycling to SERF, which may impact discharge from the dominant outfall (001). Discharge is recommended to be maintained at a minimum of 40,000 gallons per day (gpd) during months when evapotranspiration is highest. This discharge level is believed to be sufficient to maintain the ecologic, hydrologic, and geochemical functioning of the wetland, as described in the “100% Design Memorandum for Sandia Wetlands Stabilization Project” (LANL 2012, 240016). If future changes to effluent volume or chemistry are shown to adversely impact the wetland, or wetland evapotranspiration increases appreciably, adaptive management will be used to ensure wetland stability (e.g., engineered controls to manage sediment and water distribution to increase the area of wetland saturation). Currently, there is continuous discharge from the outfall to the wetland area. The average daily outfall volume for 2020 (212,000 gpd) exceeds the 40,000 gpd recommended discharge by a significant amount. Snowmelt and precipitation (direct and indirect) augment discharge flows necessary to support the wetland.

Surface water is generally present in a discrete channel (though in some areas surface water spreads from bank to bank) and passes through the wetland with a short residence time relative to alluvial groundwater (LANL 2009, 107453; LANL 2014, 257590). Wetland sediments are underlain by Bandelier Tuff, upon which alluvial groundwater is perched. A water-balance analysis conducted in 2007 and 2008 showed little surface water loss (approximately 2% of both effluent and runoff) occurs through the wetland (LANL 2009, 107453). A direct-current (DC) electrical-resistivity-based geophysical survey found that large continuous areas of the wetland are underlain by highly resistive welded tuffs (Qbt 2 of the Tshirege Member of the Bandelier Tuff) that represent a significant barrier to the infiltration of alluvial groundwater into the subsurface (LANL 2012, 228624). In several areas, the survey also identified subvertical conductive zones that penetrate the upper bedrock units and, in some cases, appear to correlate with mapped fault and/or fracture zones. These conductive zones may represent present-day or historical infiltration pathways. However, the DC resistivity data do not differentiate between conductive zones that contain higher water content (possibly representing active infiltration) and wetted clay-rich fracture fill that may hinder infiltration.

A GCS was installed in the lower portion of the wetland in 2013 to arrest an active headcut (up to 3 m high) and to help maintain favorable hydrologic and geochemical conditions that would minimize contaminant migration (LANL 2011, 203454). The GCS was designed to meet the following objectives:

- Minimize erosion during large flow events
- Provide an even grade to allow wetland expansion and further stabilization
- Be sufficiently impervious to prevent the draining of alluvial soils and promote a high water table
- Facilitate nonchannelized flow
- Support wetland function under potentially reduced effluent conditions

The GCS transitions the grade approximately 11 vertical ft from the elevation of the wetland just upgradient of the former headcut location to the natural streambed just upstream of gage E123. To maintain grade and to reduce the overall fill and size of a single structure, a set of 3 steel sheet-pile walls was installed with decreasing elevation drops. Downstream of the third sheet-pile wall, a cascade pool was constructed of boulders and cobbles to transition to the final grade. The transition from the wetland above the GCS to the stream channel below is gradual, smooth, and stepped to prevent erosive flows that could scour and destabilize the stream reach below the structure (LANL 2013, 251743). The design of the GCS should allow for a reduction of outfall effluent discharge into the wetland without compromising the physical and geochemical function of the wetland, particularly of the eastern terminus where the GCS more intimately controls wetland water levels. The area behind the GCS was backfilled and wetland vegetation was planted to allow expansion of the wetland area. These measures physically stabilize the wetland by reducing sediment and associated contaminant transport into the lower sections of the canyon and should also maintain reducing conditions within the sediment near the terminus of the wetland, thus contributing to the goal of reducing potential contaminant transport (LANL 2013, 251743). A set of as-built diagrams for the GCS is presented in Appendix C of the completion report for the construction of the GCS (LANL 2013, 251743).

Installation of the GCS has led to cessation of headcutting at the terminus of the wetland and has created an impermeable barrier to subsurface flow, such that alluvial groundwater must resurface before exiting the wetland. Given the impermeable nature of this barrier and the largely impermeable tuff underlying the wetland, the system can conceptually be thought of as a bathtub that effectively holds water with excess water spilling over the GCS at the wetland terminus. Annual evaluation of base-flow rates confirms this “bathtub” assumption as rates entering and exiting the wetland are similar, although this assumption breaks down during storm events because of additional flow from tributaries, e.g., from the former Los Alamos County landfill. However, as long as water inputs from the outfalls exceed wetland evapotranspiration, even significantly reduced outfall discharge may sustain water levels and sufficient saturation within wetland sediments. Extreme decreases in effluent input volumes into the wetland, however, could potentially result in wetland dewatering. The wetland sediment is typically saturated at the eastern end of the wetland; these conditions extend westward, but near-surface sediment is unsaturated at the margins and at the western end of the wetland. Based on vegetation surveys conducted between 2017 and 2019, there appears to be recovery of cattails in the west end of the wetland, which had been largely dewatered when the outfall that discharged directly into the wetland was relocated further upstream to the current location of Outfall 001. Channel meandering and sediment redistribution, however, are resulting in the reestablishment and expansion of cattails in this area (LANL 2016, 601432). Recent decreases in effluent volume to the wetland have not resulted in a lowering of the water table (dewatering) or decreased wetland vegetation cover (LANL 2016, 601432). The wetland vegetation community is important in mitigating storm water-related mobilization of contaminants through root binding and physical trapping of suspended sediments.

1.2 Contamination in Wetland Sediment

Hexavalent chromium [Cr(VI)] was historically released into liquid effluent from the TA-03 power plant at the head of Sandia Canyon from 1956 to 1972. Some of the Cr(VI) made its way to the regional aquifer beneath Sandia and Mortandad Canyons, and Cr(VI) concentrations in the regional aquifer presently exceed NMED groundwater standards and U.S. Environmental Protection Agency (EPA) maximum contaminant levels (MCLs). Historical releases of PCBs from a one-time transformer storage area and PAHs from an asphalt batch plant also discharged to the wetland, which still contains an inventory of these contaminants. Sandia Canyon wetland performance monitoring is related to the overall chromium remediation project because a large portion of the original chromium inventory and other contaminants (i.e., PCBs and PAHs) are currently sequestered in the wetland sediment. The results of characterization work conducted to date in Sandia Canyon are described in the “Investigation Report for Sandia Canyon” (hereafter, the Phase I IR) (LANL 2009, 107453) and in the “Phase II Investigation Report for Sandia Canyon” (hereafter, the Phase II IR) (LANL 2012, 228624).

Detailed sediment mapping was performed during the Phase I IR (LANL 2009, 107453). Canyon reach S-2, which contains the Sandia wetland, contains high concentrations and proportions of the originally released contaminant inventory. Reasons include

- proximity to contaminant sources,
- the large volume of sediment deposited during the period of active contaminant releases,
- the presence of high concentrations of organic matter in the wetland, and
- the presence of large amounts of silt and clay.

Contaminants commonly adsorb to, or can be precipitated with, sediment particles, clay, or organic matter. Chromium is the major inorganic contaminant of concern in the wetland that could be affected by both oxidation-reduction (redox) changes in the wetland and physical destabilization. Arsenic may also be released from wetland sediments upon dewatering (LANL 2009, 107453). Two groups of organic contaminants of concern, PCBs and PAHs, are primarily subject to physical transport in floods because of low solubility and a strong affinity for organic material and sediment particles. Important source areas for these contaminants are the former outfall for the power plant cooling towers in upper Sandia Canyon (chromium), a former transformer storage area along the south fork of Sandia Canyon (PCBs), and the former asphalt batch along the north fork of Sandia Canyon (PAHs) (LANL 2009, 107453).

The inventory of chromium contamination within the Sandia wetland exists primarily in the form of trivalent chromium [Cr(III)] because of reducing conditions. Alluvial saturation, along with significant amounts of solid organic matter produced from wetland vegetation, results in reducing alluvial aquifer conditions as indicated by high dissolved iron and manganese concentrations in alluvial groundwater. Oxidation by manganese oxides under aqueous conditions is the primary mechanism responsible for oxidation of Cr(III) to Cr(VI) (Rai et al. 1989, 249300). Complete oxidation of Cr(III) to Cr(VI) is likely to occur if the molar concentrations of manganese dioxide [Mn(IV)] exceed those of ferrous oxide [Fe(II)], Cr(III), and Cr binding sites on organic matter. This situation, however, is unlikely within the active Sandia wetland because concentrations of total iron, consisting mainly of Fe(II), and solid organic matter are present at much higher weight-percent concentrations than Mn(IV), which is usually present in the parts per million range (discussed in more detail in Appendix J of the Phase I IR) (LANL 2009, 107453). In addition, drying and leaching experiments conducted on Sandia wetland sediments to quantify the potential release of Cr(VI) during drying of the wetland material showed that Cr(III) appears to remain stable, suggesting insufficient Mn(IV) is produced to oxidize appreciable amounts of Cr(III) to Cr(VI) (LANL 2009, 107453). Dissolved chromium in leachates was primarily in the form of Cr(III), indicating that most chromium measured in a filtered wetland performance monitoring sample was resistant to oxidation and likely occurs as colloids. This explanation is supported by analyses of Cr(VI), which is generally below the method detection limit (MDL) (LANL 2016, 601432).

Data from geochemical studies presented in the Phase I IR (LANL 2009, 107453) and previous Sandia Wetland performance reports indicate that chromium in wetland sediments is predominantly geochemically stable as Cr(III) and is not likely to become a future source of chromium contamination in groundwater, especially if saturated conditions are maintained within the wetland. The frequent nondetections of Cr(VI) in alluvial water confirm that most if not all the chromium exists as Cr(III) (see results in section 3.0). Results from baseline monitoring of the wetland (LANL 2014, 257590) and from monitoring in 2014 (LANL 2015, 600399), 2015 (LANL 2016, 601432), 2016 (LANL 2017, 602341), 2017 (LANL 2018, 603022), 2018 (N3B 2019, 700415), and 2019 (N3B 2020, 700810) show that the Sandia wetland system is chemically and physically stable, with stable-to-increasing wetland vegetation cover in different parts of the system. Most importantly, results of storm water monitoring from gage station E123 have shown a reduction of PCBs and chromium following the GCS installation.

1.3 Project Goals

N3B has prepared this document pursuant to the Compliance Order on Consent, signed June 24, 2016, and environmental surveillance at the Laboratory (LANL 2020, 701238). Specifically, the results presented in this report fulfill requirements set forth in the “Work Plan and Final Design for Stabilization of the Sandia Canyon Wetland” (LANL 2011, 207053). In that plan, the Laboratory proposed reporting Sandia wetland monitoring data to NMED by April 30 of each year. The requirement for designing a Sandia wetland monitoring program was previously set forth in NMED’s “Approval with Modification, Interim Measures Work Plan for Stabilization of the Sandia Canyon Wetland” (NMED 2011, 203806) in response to the Laboratory's "Interim Measures Work Plan for Stabilization of the Sandia Canyon Wetland" (LANL 2011, 203454). The monitoring plan was provided in the work plan (LANL 2011, 207053) and is summarized in section 2.0 of this report. The monitoring plan is designed to identify physical or chemical changes in the Sandia wetland related to (1) the installation of a GCS at the terminus of the wetland (LANL 2013, 251743) and (2) changes in outfall chemistry and discharge volumes related to the SERF expansion (DOE 2010, 206433).

Specifically, monitoring efforts address the following questions:

- Are outfall volumes high enough to maintain the wetland?
- Is the physical stability of the wetland being maintained by the GCS?
- Is the GCS functioning to attenuate storm flow and prevent migration of contaminants?
- Is the wetland chemically stable?

2.0 METHODS

Monitoring was conducted in 2020 for surface water and alluvial groundwater. (Note that geomorphology and vegetation surveys are conducted every 3 yr.) Data are assessed relative to baseline conditions presented in the "Sandia Wetland Performance Report, Baseline Conditions 2012–2014" (LANL 2014, 257590). The current year's data are also compared with previous years to identify any physical and geochemical changes during the monitoring period. Monitoring data include

- water levels and water chemistry from alluvial wells that monitor the alluvial groundwater in the wetland,
- surface water and storm water data from two gaging stations located upstream of the wetland and one gaging station located downstream,
- light detection and ranging (LiDAR) data to monitor vegetation and detect geomorphic change (triennially),
- annual post-monsoon walkdowns with NMED, and
- semiannual and greater-than-50 cubic feet per second (cfs) inspections of the GCS and the log-check dams on the tributary.

In the case of a large disturbance event (approximately 100 cfs at E123) additional monitoring will occur. This metric has been defined based on historical knowledge, which showed that approximately 100-cfs storm events have the potential to cause significant erosion. If discharge at gaging station E123 reaches this discharge value, N3B will consider this a large storm event that might warrant an aerial-based geomorphic and vegetation survey in advance of the routine third-year survey. If significant erosion or vegetation disturbance is observed after a scheduled field visit is performed, aerial surveys will be performed after/during the monsoon season (after for geomorphic surveys and during for vegetation surveys). If noteworthy features are identified in the aerial surveys, the features will be field-checked and additional ground-based survey methods may be implemented.

2.1 Changes to Monitoring in 2020

With guidance and approval from NMED, N3B did not make any changes to the monitoring plan in 2020 and followed the same plan as in 2019. A detailed description of changes to monitoring that occurred in 2019 are included in the 2019 Sandia Wetland Performance Report (N3B 2020, 700810). N3B will continue monitoring according to this plan through the 2021 monitoring year, at which time N3B and NMED will reassess monitoring needs and requirements.

2.2 Monitoring Conducted in 2020

Quarterly sampling of Sandia wetland surface water and annual sampling of alluvial groundwater is coordinated with the Chromium Investigation monitoring group sampling, conducted under the "Interim Facility-Wide Groundwater Monitoring Plan for the 2020 Monitoring Year, October 2019–September 2020" (IFGMP) (N3B 2019, 700451). In 2020, sampling was conducted at eight alluvial wells within the wetland (collocated with the piezometers where water was collected through 2016 [Table 2.2-1]), as well as at surface water gaging stations E121 and E122 (above the wetland) and E123 (below the wetland). (See Figure 1.0-1.)

New Mexico Water Quality Control Commission groundwater standards (20.6.2 NMAC), EPA MCLs, NMED screening levels for tap water, and EPA regional screening levels for tap water were used to establish a set of screening values for evaluating monitoring data. Base-flow and storm water analytical results were screened against the appropriate surface water quality standards in 20.6.4 NMAC (see section 3.0). All analyses were performed off-site by U.S. Department of Energy Consolidated Audit Program– (DOECAP-) certified contract laboratories.

Analytical results meet the N3B minimum data quality objectives (DQOs) as outlined in N3B-PLN-SDM-1000: "Sample and Data Management Plan." N3B-PLN-SDM-1000 sets the validation frequency criteria at 100% Level 1 examination and Level 2 verification of data, and at 10% minimum Level 3 validation of data. A Level 1 examination assesses the completeness of the data as delivered from the analytical laboratory, identifies any reporting errors, and checks the usability of the data based on the analytical laboratory's evaluation of the data. A Level 2 verification evaluates the data to determine the extent to which the laboratory met the analytical method and the contract-specific quality control and reporting requirements. A Level 3 validation includes Levels 1 and 2 criteria and determines the effect of potential anomalies encountered during analysis and possible effects on data quality and usability. A Level 3 validation is performed manually with method-specific data validation procedures. Laboratory analytical data are validated by N3B personnel as outlined in N3B-PLN-SDM-1000; N3B-AP-SDM-3000: "General Guidelines for Data Validation"; N3B-AP-SDM-3014: "Examination and Verification of Analytical Data"; and additional method-specific analytical data validation procedures. All associated validation procedures have been developed, where applicable, from the EPA QA/G-8 Guidance on Environmental Data Verification and Data Validation, the Department of Defense/Department of Energy Consolidated Quality Systems Manual for Environmental Laboratories, the EPA National Functional Guidelines for Data Validation, and the American National Standards Institute/American Nuclear Society 41.5: Verification and Validation of Radiological Data.

2.2.1 Surface Water Monitoring

Surface water gaging stations E121 and E122 are located in the upgradient western end of the Sandia Canyon watershed. Surface water gaging station E123 is located to the east immediately below the terminus of the wetland. Figure 1.0-1 shows the locations of the gaging stations and outfalls as well as the extent of the Sandia wetland. In 2020, gaging station E121 measured discharge from Outfall 001 and storm water runoff from approximately 50 acres of TA-03. With changes at SERF in September 2016, discharge from SCC cooling towers is primarily directed to Outfall 001, with Outfall 03A027 used only for maintenance and emergency discharge. Gaging station E122 measures discharge from Outfall 03A199 and storm water runoff from approximately 50 acres from TA-03. Gaging station E123 measures surface water flow below the wetland, including discharge from all outfalls and storm water runoff from approximately 185 acres, 100 acres of which are monitored by E121 and E122. Flow rates into and out of the wetland are measured at gaging stations E121, E122, and E123 during sample-triggering storm events as well as during base-flow conditions. Appendix C (on CD and included with this document) provides analytical data and 5-min stage, discharge, and precipitation data.

In 2020, ISCO 3700 automated samplers attempted to collect storm water samples when discharge was greater than 10 cfs above the base flow at gaging stations E121 and E123. At gaging station E122, the automated samplers attempted to collect storm water samples at the beginning of the season when discharge was greater than 1 cfs, although this was later changed to 5 cfs on July 27. Sampling trip levels are flexible (not arbitrary), are based on historical data, and are optimized to adapt to interannual flow conditions. This sample threshold at gaging station E122 was set lower than 10 cfs because of the lack of significant storm runoff at that gaging station. Base-flow and storm-flow samples in 2020 were analyzed based on the suites presented in Table 2.2-2. Samplers E121 and E122 were activated on July 15, 2020, and E123 was activated on July 16, 2020. Each sampler remains active until four complete samples are collected. Sampler shutdowns occurred on November 5, 2020, at gaging stations E121 and 122 and on November 9, 2020, at gaging station E123. Stations E121 and E123 are equipped with a Sutron 9210 data logger, an MDS 4710 radio transceiver, and a Sutron Accubar bubbler. Station E122 is equipped with a Sutron 9210 data logger, an MDS 4710 radio transceiver, and a VEGAPULS 61 radar sensor. Stage is recorded every 5 min and transmitted to a base station where it is archived in a database. All three gaging stations are equipped with two automated ISCO samplers: one with a 24-bottle set for suspended sediment concentration (SSC) analyses throughout the storm event, and one with a 12-bottle set for collection of chemistry samples (Table 2.2-3). Analytes other than those listed in Table 2.2-3 were sampled in storm flow in 2020 for purposes other than the monitoring of wetland performance (i.e., dissolved organic carbon [DOC], alkalinity, pH, gross alpha, and particle size). Only analytes required for the monitoring of wetland performance are presented in Table 2.2-2.

2.2.2 Deviations from the Sampling Plan

Due to the DOE EM-LA COVID-19 partial stop-work order, fieldwork was reduced to essential mission critical activities (EMCA) status beginning March 24, 2020. The second quarterly base-flow sampling event at the three gaging stations (scheduled for May 2020) was not performed because N3B was in EMCA status. Base-flow sampling was conducted in February, July, and November 2020.

The resumption of N3B's operations at LANL occurred in phases, starting with additional mission-critical activities that were both high-priority and low-risk. Even after field operations began to resume in June and July 2020, COVID-19 reduced staff availability. Sampler activation for E121, E122, and E123 was completed by July 16, 2020. Four rain events occurred between June 1 and July 16, 2020, as shown in Table 3.1-1.

Independent of COVID-19 impacts, a programming error of the alluvial water-level transducers caused data logging to stop on October 31, 2020. The error was not discovered until the data were downloaded in January 2021; hence, 2 months of data were missed.

2.2.3 Alluvial System Monitoring

Monitoring of alluvial groundwater chemistry is accomplished with alluvial wells constructed of a 2-in.-inside diameter polyvinyl chloride (PVC) casing and a 2-in. slotted PVC casing to act as a screen surrounded by a filter pack consisting of 1/20 silica sand (Table 2.2-4). The current alluvial wells (prefix SWA) were installed to replace piezometers (prefix SCPZ) between 2014 and 2016. The alluvial wells were collocated with the old piezometers (data from shared locations are reported together in the section 3.4 figures). Table 2.2-1 provides a crosswalk of the piezometers and alluvial wells. Since 2017, only water from the alluvial wells has been sampled. Initially, there were 12 alluvial wells arranged in 4 transects bisecting the surface water channel. However, beginning in 2019, only the first and fourth transects, and wells SWA-2-4 and SWA-2-6 from the second transect, were sampled for a total of 8 wells (Figure 1.0-1).

The monitored alluvial well (piezometer) transects are as follows:

- Alluvial wells SWA-1-1 (SCPZ-1), SWA-1-2 (SCPZ-2/SWA-1), and SWA-1-3 (SCPZ-3) are located on a sand-and-gravel terrace near the active channel (c1 geomorphic unit) toward the western end of the wetland, which has experienced channel incision and dewatering relative to historical conditions. These alluvial systems are located on the c3 geomorphic unit, away from the active channel and associated inset terrace (c2a geomorphic unit), which are locations of recent cattail expansion. Well SWA-1-1 is screened toward the base of alluvial fill, while the tops of the screens in wells SWA-1-2 and SWA-1-3 are approximately 6 ft and 3 ft below ground surface (bgs), respectively (Table 2.2-4).
- Wells SWA-2-4 (SCPZ-4) and SWA-2-6 (SCPZ-6/SWA-2) form a transect in the widest portion of the wetland. The tops of the well screens are 2–3 ft bgs because the wetland water level is at or very near the surface at this transect. It is at these shallowest depths that changes in water level and sediment oxidation, were they to occur, would be expected to manifest as a result of reduced effluent discharge. Similarly, the lateral margins of the wetland may dewater before the middle of the wetland as a result of reduced effluent volumes. This effect could be most pronounced where the wetland is widest and water flux is most spread out. It is also at such locations that preferential flow paths within the alluvium may form.
- The final transect of wells SWA-4-10 (SCPZ-10), SWA-4-11 (SCPZ-11B), and SWA-4-12 (SCPZ-12/SWA-4) have responded most to the rewatering that has occurred at the eastern terminus of the wetland because of the effect of the GCS. The wetland water level is at or near the surface at this transect. Water was routed around this area during GCS construction.

The 2020 sampling and analysis plan for the alluvial wells is provided in Table 2.2-2. Most of the analyses were designed as indicators of redox changes associated with potential dewatering of the wetland. Alluvial locations were instrumented with sondes for continuous monitoring of water levels, specific conductance, and temperature. Full suites were collected at all locations in October 2020. In addition, the field parameter data from the surface water and alluvial wells are provided in Table 2.2-5.

In 2019, all transducers in the Sandia wetlands were replaced with In-Situ Level Troll 500 15–30 psi data loggers (Table 2.2-6). The Level Troll 500 transducers are programmed to collect continuous measurements of water level, water pressure, and temperature every hour. The factory calibration for the Level Troll 500 is rated for 18 months of accurate data collection. Data downloads are collected every 6 months from the installation date. Each transducer will be replaced within 12 months of the installation date. Due to fieldwork limitations associated with the COVID-19 pandemic, the replacement of transducers planned for July–August 2020 did not occur. The transducers are scheduled for replacement in early 2021, which will still put them within or very close to their 18-month calibration rating.

2.2.4 Geomorphic and Vegetation Monitoring

Since 2016, aerial LiDAR surveys have been performed every 3 yr, or more often if large storm events cause significant geomorphic changes during a year when a survey is not scheduled. However, a baseline LiDAR survey was performed in 2018 because of quality issues with the 2016 LiDAR survey.

Beginning in 2019, a new aerial survey technique was used to replace ground-based GPS survey methods used in prior years. The surveys were performed on the entire Sandia wetland area using airborne hyperspectral and LiDAR equipment to collect geomorphic and vegetation data. The LiDAR surveys provide a detailed digital elevation model of the area that can be compared with historical ground-based geomorphic survey data.

In 2020, storm water peak discharge did not exceed 100 cfs at gaging station E123; hence, no additional visual inspection of the wetland to document qualitative geomorphic changes was warranted.

2.2.5 GCS Monitoring

The GCS is inspected twice a year and following rain events with discharges greater than 50 cfs (LANL 2014, 600083). If erosion or any indications of instability are observed, appropriate actions will be taken to ensure continued stability and functionality of the GCS. The GCS inspections, with photographs of these drainage controls, are presented in Appendix B.

2.3 2021 Monitoring Plan

The 2021 monitoring plan will remain the same as the plan approved in March 2019. No changes were proposed for 2021 during the pre-submittal meeting with NMED on December 9, 2020. The 2019 sampling plan will be used for three monitoring years (2019, 2020, and 2021) before being reassessed. Next year, N3B will address reporting frequency with NMED.

3.0 RESULTS AND DISCUSSION

Deleterious changes in any one metric do not necessarily represent a detriment to the overall function of the wetland and will not necessarily lead to contaminant release from wetland sediments. The wetland should be evaluated in terms of total system performance over time with multiple lines of evidence used to determine if the system is stable.

3.1 Inputs to and Hydrology of the Sandia Wetland

3.1.1 Outfalls

Outfall volumes from Outfall 001 were initially lower after SERF came online but have actually shown a slight increasing trend over the period of monitoring in the Sandia Wetland. Figure 1.1-1(b) shows there has been a significant increase in mean daily outfall volume per month since 2014, although the trend is relatively weak ($p = 0.041$, linear regression). Mean daily volume of effluent per month back to 2006 is shown in Figure 1.1-1(a). Outfall volume per day back to 2010 is shown alongside mean daily discharge from E121, E122, and E123 in Figure 3.1-1. Outfall daily volumes in the beginning of 2020 were the highest they have been since SERF came online. This increase is reflected in higher base flow at E121 during the same time period. The decrease in inputs to Outfall 001 in the summer months may have been due to the rerouting of blowdown water from the SCC to the power plant cooling towers before being discharged. This rerouting occurred to ensure effluent complied with the discharge temperature limit of 20°C. Outfall volumes continue to stay well above the 40,000 gpd needed to sustain the wetland. This is further supported by the gage and alluvial water-level data.

3.1.2 Precipitation and Gage Discharge

Winter precipitation in 2020 was average, but monsoon precipitation was well below average, leading to drought conditions. In 2020, there were no large disturbance (greater than 50 cfs) events. For each sample-triggering storm event in 2020, Table 3.1-1 shows precipitation at rain gage RG121.9, storm water peak discharge, and whether a sample was collected at E121, E122, or E123 gaging station. Storm-water discharge at E121 equaled or exceeded the trip level (10 cfs above the base flow) 4 times in 2020, and samples were collected from 1 of those events. Discharge at E122 equaled or exceeded the lowered trip level (1 cfs above the base flow at the beginning of the sampling season, then changed to 5 cfs above the base flow in late July) 7 times in 2020 and samples were collected from 2 of those events. Discharge at E123 exceeded the trip level (10 cfs above the base flow) 2 times in 2020 and samples were collected from 1 of those events. Several of the storm-water discharge trip-level exceedances occurred before samplers were activated for the season (Table 3.1-1). Hydrographs of the sample-triggering storm events in 2020 are shown in Figure 3.1-2. In 2020, the average transmission time from E121 to E123 and from E122 to E123 was approximately 113 and 117 min, respectively (Table 3.1-2). This finding indicates that storm water flows from either gage E121 or gage E122 through the wetland to gage E123 in approximately the same amount of time. Base flow levels at E121 were generally higher during January–May 2020 in comparison to 2019 but lower during the rest of the year. Base flow levels at E122 and E123 in 2020 were comparable to those in 2019 (Figure 3.1-1).

3.1.3 Alluvial Water Levels

Water-level monitoring continues as a means to determine how operational effluent releases and precipitation/snowmelt affect the overall wetland hydrology. Comparisons between the 2019 and 2020 water levels (shown in Figure 3.1-3) indicate they have been relatively stable. Seasonal decreases in water levels are observed in a few wells in the easternmost transect (SWA-4-10 and SWA-4-12), presumably as a result of high rates of evapotranspiration associated with warm temperatures and lower-magnitude precipitation events in the summers compared with those in the previous years. The water levels in the alluvial system tend to remain stable because of the relatively impermeable Bandelier Tuff bedrock base of the wetland, and an impermeable downgradient end (the GCS) keeps the water contained in the wetland. As long as water inputs exceed wetland evapotranspiration, even significantly reduced outfall discharge may be able to sustain water levels and sufficient saturation of wetland sediments. Decreased outfall discharge may manifest more in the surface water balance of the wetland than in alluvial groundwater levels. In addition, water temperatures were consistent, showing temporal changes with seasons and with less variation in wells located in the channel and wells at a depth greater than 10 ft (SWA-1-1) (Figure 3.1-3).

3.2 Physical Stability of the Wetland

The physical stability of the wetland was last assessed in 2019. The 2019 survey used aerial-based surveying methods rather than the ground-based method used in previous years. This survey has established a new baseline for the wetland with which subsequent years' data will be compared. The next geomorphic and vegetation surveys will be conducted in 2021 and 2022, respectively.

Table 3.2-1 summarizes the significant geomorphological changes that have occurred in the wetland since 2014. As in 2019, there were no significant events recorded for 2020.

3.3 GCS Performance in Containing Contamination

Inspection results from GCS monitoring, presented in Appendix B, indicate that the GCS is stable and does not require corrective or mitigating actions. As mentioned above, there were no significant flow events in Sandia Canyon in 2020. Inspections were performed in September and November 2020. The post-monsoon walkdown of the wetland with NMED that normally occurs in October did not take place in 2020. Both NMED and N3B agreed that a walkdown was not advisable due to the COVID-19 pandemic and the drought conditions in the 2020 monitoring season. Previously noted undercutting of a log check dam in a side drainage first observed in 2018 was not observed in the 2020 site inspections, presumably from infilling of sediment during subsequent storms. Inspections in 2019 revealed that a coir log in a side drainage was leading to localized scour. The coir log was scheduled to be removed and its contents dispersed in spring 2020, but this work was delayed due to the partial stop-work order prompted by the COVID-19 pandemic. The removal of the coir log has been rescheduled for spring 2021. Photos and descriptions from the inspections and walkdown are included in Appendix B.

As noted in the baseline performance report (LANL 2014, 257590), similar base-flow chemistry for many constituents between upgradient (E121) and downgradient (E123) locations indicates a relatively short residence time for surface water and little interaction (exchange) with alluvial groundwater. This finding is evident for chloride, nitrate plus nitrite, and silica, which are indicators of water quality in outfall discharge in the context of chemistry from Outfall 001 (Figures 1.1-3 to 1.1-5). Gaging station E121 is used as a monitoring point for discerning integrated impacts of changing input chemistry and decreasing effluent volumes from Outfall 001 in base flow. Generally, improvements in water chemistry discharged from Outfall 001 associated with the SERF expansion have been evident for chloride and silica (as inferred from post-SERF and post-GCS concentrations at E121) (Figures 1.1-3 and 1.1-5). Nitrate concentrations showed a small post-GCS decrease at E121 and E123 (Figure 1.1-4).

Analytical results from base flow and storm flow at the three gaging stations illustrate that the GCS is effective at minimizing the migration of contaminants out of the wetland (Figure 3.3-1). Gaging station E123, below the GCS, is the key integrating location of total wetland performance in mitigating discharges of contaminants of concern. Monitoring of storm water at E123 is used to evaluate if anomalously high levels of sediment and contaminants (e.g., chromium, PCBs, PAHs) are mobilized during floods because of a reduction in contaminant contact times with sediment, sorption capacity, or other chemical and/or physical stability in the wetland.

In the box-and-whisker plots in Figure 3.3-1, the median sediment content (measured as SSC) in base flow and storm flow are similar post-GCS. However, there is much less variability (and many fewer data points) in base-flow sediment compared with storm-flow. For example, the highest storm flow SSC in 2020 was 100 times greater than the highest 2020 base-flow samples. The effect of the GCS on base-flow sediment cannot be evaluated because sediment pre-GCS was measured as total suspended sediment (TSS) rather than SSC. The United States Geological Survey (USGS) notes that significant bias in the relation of TSS and SSC exists and these methods should not be used interchangeably. USGS also recommends that SSC be used for monitoring natural waters (Gray et al. 2000, 255422). The SSC results at E123 show that the GCS does, in general, reduce SSC in storm flow. This reduction is noteworthy because several contaminants in the wetland are strongly sorbed to sediments, and a reduction in SSC should be a good proxy for reduction of contaminant migration. Sediment volume for all of upper Sandia Canyon is positively correlated to runoff volume through the following relationship:

$$\textbf{sediment volume} = 0.194 \times \textbf{runoff volume}^{0.995} \qquad \textbf{Equation 1}$$

This model was built from calculated sediment volume and associated runoff volume data from storm events at the three gage stations from 2014 through 2020 (Table 3.3-1). As illustrated in Figure 3.3-2, the relationship is quite strong ($R^2 = 0.61$). Figure 3.3-2 also shows that sediment volume was generally higher in 2014 compared with other years, and this may have been caused by disturbance associated with the construction of the GCS.

The ability of the GCS to attenuate storm flow is less clear, as shown in base-flow and storm-flow peak discharge data at E123 in Figure 3.3-1. Base-flow peak discharge at E123 is relatively constant before and after the GCS was constructed, but storm flow is slightly higher post-GCS. Because base flow is an approximation and storm flow is classified as any discharge above base flow, this method of evaluating the GCS is less accurate than the measurements of SSC, PCBs, and chromium.

PCB concentrations in both base flow and storm flow at E123 are reduced since the GCS was constructed (Figure 3.3-1). While PCB concentrations in base flow and storm flow were higher downgradient of the wetland (relative to upgradient locations E121 and E122) before the GCS was built, the concentrations are closer in magnitude upgradient and downgradient of the wetland since the GCS was constructed. The trend in base-flow PCB concentrations at all of the gaging stations indicates a general decrease from pre-GCS to post-GCS. This may be attributed to changes in outfall chemistry. Base-flow samples in 2020 fell within the concentration range observed in other post-GCS years. All storm-flow samples in 2020 had PCB concentrations above the median post-GCS levels at each respective gaging station.

Total dissolved chromium in base flow has shown a general decreasing trend at E121 post-GCS (Figure 3.3-1). This may be because of process improvements at SERF. Dissolved Cr(VI) is much higher at the upstream gages than downstream at E123, demonstrating the reducing conditions present in the wetland [note that Cr(VI) is measured only in base flow]. Total dissolved chromium in storm flow has remained relatively stable at all locations post-GCS. Downstream, at E123, total chromium concentrations in storm flow continue to be much lower in 2020 than pre-GCS construction, demonstrating that the GCS is functioning to prevent migration of chromium downstream.

Total PAH concentrations were computed using the 18 most prominent PAHs, and nondetections were considered zero. PAHs were not analyzed in storm flow before the GCS was built. In base flow, all total PAH results were nondetections pre-GCS (Figure 3.3-1). In storm flow, total PAH concentrations are similar upgradient and downgradient of the wetland. Generally, higher concentrations of PAHs have been detected at E122 than at E121 and E123. This is likely the influence of the former asphalt batch plant near the northern fork of upper Sandia Canyon. However, one base flow sample collected in July of 2020 at E121 had exceedances of two PAHs (Table 3.3-2). A focused validation was conducted on these PAH results and N3B data stewards determined that there were data quality issues from the analytical laboratory but that the results were still usable. The data are qualified as J+ which means, “The analyte is classified as detected but the reported concentration value is expected to be more uncertain than usual with a potential positive bias.” There were no PAH exceedances from subsequent base flow sampling.

3.3.1 Base-Flow and Storm-Flow Exceedances

Base-flow and storm water analytical results from gaging stations E121, E122, and E123 in 2020 were screened against the appropriate surface water quality criteria (SWQC) (Table 3.3-2). The two main sources of surface water that enter the wetland are discharges from outfalls and storm water runoff from the developed landscape within TA-03. This run-on sourced water influences the results from E121 and E122. Flow at E123 consists of a mix of waters from E121, E122, runoff through the Sandia wetland, and urban runoff from the Laboratory and Los Alamos County. The exceedances detected in storm water and base flow in 2020 include aluminum, copper, dibenz(a,h)anthracene, dioxins, indeno(1,2,3-cd)pyrene, lead, total PCBs, and zinc. Exceedances at E121 occurred primarily in storm water, with the exception of two PAHs, dibenz(a,h)anthracene and indeno(1,2,3-cd)pyrene, which exceeded in one of three base-flow samples, and total PCBs, which exceeded in two of three base-flow samples. Exceedances at E122 were also primarily in storm water, with the exception of one base-flow copper exceedance and total PCBs, which exceeded in two of three base-flow samples. As with the other two gages, exceedances at E123 were mostly in storm water, although there was one base-flow dioxin exceedance and total PCB exceedances in three of three base-flow samples. (Table 3.3-3). The dioxin criteria apply to the sum of the dioxin toxicity equivalents expressed as tetrachlorodibenzo-p-dioxin(2,3,7,8-). The dioxin exceedances are driven by concentrations of PCB congeners.

A comparison of the average and maximum results from E121 and E122 to those from E123 shows that, with the exception of PCBs, the Sandia Wetland is not a source of industrial site-related pollutants that exceed New Mexico SWQCs. Aluminum, copper, lead, and zinc exceedances are attributed to urban runoff and naturally occurring sediments routed to the wetlands from LANL (TA-03) and Los Alamos County.

3.4 Chemical Stability of the Wetland

The alluvial well array provides valuable water-level and alluvial groundwater chemistry data. These locations monitor potential changes associated with outfall volumes, evolving geomorphology, redistribution of reducing zones, and changes in chemistry of the outfall (in the case of more conservative constituents). The metrics for identifying deleterious impacts as monitored in the wells are (1) persistent increases in contaminant concentrations [e.g., Cr(VI)] and/or increases in oxidizing conditions as indicated by redox-sensitive species (e.g., dissolved iron) and (2) persistent decreases in water levels that have deleterious effects on obligate wetland vegetation.

Selected analytical results for water chemistry time-series data (filtered) from the alluvial sampling array are presented in Figures 3.4-1 to 3.4-4. Time-series plots are presented in the relative spatial distribution of the wells in the wetland, as follows:

- the upper plots are from the most northerly wells in each transect, ordered from west to east;
- the middle plots are from wells in the center of each transect, ordered from west to east; and
- the bottom plots are from the southernmost wells in each transect, in the same orientation.

The alluvial sampling array is composed of three transects running north to south and spread out along the length of the wetland. In addition, data for surface water entering the wetland at gaging station E121 and exiting the wetland at gaging station E123 are plotted at the western- and easternmost parts of the wetland, respectively, to provide a comparison of input and output base-flow chemistry (Figure 1.0-1). Differences between base-flow data and alluvial groundwater data may indicate subsurface processes (e.g., reduction) and provide information about residence times in the alluvial system. Key analytes plotted include redox-sensitive species (iron and manganese), and key contaminants (dissolved arsenic and chromium) (Figures 3.4-1 to 3.4-4). Table 2.2-5 details surface water base-flow sampling and field parameters, respectively, for samples collected in CY 2020.

3.4.1 Redox-Sensitive Species

Redox-sensitive species provide information on the degree of reduction occurring in the wetland sediments. Concentrations of arsenic, manganese, and iron tend to be higher in the alluvial system than in surface water, indicating reducing conditions in the alluvial system owing to increased mobility of most reduced metals. Within the surface-water system, concentrations at E121 and E123 are similar for all redox-sensitive species (Figures 3.4-1 through 3.4-4).

Fe(II), the reduced form of iron, is the predominant form present in alluvial waters of the wetland, plotting on or just slightly below the total iron (Figure 3.4-1). Total-iron concentrations higher than Fe(II) are believed to be samples with colloidal Fe(III), or iron chelated by microbial or phyto-siderophores.

Measurement of speciated iron stopped midway through 2018, although based on previous data, the majority of total iron is assumed to be Fe(II). Total iron concentrations in 2020 are similar to those measured in 2019. Alluvial samples continue to have much higher iron concentrations than those shown by the input and output gages. The historically higher values for total iron in the easternmost transect are believed to be of colloidal iron, which has decreased as a result of the recovery from disturbance caused by the installation of the GCS, as suggested by other constituents.

All the locations appear to be strongly reducing with respect to manganese at the depth of screen completion (Figure 3.4-2). Locations SWA-1-2 and SWA-1-3 have somewhat lower manganese concentrations, consistent with their shallow completion depths in sands and gravels. Most of the manganese is believed to be in its reduced form, with increases indicating increasing reducing conditions in alluvial sediment. Manganese concentrations measured in 2020 were relatively similar to those of previous years, with continually higher concentrations in the wetland compared with the gaging stations.

Arsenic can exist as arsenite [As(III)] or arsenate [As(V)]. Arsenite is relatively mobile and should predominate under reducing conditions. Within the range of analytical error, most of the total arsenic detected in analytical results from alluvial wells was As(III), confirming the reducing conditions of the wetland (Figure 3.4-3). In 2020, arsenic concentrations were consistent with those of previous years, continuing to demonstrate the reducing conditions in the wetland.

Dissolved chromium concentrations in the wetland alluvial system are quite high (the NMED groundwater exceedance criterion for chromium is 50 ppb) (Table 3.4-1). There is significant spatial variation in chromium distribution (Figure 3.4-4). Given the varied environmental fate and transport of the different forms of chromium, including those in organo-metal moieties, it is difficult to make meaningful spatial comparisons of total chromium. However, locations SWA-1-2, SWA-1-3, SWA-4-10, SWA-4-11, and SWA-4-12 have higher concentrations on average, with concentrations at the latter three locations perhaps resulting from disturbance associated with GCS construction in the easternmost transect. This trend continued in 2020; the reason for higher Cr(III) in the westernmost transect remains unclear.

The concentrations of dissolved Cr(VI) measured in the alluvial system over the past 4 yr were nearly all at the detection limit (0.152 µg/L since May 2017) or were nondetections (Figure 3.4-4). All alluvial samples collected in 2020 were nondetections. Before 2017, samples analyzed for Cr(VI) were not filtered, with the exception of a few unfiltered test samples in 2013. Because reporting is to the dissolved chromium standard criterion, only the filtered data are shown. The consistently low or nondetected Cr(VI) concentrations reflect the strong reducing conditions in the wetland. The highest detections of Cr(VI) concentration were at E121 and E122 (Fig. 3.1-1). These higher concentrations of Cr(VI) entering the wetland are believed to be from potable water derived from the regional aquifer and concentrated in the cooling towers. Station E123, at the terminus of the wetland, has Cr(VI) concentrations below or just at the detection limit, indicating the chromium exchange capacity and other abiotic immobilizing reductions in Cr(VI) as it moves through the wetland.

3.4.2 Alluvial Groundwater Exceedances

The alluvial system data from 2020 were screened to groundwater standards (Table 3.4-1). Exceedances in alluvial groundwater included arsenic, chromium, iron, and manganese. One arsenic exceedance was observed at SWA-2-6. This location has had consistently high arsenic concentrations (Fig. 3.4-3). Previous speciated arsenic data indicate that most of the aqueous arsenic in the alluvial system is As(III), the reduced form. Iron and manganese exceedances were the most commonly observed and are expected because of the reducing wetland conditions, bringing these likely geology-derived metals into solution. Dissolved manganese is more persistent than iron because of manganese oxidation kinetics, and it has been observed in surface water at E123 in past surveys. There was one chromium exceedance at SWA-1-2. This location also exceeded in 2019 and has had consistently high chromium concentrations (Fig. 3.4-4). Most of the total chromium concentration in alluvial groundwater in the wetland is Cr(III); the measured Cr(VI) at the locations of the exceedances is at or below the MDL.

4.0 CONCLUSIONS

This performance period covers the seventh year following baseline monitoring. The monitoring performed during the performance period indicates that the Sandia wetland is stable and generally expanding following installation of the GCS. Yearly comparisons of analytical results indicate that the wetland is discharging lower concentrations of contaminants of concern in storm water since construction of the GCS. Even with periods of lower effluent volumes entering the wetland and seasonal evapotranspiration, the alluvial system remains stable and wetland sediments remain highly reducing, with no concerning temporal trends in chemistry noted.

Despite overall reduced effluent discharge volumes after SERF came online in 2012, water levels remain sufficiently high to sustain and promote the expansion of the obligate wetland vegetation. Continuing vegetation monitoring in future years will be valuable in assessing wetland performance, with abundant wetland vegetation promoting sediment stability and preserving reducing conditions. No large-scale, systematic erosion has been noted in the wetland, and the system seems to be highly stable from a physical perspective. The GCS has arrested headcutting at the terminus of the wetland. Planted wetland vegetation has rapidly established around the GCS, and wetland vegetation is expanding in the upper portion of the system. Storm water data indicate that the GCS has had a positive impact on mitigation of contaminant transport. Suspended sediment, PCBs, and chromium concentrations have decreased at E123 post-GCS, presumably because of cessation of headcutting at the terminus of the wetland and conditions that promote immobilization.

Ongoing monitoring will continue to allow assessment of changes within the Sandia wetland related to the GCS, changes in effluent chemistry, and decreases in effluent volumes and discharge rates. An adaptive management strategy will be employed should adverse changes be noted.

5.0 REFERENCES AND MAP DATA SOURCES

5.1 References

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

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LANL (Los Alamos National Laboratory), December 15, 2014. “2014 Annual Monitoring Report for Sandia Canyon Wetland Grade-Control Structure (SPA-2012-00050-ABQ),” Los Alamos National Laboratory letter and attachments (ENV-DO-14-0378) to K.E. Allen (USACE) from A.R. Grieggs (LANL), Los Alamos, New Mexico. (LANL 2014, 600083)

LANL (Los Alamos National Laboratory), April 2015. “Sandia Wetland Performance Report, Performance Period April 2014–December 2014,” Los Alamos National Laboratory document LA-UR-15-22463, Los Alamos, New Mexico. (LANL 2015, 600399)

LANL (Los Alamos National Laboratory), April 2016. “2015 Sandia Wetland Performance Report,” Los Alamos National Laboratory document LA-UR-16-22618, Los Alamos, New Mexico. (LANL 2016, 601432)

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LANL (Los Alamos National Laboratory), September 2020. “Los Alamos National Laboratory 2019 Annual Site Environmental Report,” Los Alamos National Laboratory document LA-UR-20-26673, Los Alamos, New Mexico. (LANL 2020, 701238)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), April 2019. “2018 Sandia Wetland Performance Report,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0091, Los Alamos, New Mexico. (N3B 2019, 700415)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), May 2019. “Interim Facility-Wide Groundwater Monitoring Plan for the 2020 Monitoring Year, October 2019–September 2020,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2019-0156, Los Alamos, New Mexico. (N3B 2019, 700451)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), March 2020. “2019 Sandia Wetland Performance Report,” Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0020, Los Alamos, New Mexico. (N3B 2020, 700810)

NMED (New Mexico Environment Department), June 9, 2011. “Approval with Modification, Interim Measures Work Plan for Stabilization of the Sandia Canyon Wetland,” New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M.J. Graham (LANL) from J.E. Kieling (NMED-HWB), Santa Fe, New Mexico. (NMED 2011, 203806)

Rai, D., L.E. Eary, and J.M. Zachara, October 1989. “Environmental Chemistry of Chromium,” *Science of the Total Environment,* Vol. 86, No. 1–2, pp. 15–23. (Rai et al. 1989, 249300)

5.2 Map Data Sources

Rain Gages; Los Alamos National Laboratory; ER-ES Surface Hydrology Group; 2017.

WQH NPDES Outfalls; Los Alamos National Laboratory, ENV Water Quality and Hydrology Group; Edition 2002.01; 01 September 2003.

Alluvial Well Locations; Los Alamos National Laboratory, Waste and Environmental Services Division; Locus EIM database pull; 2017.

Paved Road Arcs; Los Alamos National Laboratory, FWO Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

Grade Control Structure and Cascade Pool; Los Alamos National Laboratory; ER-ES Engineering Services; as published, project 14-0015; 2017.

Structures; Los Alamos National Laboratory, FWO Site Support Services, Planning, Locating and Mapping Section; 06 January 2004; as published 29 November 2010.

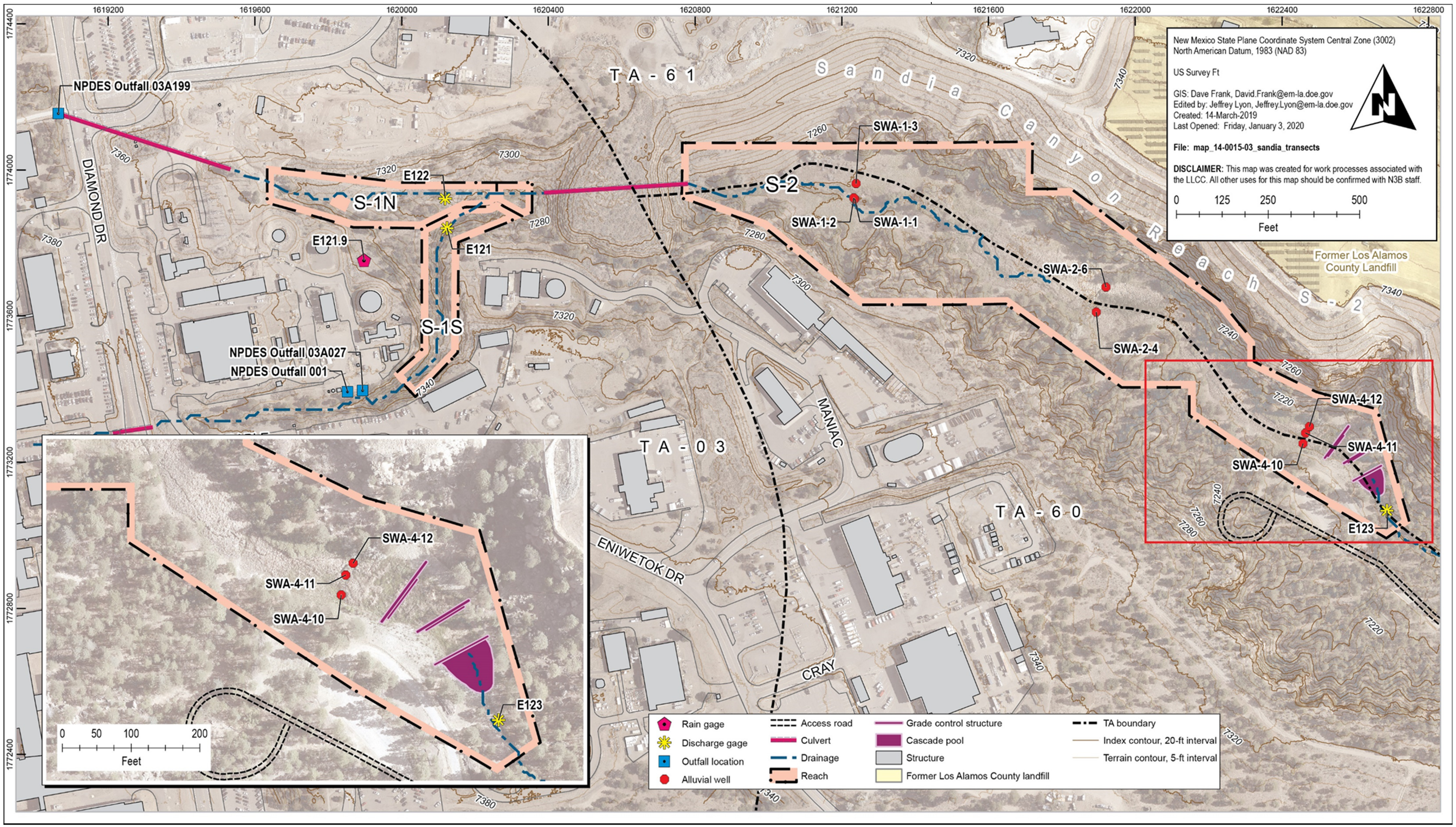
Former Los Alamos County Landfill; Los Alamos National Laboratory; ER-ES Engineering Services; as published, project 14-0015; 2017.

Canyon Reaches; Los Alamos National Laboratory, ENV Environmental Remediation and Surveillance Program, ER2002-0592; 1:24,000 Scale Data; Unknown publication date.

Technical Area Boundaries; Los Alamos National Laboratory, Site Planning & Project Initiation Group, Infrastructure Planning Office; September 2007; as published 13 August 2010.

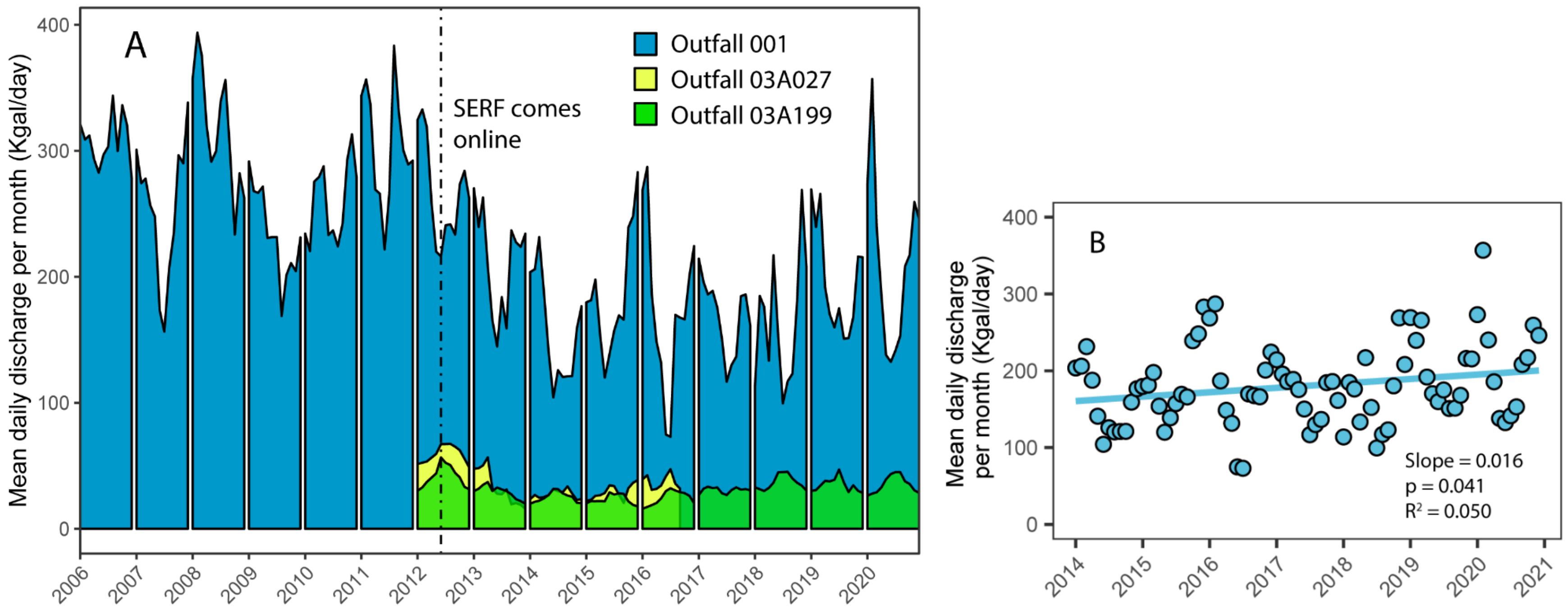
Orthophotography, Los Alamos National Laboratory Site, 2014; Los Alamos National Laboratory, Site Planning and Project Initiation Group, Space and Site Management Office; 2014.

Contours, 20 and 5-ft intervals; as generated from 2014 LiDAR elevation data; Los Alamos National Laboratory, ER-ES; as published, project 14-0015; 2017.



Notes: Reaches S-1N and S-1S are upstream of the wetland; S-2 essentially encompasses the wetland.

Figure 1.0-1 **Locations of the Sandia GCS; NPDES outfalls; precipitation gage E121.9; alluvial wells; surface and storm water gaging stations; former Los Alamos County landfill; surrounding technical areas; and reaches S-1N, S-1S, and S-2**



Notes: Monthly average effluent release volumes are shown for Outfall 001 from January 2006 through December 2020 (blue); for Outfall 03A027 from January 2012 through September 2016 (yellow); and for Outfall 03A199 from January 2012 through December 2020 (green). Note that no discharges to Outfall 03A027 have occurred since September 2016. Linear regression fitted to mean daily discharge per month data. There have been no significant changes in discharge volumes since 2014, although there has been a general increasing trend (p = 0.041, linear regression).

Figure 1.1-1 (a) Monthly average effluent release volumes (expressed as Kgal./day) and (b) Linear regression fitted to mean daily discharge per month data

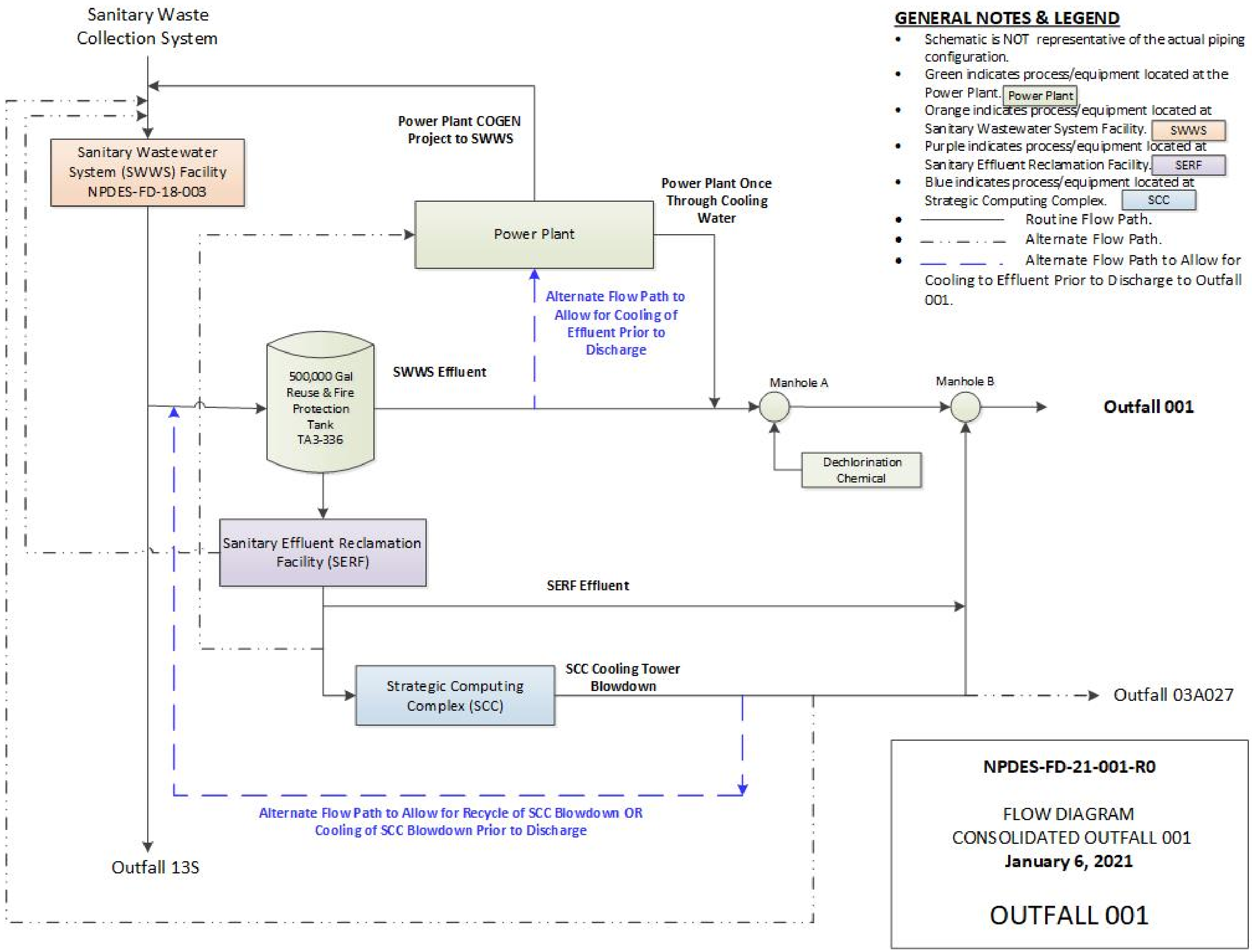
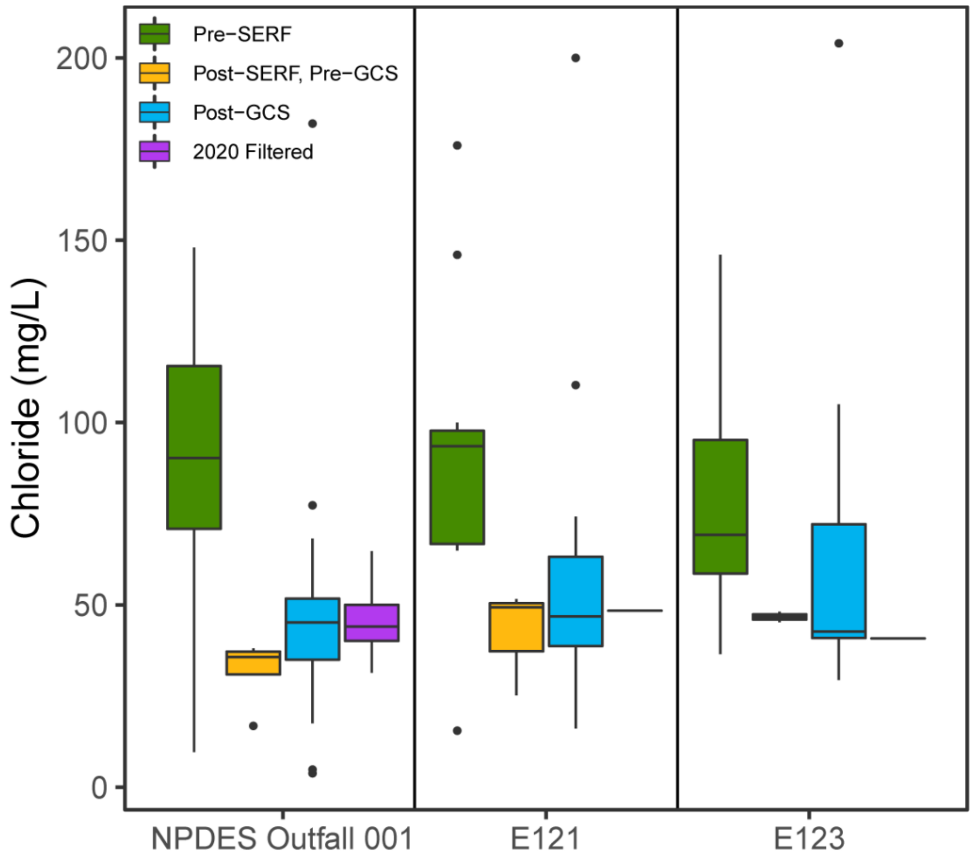
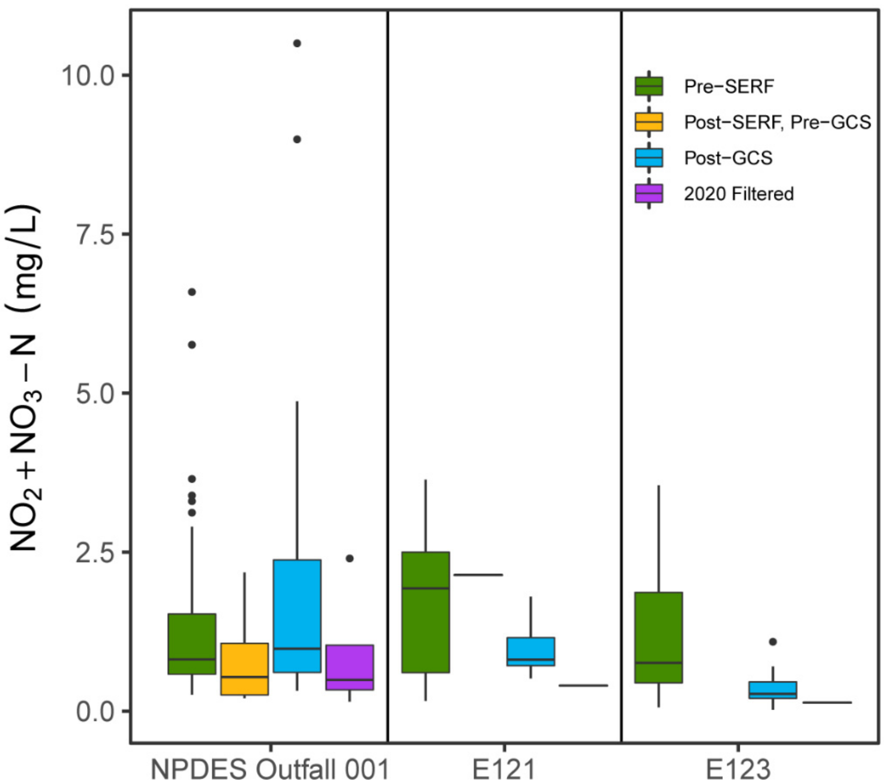


Figure 1.1-2 Updated process schematic for the power plant, SWWS, and SERF connections to Outfall 001 (current configuration)



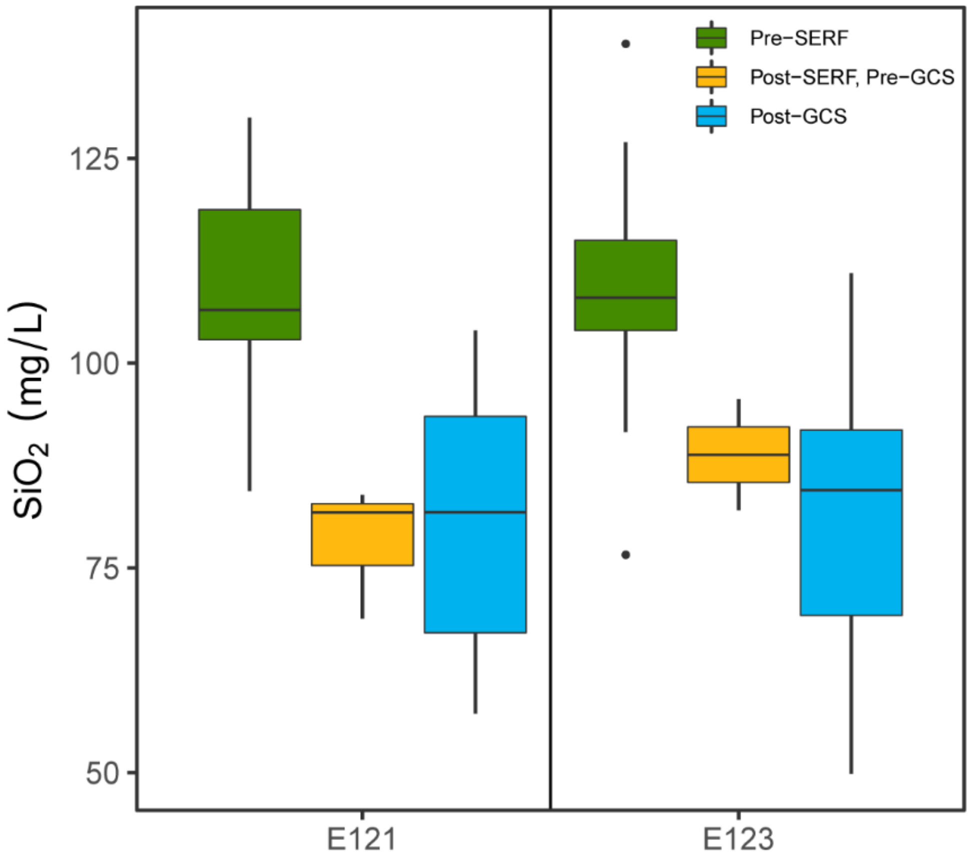
Notes: The lower and upper bounds of each box correspond to the first and third quartiles, respectively, and the thick black line in each box shows the median. Whiskers extend to the largest or smallest value, or at most 1.5 times +/- the interquartile range (the height of the box). Values above or below the whiskers are marked as outliers (solid black points). Note that because of differences in monitoring requirements at Outfall 001 compared with E121 and E123, concentrations prior to 2020 should not be compared across locations. Outfall 001 samples through 2019 were unfiltered, while data from gaging stations E121 and E123 have always been filtered. Beginning in 2020, Outfall 001 samples changed to being filtered, meaning the “2020 Filtered” boxplots can be compared across locations.

Figure 1.1-3 Box-and-whisker plots of chloride concentration, a water quality indicator, before and after SERF came online and before and after the GCS was constructed, at Outfall 001 and at gaging stations E121 and E123



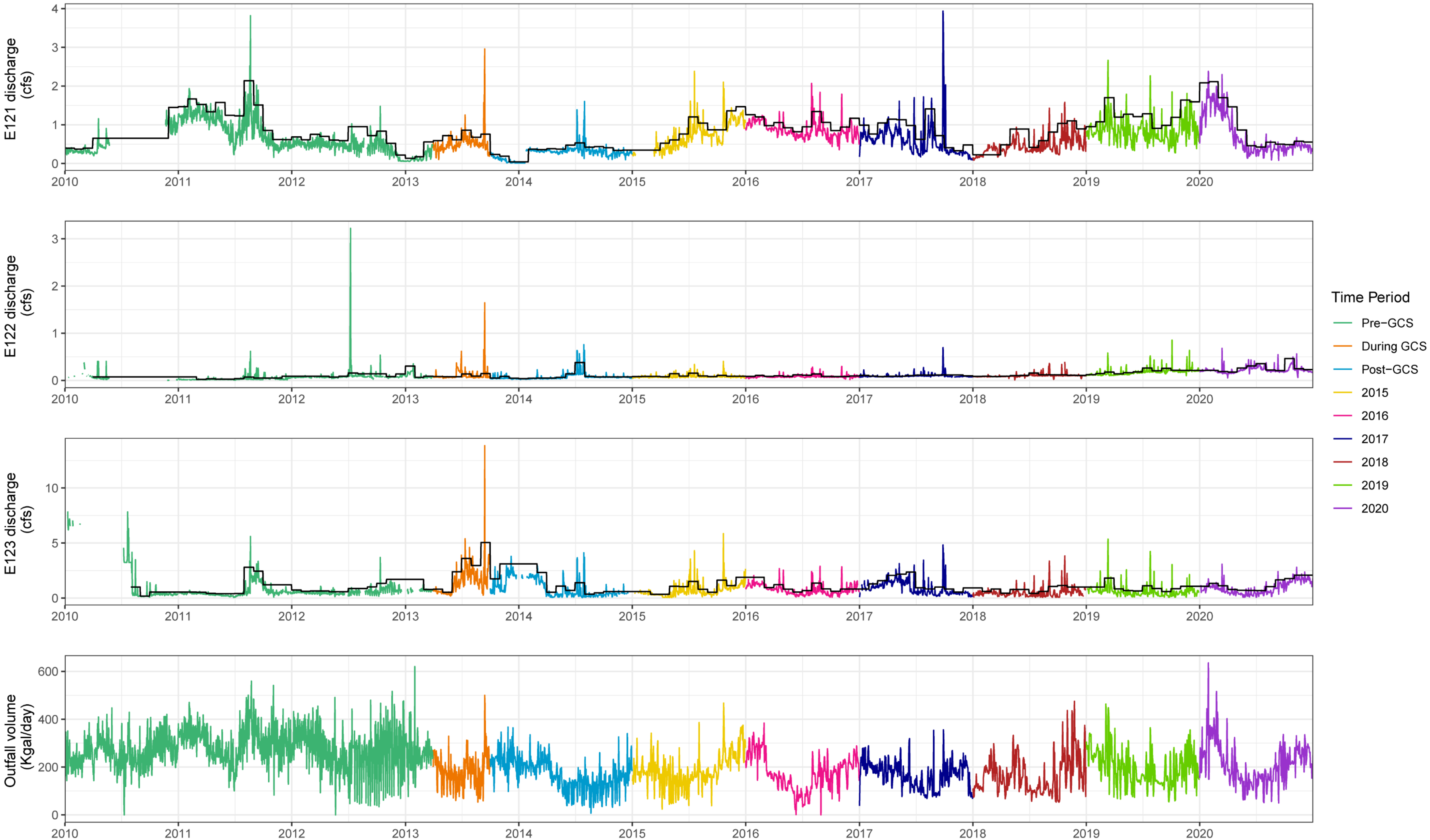
Notes: The lower and upper bounds of each box correspond to the first and third quartiles, respectively, and the thick black line in each box shows the median. Whiskers extend to the largest or smallest value, or at most 1.5 times +/- the interquartile range (the height of the box). Values above or below the whiskers are marked as outliers (solid black points). Note that because of differences in monitoring requirements at Outfall 001 compared with E121 and E123, concentrations prior to 2020 should not be compared across locations. Outfall 001 samples through 2019 were unfiltered, while data from gaging stations E121 and E123 have always been filtered. Beginning in 2020, Outfall 001 samples changed to being filtered, meaning the “2020 Filtered” boxplots can be compared across locations.

Figure 1.1-4 Box-and-whisker plots of nitrate plus nitrite as nitrogen concentration, a water quality indicator, before and after SERF came online and before and after the GCS was constructed, at Outfall 001 and at gaging stations E121 and E123



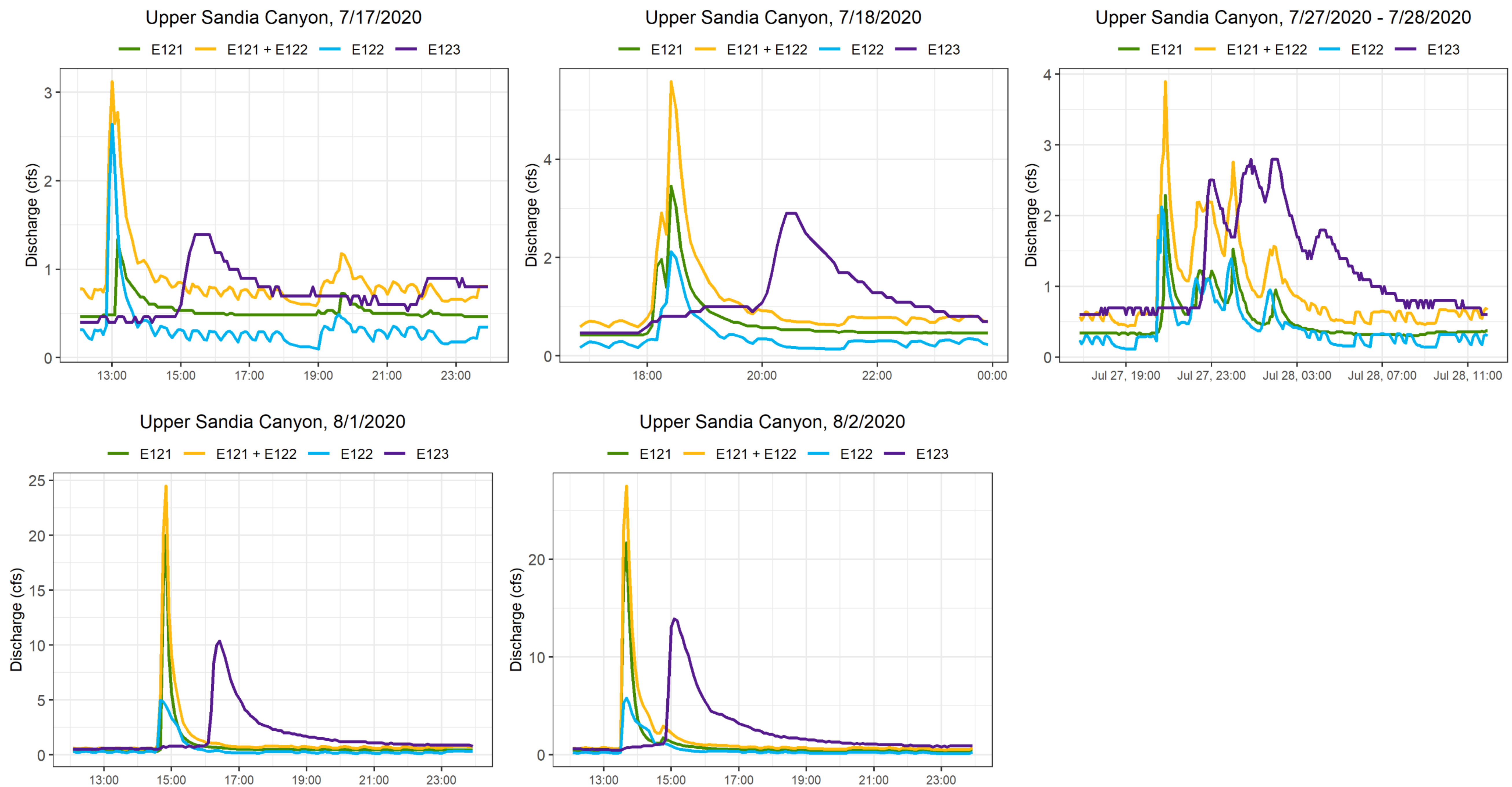
Notes: The lower and upper bounds of each box correspond to the first and third quartiles, respectively, and the thick black line in each box shows the median. Whiskers extend to the largest or smallest value, or at most 1.5 times +/- the interquartile range (the height of the box). Values above or below the whiskers are marked as outliers (solid black points).

Figure 1.1-5 Box-and-whisker plots of silicon dioxide concentration, a water quality indicator, before and after SERF came online and before and after the GCS was constructed, at Outfall 001 and at gaging stations E121 and E123



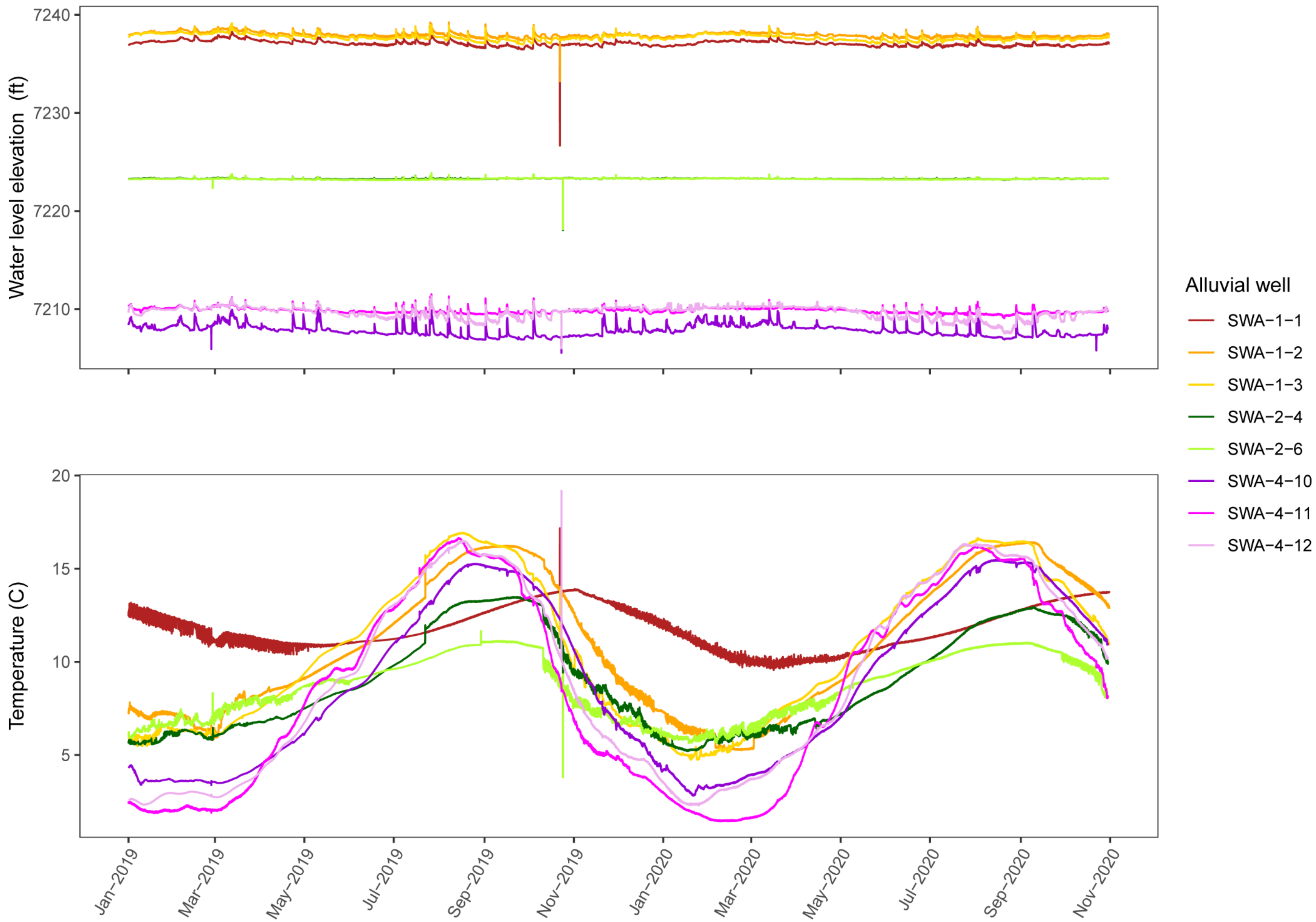
Note: Black lines show approximate base flow, calculated as the monthly median daily discharge plus 1.5 times the interquartile range.

Figure 3.1-1 Time series plots from 2010 to 2020 showing mean daily discharge at gaging stations E121, E122, and E123 and Outfall 001



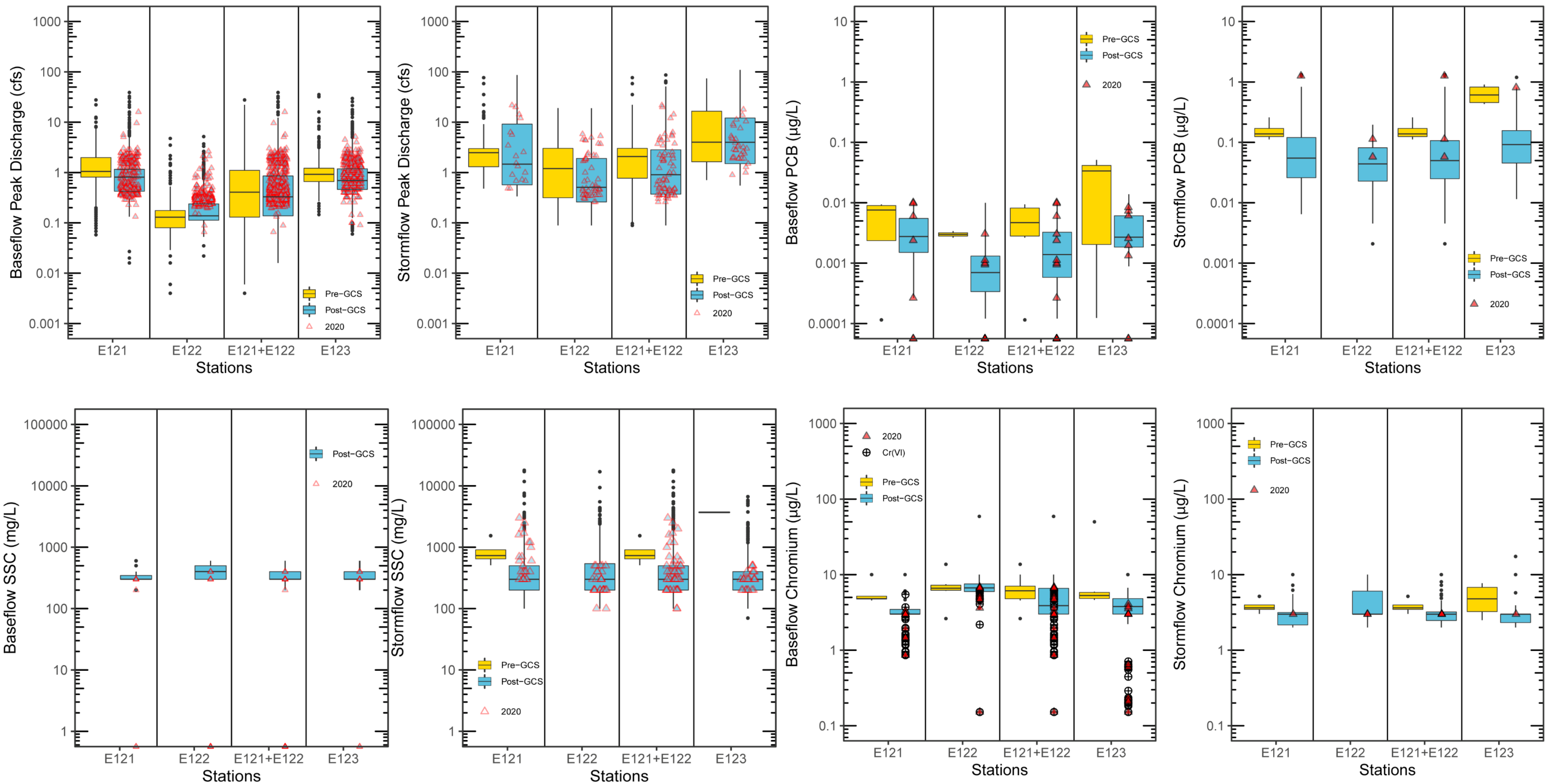
Notes: Not all gages were sampled during every storm event. Refer to Table 3.1-1 for details on each gage. Due to field restrictions associated with the COVID-19 pandemic, samplers were not activated until mid-July and some storms in June were missed.

Figure 3.1-2 Hydrographs of storm water discharge at E121, E122, and E123 during each sample-triggering storm event in 2020



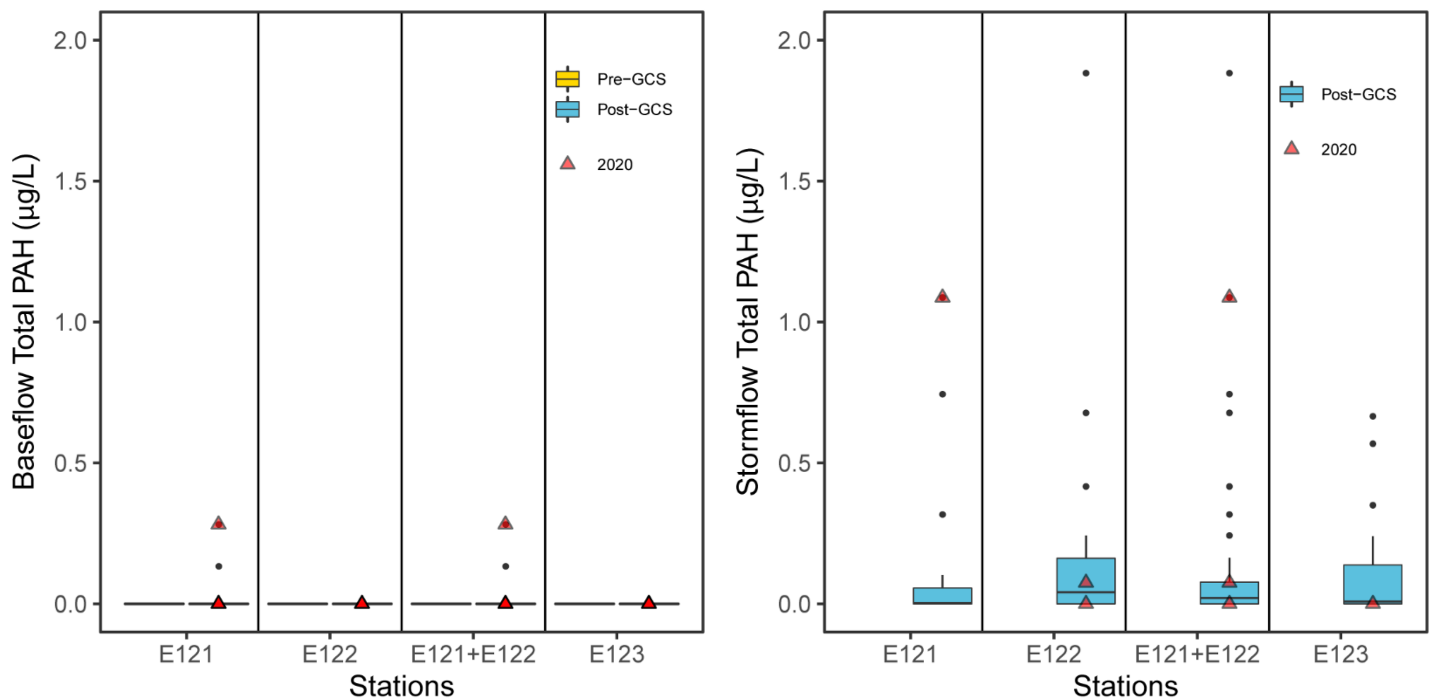
Note: Due to a programming error of the pressure transducers, data collection stopped on October 31, 2020.

Figure 3.1-3 Alluvial water levels and alluvial water temperature in 2019 and 2020



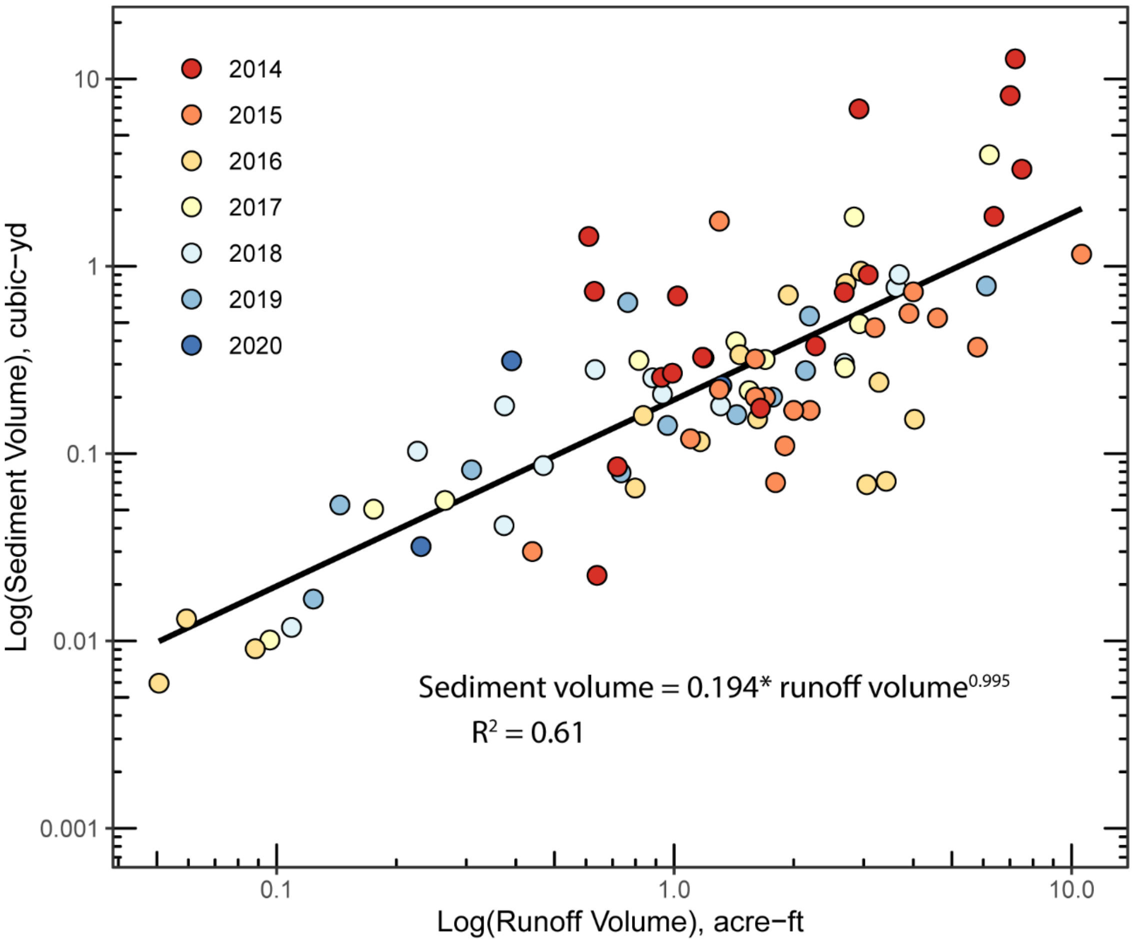
Notes: Data for 2020 are included in the post-GCS boxplot and are also overlaid as triangles. Triangles falling directly on the x-axis represent zeros (the log-scale is not defined for zero). The lower and upper bounds of each box correspond to the first and third quartiles, respectively, and the thick black line in each box shows the median. Whiskers extend to the largest or smallest value, or at most 1.5 times +/- the interquartile range (the height of the box). Values above or below the whiskers are marked as outliers (solid black points). Before 2012, TSS was measured rather than SSC; TSS data are not shown on the SSC plots as they are not comparable metrics. There were no pre-GCS base-flow data for SSC and limited pre-GCS storm-flow data.

Figure 3.3-1 Pre- and post-GCS box-and-whisker plots of peak discharge, SSC, total PCBs, dissolved chromium and Cr(VI), and PAHs for base flow and storm flow at gaging stations E121, E122, and E123



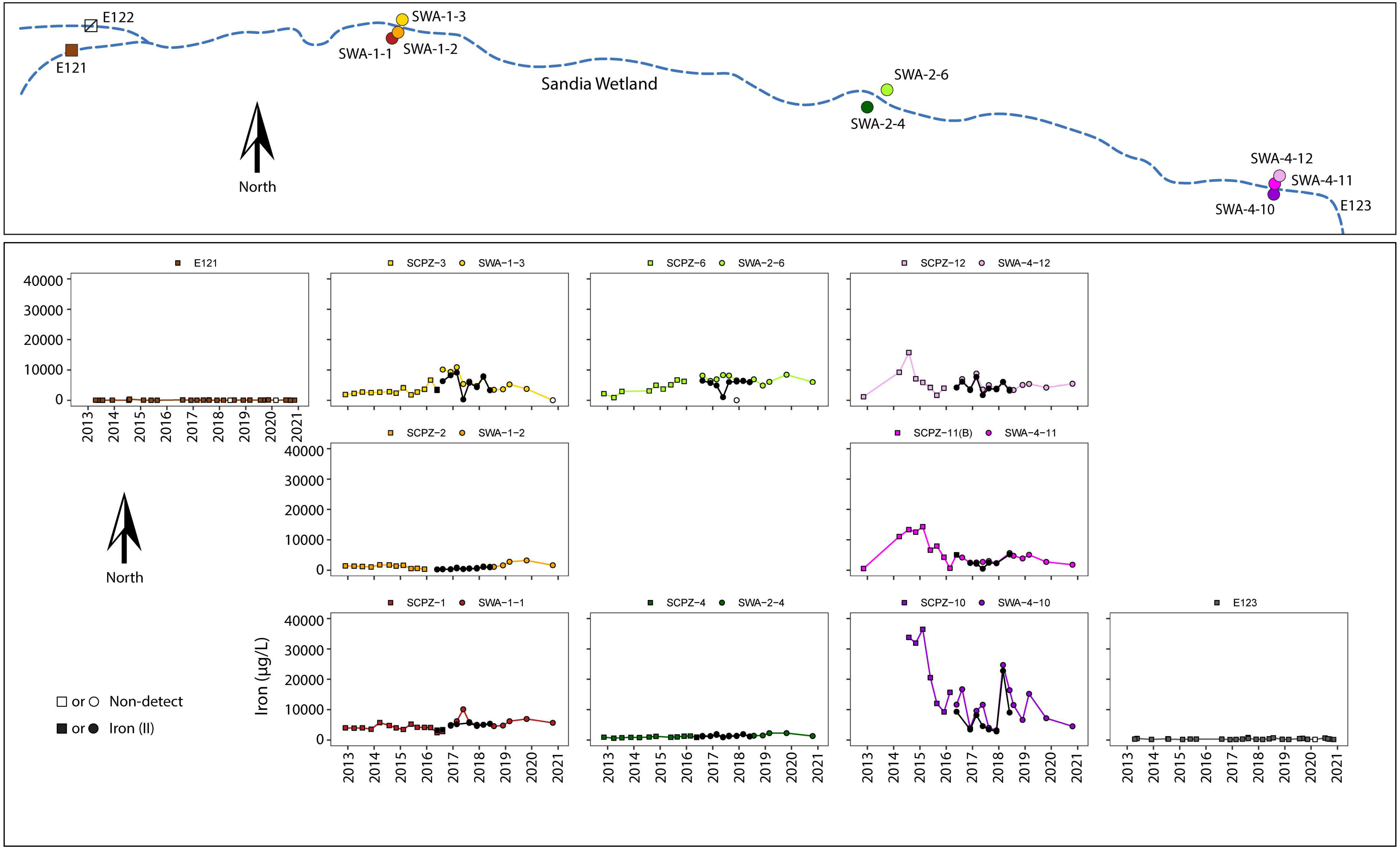
Notes: Data for 2020 are included in the post-GCS boxplot and are also overlaid as triangles. Triangles falling directly on the x-axis represent zeros (the log-scale is not defined for zero). The lower and upper bounds of each box correspond to the first and third quartiles, respectively, and the thick black line in each box shows the median. Whiskers extend to the largest or smallest value, or at most 1.5 times +/- the interquartile range (the height of the box). Values above or below the whiskers are marked as outliers (solid black points). Before 2012, TSS was measured rather than SSC; TSS data are not shown on the SSC plots as they are not comparable metrics. There were no pre-GCS base-flow data for SSC and limited pre-GCS storm-flow data.

Figure 3.3-1 (continued) **Pre- and post-GCS box-and-whisker plots of peak discharge, SSC, total PCBs, dissolved chromium and Cr(VI), and PAHs for base flow and storm flow at gaging stations E121, E122, and E123**



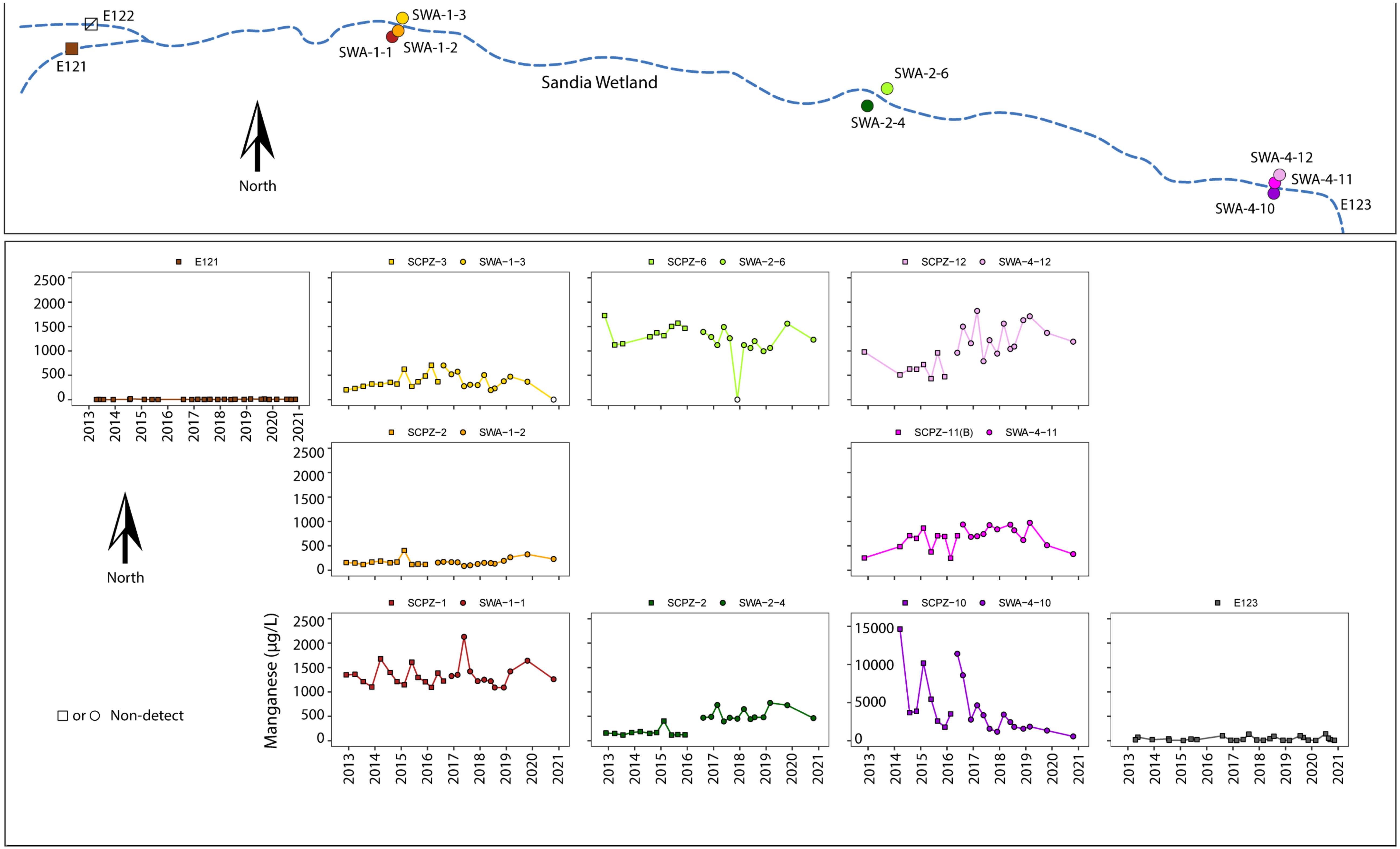
Notes: The best-fit line is shown in black. Note that the model generated is not linear because data are displayed on a log-scale. Sediment volume was not calculated for the storm event at E122 on 7/17/2020 because the 24-bottle ISCO did not collect samples. Therefore, there were not enough SSC samples to make an accurate calculation.

Figure 3.3-2 Log-log plot showing the relationship between sediment volume and runoff volume from storm events from 2014 through 2020 at gaging stations E121, E122, and E123



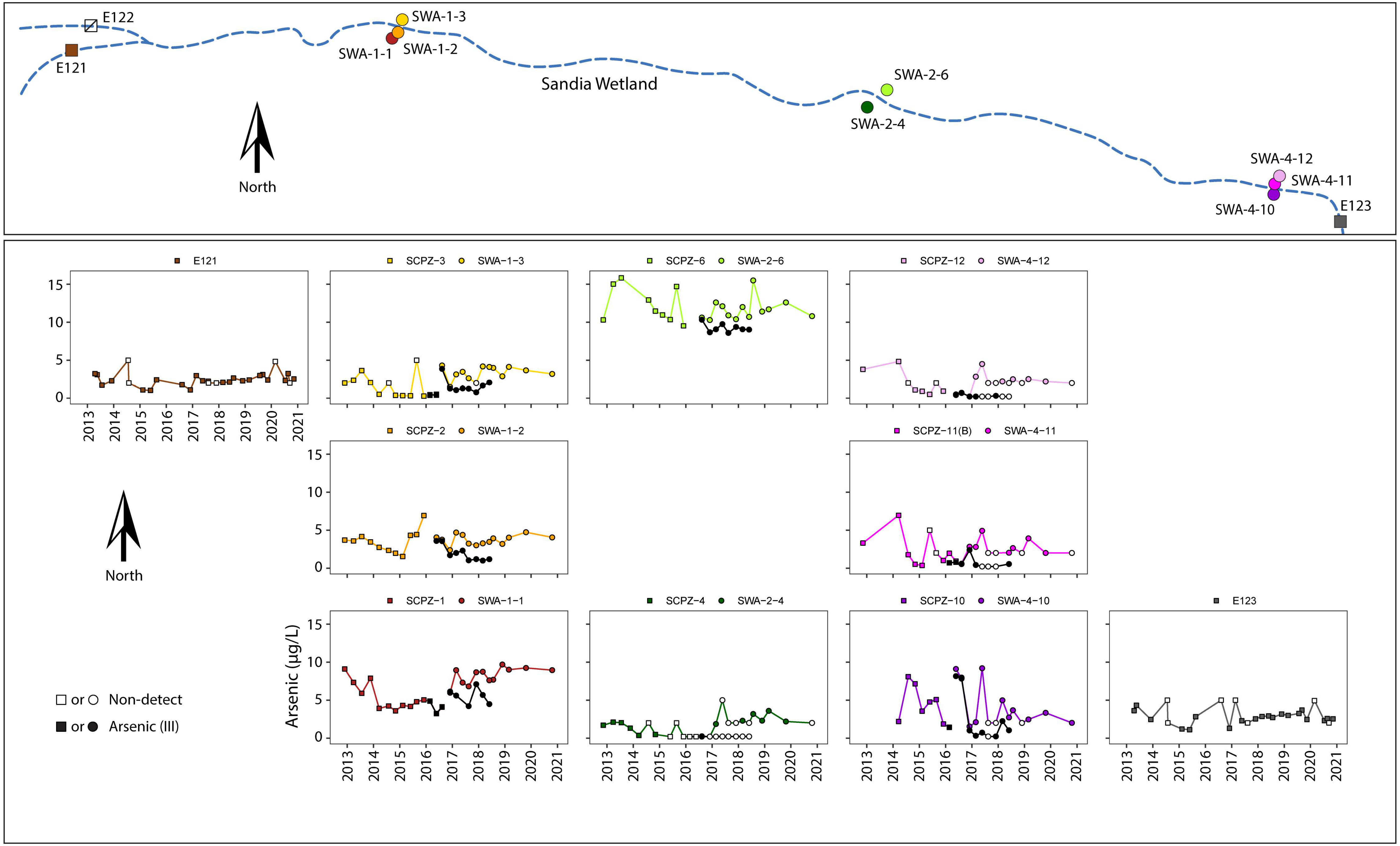
Notes: Surface water stations include E121, E122 (plot not shown), and E123. Piezometers are labeled with the prefix SCPZ (square symbols), and alluvial wells are labeled with the prefix SWA (circle symbols). The plots are arranged in three transects from west to east. Data are plotted for the full period of wetland monitoring. Nondetections are plotted as the MDL with open symbols. Total iron is represented with colored symbols and Fe(II) with black symbols. Monitoring at piezometers SWA-2-5, SWA-3-7, SWA-3-8, and SWA-3-9 was discontinued in 2019; data can be found in previous years' reports. The map above is not to scale but shows approximate sampling locations in relation to the approximate thalweg (blue dashed line).

Figure 3.4-1 Iron concentrations in Sandia wetland surface water and alluvial system



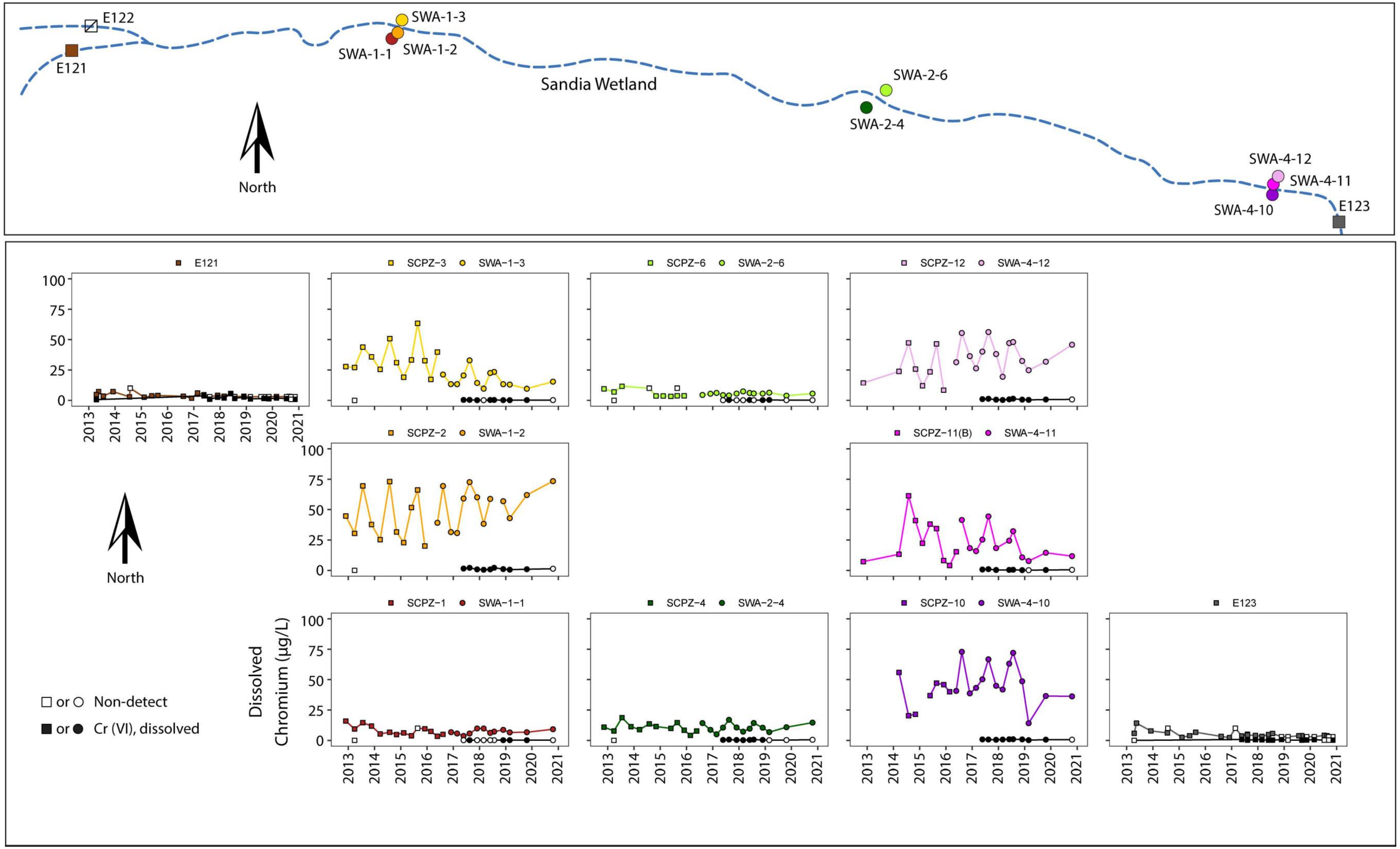
Notes: Surface water stations include E121, E122 (plot not shown), and E123. Piezometers are labeled with the prefix SCPZ (square symbols), and alluvial wells are labeled with the prefix SWA (circle symbols). The plots are arranged in three transects from west to east. Data are plotted for the full period of wetland monitoring. Nondetections are plotted as the MDL with open symbols. Monitoring at piezometers SWA-2-5, SWA-3-7, SWA-3-8, and SWA-3-9 was discontinued in 2019; data can be found in previous years' reports. The map above is not to scale but shows approximate sampling locations in relation to the approximate thalweg (blue dashed line).

Figure 3.4-2 Manganese concentrations in Sandia wetland surface water and alluvial system



Notes: Surface water stations include E121, E122 (plot not shown), and E123. Piezometers are labeled with the prefix SCPZ (square symbols), and alluvial wells are labeled with the prefix SWA (circle symbols). The plots are arranged in three transects from west to east. Data are plotted for the full period of wetland monitoring. Nondetections are plotted as the MDL with open symbols. Total arsenic is represented with colored symbols and As(III) with black symbols. Monitoring at piezometers SWA-2-5, SWA-3-7, SWA-3-8, and SWA-3-9 was discontinued in 2019; data can be found in previous years' reports. The map above is not to scale but shows approximate sampling locations in relation to the approximate thalweg (blue dashed line).

Figure 3.4-3 Arsenic concentrations in Sandia wetland surface water and alluvial system



Notes: Surface water stations include E121, E122 (plot not shown), and E123. Piezometers are labeled with the prefix SCPZ (square symbols), and alluvial wells are labeled with the prefix SWA (circle symbols). The plots are arranged in three transects from west to east. Data are plotted for the full period of wetland monitoring. Nondetections are plotted as the MDL with open symbols. Total chromium is represented with colored symbols and Cr(VI) with black symbols. Monitoring at piezometers SWA-2-5, SWA-3-7, SWA-3-8, and SWA-3-9 was discontinued in 2019; data can be found in previous years' reports. The map above is not to scale but shows approximate sampling locations in relation to the approximate thalweg (blue dashed line).

Figure 3.4-4 Chromium concentrations in Sandia wetland surface water and alluvial system

Table 2.2-1
Schema Crosswalk: Past Piezometers and Current Alluvial Wells

Piezometer	To Alluvial Well	Date of Alluvial Well Installation
SCPZ-1	SWA-1-1	8/19/2016
SCPZ-2	SWA-1/SWA-1-2*	12/18/2014
SCPZ-3	SWA-1-3	7/21/2016
SCPZ-4	SWA-2-4	7/20/2016
SCPZ-6	SWA-2 / SWA-2-6*	12/16/2014
SCPZ-10	SWA-4-10	4/27/2016
SCPZ-11B	SWA-4-11	7/19/2016
SCPZ-12	SWA-4 / SWA-4-12*	12/15/2014

* SWA-1, SWA-2, SWA-3, and SWA-4 were pilot wells installed in December 2016;
SWA-1-2, SWA-2-6, SWA-3-8, SWA-4-12 are the same wells relabeled in 2015.

Table 2.2-2
2019–2021 Sampling and Preservation Requirements for Sandia Wetland

Analytical Suite	Analytical Method	Sample Type[a]	Frequency	Filtered[b]	Preservation	Field Storage	Holding Time	Ideal Volume	Minimum Volume	Comment
Alluvial Wells[c]										
Cr(VI) speciation	IC-ICPMS:metals[d]	W	Annually	F	$NH_4OH/(NH_4)_2SO_4$ (liquid) buffer (1 mL to 100 mL of sample) to pH >9.0–9.5; zero headspace; ice	<4°C	28 days	125 mL	125 mL	—[e]
TAL metals	SW-846:6010C and SW-846:6020 SW-846:7470A (Hg)	W	Annually	F	Nitric acid; ice	<4°C	6 mo 28 days for Hg	1 L	300 mL	—
Surface Water Base Flow at Gages E121, E122, and E123										
PAH congeners	SW-846:8270D GC/MS-SIM[f]	WS	Qtrly	UF	$Na_2O_3S_2$ if residual Cl is present; ice	<4°C	7 days	3 L	1 L	Amber glass with Teflon lid
PCB congeners	EPA:1668C	WS	Qtrly	UF	Ice	<4°C	1 yr	3 L	1L	Amber glass with Teflon lid
SVOC[g]	SW-846:8270D	WS	Qtrly	UF	Ice	<4°C	7 days	3 L	1 L	Amber glass with Teflon lid
TAL metals + total recoverable aluminum	SW-846:6010C and SW-846:6020 SW-846:7470A (Hg)	WS	Qtrly	F, UF, F10	Nitric acid; ice	<4°C	6 mo 28 days for Hg	1 L	300 mL	—
Cr(VI) speciation	IC-ICPMS:metals	WS	Qtrly	F	$NH_4OH/(NH_4)_2SO_4$ (liquid) buffer (1 mL to 100 mL of sample) to pH >9.0–9.5; zero headspace; ice	<4°C	14 days	100 mL	100 mL	—
SSC	ASTM:D3977-97	WS	Qtrly	UF	Ice	No requirement	n/a[h]	1 L	1 L	—
Surface Water Storm Flow at Gages E121, E122, and E123										
PAH congeners	SW-846:8270D GCMS_SIM	WT	>10 cfs[i]	UF	$Na_2O_3S_2$ if residual Cl is present; ice	<4°C	7 days	3 L	1 L	Amber glass with Teflon lid
PCB congeners	EPA:1668C	WT	>10 cfs	UF	Ice	<4°C	1 yr	3 L	1L	Amber glass with Teflon lid
SVOC	SW-846:8270D	WT	>10 cfs	UF	Ice	<4°C	7 days	3 L	1 L	Amber glass with Teflon lid
TAL metals + total recoverable aluminum	SW-846:6010C and SW-846:6020 SW-846:7470A (Hg)	WT	>10 cfs	F, UF, F10	Nitric acid; ice	<4°C	6 mo 28 days for Hg	1 L	300 mL	—
SSC	ASTM:D3977-97	WT	>10 cfs	UF	Ice	No requirement	n/a	1 L	1 L	—

[a] W = Alluvial groundwater samples; WS = base-flow water samples; WT = storm-flow water samples.
[b] F = Filtered using a 0.45-µm filter; UF = unfiltered; F10 = filtered using a 10-µm filter (for total recoverable aluminum only).
[c] Alluvial wells will be reduced to transect 1 (SWA-1-1, SWA-1-2, SWA-1-3), transect 4 (SWA-4-10, SWA-4-11, SWA-4-12), and wells SWA-2-4 and SWA-2-6.
[d] IC-ICPMS = Ion chromatography inductively coupled plasma mass spectrometry.
[e] — = None.
[f] GC/MS-SIM = Gas Chromatography/mass spectrometry–selective ion monitoring.
[g] SVOC = Semivolatile organic compound.
[h] n/a = Not applicable.
[i] >10 cfs = Greater than 10 cfs for E121 and E123 or greater than 1 cfs for E122; up to four samples.

Table 2.2-3
ISCO Bottle Configurations and Analytical Suites
2020 Storm Water Sampling Plan for E121, E122, and E123

Sample Bottle (1 L)	Start Time (min) 12-Bottle ISCO	Analytical Suites 12-Bottle ISCO	Start Time (min) 24-Bottle ISCO	Analytical Suites 24-Bottle ISCO
1	Peak+10	SSC; particle size	Trigger	SSC
2	Peak+12	PCBs (UF[a]) Part 1[b]	Trigger+2	SSC
3	Peak+14	DOC (F[c]) + alkalinity (UF) + pH (UF)	Trigger+4	SSC
4	Peak+16	PCBs (UF) Part 2	Trigger+6	SSC
5	Peak+18	TAL metals[d] + boron + uranium + hardness (F/UF) + total recoverable aluminum (F10µ[e])	Trigger+8	SSC
6	Peak+20	PAH[f] (UF)	Trigger+10	SSC
7	Peak+22	SVOC[g] (UF)	Trigger+12	SSC
8	Peak+24	Gross alpha (UF)	Trigger+14	SSC
9	Peak+26	SSC	Trigger+16	SSC
10	Peak+28	Extra bottle	Trigger+18	SSC
11	Peak+30	Extra bottle	Trigger+20	SSC
12	Peak+32	Extra bottle	Trigger+22	SSC
13	n/a[h]	n/a	Trigger+24	SSC
14	n/a	n/a	Trigger+26	SSC
15	n/a	n/a	Trigger+28	SSC
16	n/a	n/a	Trigger+30	SSC
17	n/a	n/a	Trigger+50	SSC
18	n/a	n/a	Trigger+70	SSC
19	n/a	n/a	Trigger+90	SSC
20	n/a	n/a	Trigger+110	SSC
21	n/a	n/a	Trigger+130	SSC
21	n/a	n/a	Trigger+150	SSC
23	n/a	n/a	Trigger+170	SSC
24	n/a	n/a	Trigger+190	SSC

Notes: E121 = Sandia right fork at power plant, E122 = Sandia left fork at asphalt plant or south fork of Sandia at E122, and E123 = Sandia below wetland. The 12-bottle ISCO begins collection 10 min after the peak discharge (i.e., “Peak+10”) and the 24-bottle ISCO begins collection as soon as water is detected by the liquid level actuator (i.e., “Trigger”).

[a] UF = Unfiltered.

[b] Bottles 2 and 4 are to be sent to the analytical laboratory together for one PCB analysis.

[c] F = Filtered through a 0.45-µm membrane.

[d] TAL metals are Ag, Al, As, Ba, Be, Ca, Cd, Co, Cr, Cu, Fe, Hg, K, Mg, Mn, Na, Ni, Pb, Sb, Se, Tl, V, and Zn; hardness is calculated from calcium and magnesium, components of the TAL list.

[e] F10µ = Filtered through a 10-µm membrane.

[f] PAH = Polycyclic aromatic hydrocarbon.

[g] SVOC = Semivolatile organic compound.

[h] n/a = Not applicable.

Table 2.2-4

Completion Data for Alluvial Piezometers and Collocated Alluvial Wells

Piezometers									
	SCPZ-1	**SCPZ-2**	**SCPZ-3**	**SCPZ-4**	**SCPZ-6**	**SCPZ-10**	**SCPZ-11(A)**	**SCPZ-11(B)**	**SCPZ-12**
Total length (ft)	20.5	11.4	8.3	8.3	8.3	8.3	8.3	8.3	8.3
Stick up (ft)	4.36	3.26	3.19	3.16	3.18	4.01	3.8	4.48	3.77
Top of screen (ft bgs)	13.8	6.0	3	3	3	3	3	1	3
Total depth (ft bgs)	16.2	8.3	5.4	5.4	5.4	5.4	5.4	5.4	5.4
Alluvial Wells									
	SWA-1-1	**SWA-1-2**	**SWA-1-3**	**SWA-2-4**	**SWA-2-6**	**SWA-4-10**		**SWA-4-11**	**SWA-4-12**
Ground elevation (ft amsl[a])	7239.90	7239.96	7239.23	7223.25	7222.90	7209.60		7210.70	7210.50
Total length (ft)	18.33	13.17	9.37	9.00	8.22	8.44		7.93	8.19
Stick up (ft)	3.03	4.57	3.37	3.23	2.86	3.46		3.37	2.54
Top of screen (ft bgs)	13.0	6.03	3.0	3.0	3.12	2.5		3.0	2.99
Bottom of screen (ft bgs)	15.5	8.53	5.5	5.5	5.62	5		5.5	5.49
Total depth (ft bgs)	16.0	9.03	6.0	6.0	6.12	5.5		6.0	5.99
Total depth (ft bTOC[b])	18.76	13.35	9.40	9.04	8.66	8.48		9.16	8.05

Note: Alluvial well shown below collocated piezometer.

[a] amsl = Above mean sea level.

[b] ft bTOC= feet below top of casing (measured in field and could vary).

Table 2.2-5
Field Data for Alluvial Locations and Surface Water Stations—2020 Sampling Events

Location Name	Date	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	pH	Specific Conductance (µS/cm)	Temperature (°C)	Turbidity (NTU[a])
Surface Water Stations							
Sandia right fork at Pwr Plant (E121)	2/26/2020	8.18	ND[b]	7.83	359.6	12.0	0.93
	7/13/2020	7.56	ND	8.22	495.7	20.4	0.44
	11/10/2020	7.89	ND	8.27	477.4	13.4	0.91
South fork of Sandia at E122	2/26/2020	7.85	ND	7.82	302.3	11.3	2.56
	7/13/2020	6.80	ND	8.05	303.2	22.9	5.70
	11/10/2020	3.50	ND	7.58	462.8	5.1	1.05
Sandia below Wetlands (E123)	2/26/2020	10.09	ND	7.72	404.4	1.1	1.81
	7/13/2020	6.79	ND	7.93	462.9	20.8	4.05
	11/10/2020	10.42	ND	7.96	492.8	3.0	1.52
Alluvial Wells							
SWA-1-1	10/20/2020	0.71	-154.6	7.16	541.0	13.8	2.14
SWA-1-2	10/20/2020	1.03	-111.9	7.15	463.2	14.6	4.25
SWA-1-3	10/20/2020	0.98	-114.6	7.04	458.7	13.1	3.18
SWA-2-4	10/21/2020	0.83	-102.0	6.92	489.5	12.2	3.60
SWA-2-6	10/21/2020	0.52	-167.4	7.26	562.0	10.6	5.86
SWA-4-10	10/22/2020	1.89	-28.8	6.15	542.0	12.1	372*
SWA-4-11	10/22/2020	0.86	-66.8	6.71	441.5	10.4	4.45
SWA-4-12	10/22/2020	0.70	-83.2	6.64	493.7	11.9	4.0

Note: Well had very little water and sample was murky.

[a] NTU = Nephelometric turbidity unit.

[b] ND = No data.

Table 2.2-6
Installation and Calibration Information for Transducers in Alluvial Wells

Well	Installation Date	Transducer Calibration Date	Level Troll 500 PSI Rating
SWA-1-1	7/22/2019	6/17/2019	15 psi
SWA-1-2	7/22/2019	6/17/2019	15 psi
SWA-1-3	7/22/2019	6/19/2019	15 psi
SWA-2-4	7/22/2019	6/17/2019	15 psi
SWA-2-6	8/29/2019	6/23/2019	30 psi
SWA-4-10	7/18/2019	6/18/2019	15 psi
SWA-4-11	7/18/2019	6/12/2019	15 psi
SWA-4-12	7/18/2019	6/12/2019	15 psi

Table 3.1-1
Precipitation, Storm Water Peak Discharge, and Samples Collected at Gaging Stations E121, E122, and E123 for Each Sample-Triggering Storm Event in 2020

Storm Event Date	RG121.9 Total Precipitation (in.)	E121 Peak Discharge (cfs)	E122 Peak Discharge (cfs)	E123 Peak Discharge (cfs)
6/6/2020	0.15	2 BT[a]	2.2	3.9 BT
6/14/2020	0.36	16	5.3	11
6/25/2020	0.28	12	4.6	8.5 BT
7/5/2020	0.21	3 BT	2.4	3.4 BT
7/17/2020	0.10	1.4 BT	2.6 P[b]	1.4 BT
7/18/2020	0.23	3.5 BT	2.1 NS[c]	2.9 BT
7/27/2020	0.24	2.3 BT	2.1 S	2.5 BT
8/1/2020	0.40	20 S[d]	5[e] BT	10 BT
8/2/2020	0.35	21 NS	5.8 BT	14 S

Note: Boxes shaded grey are storm events that were missed due to sampler-activation delays associated with the COVID-19 pandemic.

[a] BT = Below trip level.

[b] P = Partial sample.

[c] NS = Previous sample had not yet been retrieved so sampler could not collect.

[d] S = Sample was collected. These discharge levels are shaded in green to emphasize those events for which discharge exceeded the trip level and samples were collected.

[e] The trip level at E122 was raised after the storm on 7/27/2020.

Table 3.1-2
Travel Time of Flood Bore, Peak Discharge, Increase or Decrease in Peak Discharge, and Percent Change in Peak Discharge from Upgradient to Downgradient of the Wetland for Each Sample-Triggering Storm Event in 2020

Date	Travel Time from E121 to E123 (min)	Peak Discharge (cfs)		+/–[a]	%[b]	Travel Time from E122 to E123 (min)	Peak Discharge (cfs)		+/–	%[b]
		E121	E123				E122	E123		
6/6/2020	115	2	3.9	+	95	115	2.2	3.9	+	77
6/14/2020	100	16	31	+	94	100	5.3	11	+	108
6/25/2020	105	12	8.5	-	29	105	4.6	8.5	+	85
7/5/2020	120	3	3.4	+	13	120	2.4	3.4	+	42
7/17/2020	140	1.4	1.4	n/a[c]	0	150	2.6	1.4	-	46
7/18/2020	120	3.5	2.9	-	17	120	2.1	2.9	+	38
7/27/2020	130	2.3	2.5	+	9	140	2.1	2.5	+	19
8/1/2020	100	20	10	-	50	110	5.0	10	+	100
8/2/2020	90	22	14	-	36	90	5.8	14	+	141
Min	90	1.4	1.4	n/a	0	90	2.1	1	n/a	52
Mean	113	9.1	8.6	n/a	5	116.7	3.6	6	n/a	67
Max	140	22	31	n/a	41	150	5.8	14	n/a	141

Note: Boxes shaded grey are storm events that were missed due to sampler-activation delays associated with the COVID-19 pandemic.

[a] + = Increase; - = decrease.

[b] % = Percent change in peak discharge.

[c] n/a = Not applicable.

Table 3.2-1
Significant Geomorphic Changes and Associated Peak Discharges

Date*	Station	Peak Discharge (cfs)	Noted Erosion in Geomorphic Surveying
9/13/2013	E123	108	Extensive repairs were required, including the design and construction of best management practice run-on control structures, replacement of boulders and repair of the cascade pool liner, removal of deposited sediments, and replanting of the lost vegetation in the GCS (section 3.4.2 of “Completion Report for Sandia Grade-Control Structure,” (LANL 2013, 251743).
7/7/2014	E123	80	Overall, erosion within the system seems to be associated with scouring in small side channels outside the wetland proper or with channel rearrangement within the wetland proper. There is evidence of increased channelization in the lower part of the wetland and a new nick point, located upgradient of the most upstream sheet pile.
7/8/2014	E123	76	Overall, erosion within the system seems to be associated with scouring in small side channels outside the wetland proper or with channel rearrangement within the wetland proper. There is evidence of increased channelization in the lower part of the wetland and a new nick point, located upgradient of the most upstream sheet pile.
7/31/2014	E123	109	Overall, erosion within the system seems to be associated with scouring in small side channels outside the wetland proper or with channel rearrangement within the wetland proper. There is evidence of increased channelization in the lower part of the wetland and a new nick point, located upgradient of the most upstream sheet pile.
7/26/2017	E121	87	Repeat GPS surveys in conjunction with field observations indicated that no significant geomorphic changes occurred in the wetland after the 2017 monsoon season. A small amount of deposition was detected in the plunge pool from storm runoff but has not affected the plunge pool area.
7/26/2017	E123	78	Repeat GPS surveys in conjunction with field observations indicated that no significant geomorphic changes occurred in the wetland after the 2017 monsoon season. A small amount of deposition was detected in the plunge pool from storm runoff but has not affected the plunge pool area.

* There were no large storm events in 2015, 2016, 2018, 2019, or 2020.

Table 3.3-1
Calculated Sediment Yield and Runoff Volume at Gaging Stations E121, E122, and E123 for Each Sample-Triggering Storm Event from 2014 to 2020

Station	Date	Sediment Yield (ton)	Sediment Volume (yd^3)	Runoff Volume (acre-feet)	Peak Discharge (cfs)
2020					
E121	8/1/2020	0.70	0.31	0.39	19
E122*	7/27/2020	0.07	0.03	0.02	2.1
E123	8/2/2020	0.51	0.23	1.3	14
2019					
E121	7/2/2019	1.43	0.64	0.8	25
E121	7/7/2019	0.17	0.08	0.7	16
E121	7/15/2019	0.72	0.32	1.2	33
E121	7/25/2019	0.32	0.14	1.0	34
E121	7/26/2019	1.21	0.54	2.2	36
E122	7/2/2019	0.12	0.05	0.1	3.7
E122	7/13/2019	0.04	0.02	0.1	1.8
E122	7/15/2019	0.18	0.08	0.3	5.2
E123	7/7/2019	0.36	0.16	1.4	12
E123	7/15/2019	0.62	0.28	2.1	24
E123	7/25/2019	0.45	0.20	1.8	29
E123	7/26/2019	1.75	0.78	6.1	40
2018					
E121	7/15/2018	0.09	0.04	0.4	14
E121	7/17/2018	0.46	0.21	0.9	29
E121	8/7/2018	0.19	0.09	0.5	18
E121	8/9/2018	0.63	0.28	0.6	21
E121	8/15/2018	0.57	0.25	0.9	42
E121	9/4/2018	0.40	0.18	1.3	38
E122	7/15/2018	0.03	0.01	0.1	3.3
E122	8/9/2018	0.23	0.10	0.2	3.8
E122	9/4/2018	0.40	0.18	0.4	4.3
E123	7/17/2018	1.72	0.77	3.6	31
E123	9/3/2018	0.68	0.30	2.7	21
E123	9/4/2018	2.02	0.90	3.7	35
2017					
E121	6/6/2017	0.70	0.31	0.8	26
E121	6/25/2017	0.71	0.32	1.7	21
E121	7/18/2017	0.48	0.22	1.5	36
E121	7/26/2017	4.09	1.83	2.8	87
E121	7/29/2017	0.88	0.40	1.4	30

Table 3.3-1 (continued)

Station	Date	Sediment Yield (ton)	Sediment Volume (yd³)	Runoff Volume (acre-feet)	Peak Discharge (cfs)
E122	7/18/2017	0.11	0.05	0.2	5
E122	7/27/2017	0.02	0.01	0.1	2
E122	7/29/2017	0.13	0.06	0.3	5
E122	8/21/2017	<0.01	<0.01	0.2	2
E123	6/25/2017	1.10	0.49	2.9	30
E123	7/26/2017	8.79	3.94	6.2	78
E123	7/29/2017	0.64	0.29	2.7	29
2016					
E121	7/1/2016	0.36	0.16	0.8	22
E121	7/15/2016	0.26	0.12	1.2	22
E121	7/31/2016	1.80	0.81	2.7	47
E121	8/3/2016	0.34	0.15	1.6	37
E121	8/27/2016	1.57	0.70	1.9	51
E121	9/6/2016	0.75	0.34	1.5	40
E121	11/4/2016	0.15	0.07	0.8	8.4
E122	10/3/2016	0.02	0.01	0.1	22
E122	10/8/2016	0.01	0.01	0.1	22
E122	11/4/2016	0.03	0.01	0.1	47
E123	7/31/2016	0.34	0.15	4.0	46
E123	8/3/2016	2.10	0.94	2.9	13
E123	8/27/2016	0.54	0.24	3.3	28
E123	9/6/2016	0.15	0.07	3.1	18
E123	11/5–11/6/2016	0.16	0.07	3.4	15
2015					
E121	6/1/2015	0.45	0.20	1.7	20
E121	6/26/2015	3.88	1.74	1.3	18
E121	7/3/2015	0.71	0.32	1.6	30
E121	7/15–7/16/2015	0.50	0.22	1.3	39
E121	7/20–7/21/2015	1.62	0.73	4.0	50
E121	7/29–7/30/2015	0.38	0.17	2.2	14
E121	7/31/2015	0.27	0.12	1.1	9.2
E121	8/17/2015	0.45	0.20	1.6	36
E121	10/23–10/24/2015	0.38	0.17	2.0	28
E122	10/23–10/24/2015	0.07	0.03	0.4	5.1
E123	7/3/2015	1.26	0.56	3.9	35
E123	7/20–7/21/2015	2.58	1.16	10.6	64
E123	7/29–7/30/2015	0.84	0.37	5.8	29
E123	8/8/2015	0.15	0.07	1.8	16

Table 3.3-1 (continued)

Station	Date	Sediment Yield (ton)	Sediment Volume (yd³)	Runoff Volume (acre-feet)	Peak Discharge (cfs)
E123	8/17/2015	1.06	0.47	3.2	38
E123	10/20/2015	0.25	0.11	1.9	16
E123	10/23/2015	1.19	0.53	4.6	48
2014					
E121	7/7/2014	0.84	0.38	2.3	63
E121	7/14–7/15/2014	0.19	0.09	0.7	4.8
E121	7/15–7/16/2014	1.64	0.73	0.6	10
E121	7/19/2014	3.22	1.44	0.6	11
E121	7/27–7/28/2014	0.57	0.26	0.9	29
E121	7/31/2014	15.4	6.91	2.9	66
E122	7/8/2014	0.60	0.27	1.0	10
E122	7/27–7/28/2014	0.05	0.02	0.6	6.2
E122	7/29/2014	0.73	0.33	1.2	12
E122	7/31/2014	1.55	0.69	1.0	19
E123	5/23/2014	1.62	0.73	2.7	18
E123	7/7/2014	4.12	1.84	6.4	80
E123	7/8/2014	18.2	8.14	7.0	76
E123	7/15–7/16/2014	2.01	0.90	3.1	20
E123	7/19/2014	0.39	0.17	1.7	18
E123	7/29/2014	7.36	3.30	7.5	62
E123	7/31/2014	28.6	12.8	7.2	109

* Sediment yield and volume were not calculated for the storm event at E122 on 7/17/2020 because the 24-bottle ISCO did not collect samples. Therefore, there were not enough SSC samples to make an accurate calculation.

Table 3.3-2
Analytical Exceedances in Surface Water at Gaging Stations E121, E122, and E123

Gage	Sample Date	Analyte	Field Prep Code[b]	Sample Type[c]	Result	MDL[d]	PQL[e]	Unit[f]	Hardness Used[g]	Exceedance Ratio[a]				
										LW[h]	WH[i]	AAL[j]	CAL[k]	HH-OO[l]
E121	07/13/2020	Dibenz(a,h)anthracene	UF	WS	0.489	0.358	1.19	µg/L	—[m]	—	—	—	—	2.72
E121	07/13/2020	Indeno(1,2,3-cd)pyrene	UF	WS	0.441	0.358	1.19	µg/L	—	—	—	—	—	2.45
E121	07/13/2020	Total PCB	UF	WS	0.0101	—	—	µg/L	—	—	0.72	0.01	0.72	15.78
E121	08/01/2020	Aluminum	F10µ	WT	777	19.3	50.0	µg/L	16.8	—	—	2.61	6.52	—
E121	08/01/2020	Copper	F	WT	5.90	0.300	2.00	µg/L	16.8	0.01	—	2.36	3.02	—
E121	08/01/2020	Dioxin[n]	UF	WT	1.22E-06	—	—	µg/L	—	—	—	—	—	23.83
E121	08/01/2020	Total PCB	UF	WT	1.26	—	—	µg/L	—	—	90.0	0.63	90.0	1969
E121	08/01/2020	Zinc	F	WT	36.6	3.30	20.0	µg/L	16.8	<0.01	—	1.16	1.53	<0.01
E121	11/10/2020	Total PCB	UF	WS	0.00238	—	—	µg/L	—	—	0.17	<0.01	0.17	3.72
E122	02/26/2020	Copper	F	WS	8.31	0.300	2.00	µg/L	74.3	0.02	—	0.82	1.20	—
E122	07/13/2020	Total PCB	UF	WS	0.000942	—	—	µg/L	—	—	0.07	<0.01	0.07	1.47
E122	07/17/2020	Copper	F	WT	21.7	0.300	2.00	µg/L	35.8	0.04	—	4.25	5.83	—
E122	07/17/2020	Dioxin	UF	WT	3.84E-07	—	—	µg/L	—	—	—	—	—	7.52
E122	07/17/2020	Total PCB	UF	WT	0.113	—	—	µg/L	—	—	8.07	0.06	8.07	177
E122	07/17/2020	Zinc	F	WT	101	3.30	20.0	µg/L	35.8	<0.01	—	1.61	2.12	<0.01
E122	07/27/2020	Aluminum	F10µ	WT	753	19.3	50.0	µg/L	21.2	—	—	1.84	4.60	—
E122	07/27/2020	Copper	F	WT	12.3	0.300	2.00	µg/L	21.2	0.02	—	3.95	5.17	—
E122	07/27/2020	Dioxin	UF	WT	1.20E-07	—	—	µg/L	—	—	—	—	—	2.35

Table 3.3-2 (continued)

Gage	Sample Date	Analyte	Field Prep Code[b]	Sample Type[c]	Result	MDL[d]	PQL[e]	Unit[f]	Hardness Used[g]	Exceedance Ratio[a]				
										LW[h]	WH[i]	AAL[j]	CAL[k]	HH-OO[l]
E122	07/27/2020	Lead	F	WT	0.540	0.500	2.00	µg/L	21.2	0.01	—	0.05	1.20	—
E122	07/27/2020	Total PCB	UF	WT	0.0574	—	—	µg/L	—	—	4.10	0.03	4.10	89.69
E122	07/27/2020	Zinc	F	WT	55.2	3.30	20.0	µg/L	21.2	<0.01	—	1.41	1.87	<0.01
E122	11/10/2020	Total PCB	UF	WT	0.00112	—	—	µg/L	—	—	0.08	<0.01	0.08	1.75
E123	02/26/2020	Total PCB	UF	WS	0.00609	—	—	µg/L	—	—	0.44	<0.01	0.44	9.52
E123	07/13/2020	Total PCB	UF	WS	0.00732	—	—	µg/L	—	—	0.52	<0.01	0.52	11.44
E123	08/02/2020	Aluminum	F10µ	WT	1610	19.3	50.0	µg/L	23.2	—	—	3.48	8.69	—
E123	08/02/2020	Copper	F	WT	5.38	0.300	2.00	µg/L	23.2	0.01	—	1.59	2.09	—
E123	08/02/2020	Dioxin	UF	WT	7.18E-07	—	—	µg/L	—	—	—	—	—	14.09
E123	08/02/2020	Lead	F	WT	0.563	0.500	2.00	µg/L	23.2	0.01	—	0.04	1.13	—
E123	08/02/2020	Total PCB	UF	WT	0.806	—	—	µg/L	—	—	57.6	0.40	57.6	1259
E123	11/10/2020	Total PCB	UF	WT	0.00133	—	—	µg/L	—	—	0.10	<0.01	0.10	2.08

[a] Analytical results are normalized by calculating an exceedance ratio. This ratio is defined as the analytical result divided by the applicable water quality standard. Thus, results exceeding the standard will be greater than an exceedance ratio of 1.0.

[b] Field preparation code: UF = unfiltered; F10µ = filtered to 10 µm; F = filtered to 0.45 µm.

[c] Sample type: WS = base flow; WT = storm water.

[d] MDL = Method detection limit.

[e] PQL = Practical quantitation limit or uncertainty.

[f] Unit applies to result, MDL, PQL, and screening level.

[g] The hardness measured during the storm event was used to calculate hardness-based screening levels. Hardness units are mg/L.

[h] LW = Livestock watering.

[i] WH = Wildlife habitat.

[j] AAL = Acute aquatic life.

[k] CAL = Chronic aquatic life.

[l] HH-OO = Human health-organism only.

[m] — = Not provided by the analytical laboratory or not applicable.

[n] The dioxin criteria apply to the sum of the dioxin toxicity equivalents expressed as tetrachlorodibenzo-p-dioxin(2,3,7,8-). The exceedances are driven by PCB concentrations.

Table 3.3-3
Summary of 2020 Base Flow and Storm Water SWQC Exceedances

Location	Media Type	Filtration	Analyte	Total Samples	Number of Samples Exceeding SWQC	Average of Sample Results Exceeding SWQC	Maximum Sample Results Exceeding SWQC	Units
E121	Storm water	F10µ[a]	Aluminum	1	1	777	777	µg/L
E122	Storm water	F10µ	Aluminum	2	1	753	753	µg/L
E123	Storm water	F10µ	Aluminum	1	1	1610	1610	µg/L
E121	Storm water	F[b]	Copper	1	1	5.90	5.90	µg/L
E122	Storm water	F	Copper	2	2	17.0	21.7	µg/L
E123	Storm water	F	Copper	1	1	5.38	5.38	µg/L
E122	Base flow	F	Copper	3	1	8.31	8.31	µg/L
E121	Base flow	UF[c]	Dibenz(a,h)anthracene	3	1	0.489	0.489	µg/L
E121	Storm water	UF	Dioxin[d]	1	1	1.22E-06	1.22E-06	µg/L
E122	Storm water	UF	Dioxin	2	2	2.52E-07	3.84E-07	µg/L
E123	Storm water	UF	Dioxin	1	1	7.18E-07	7.18E-07	µg/L
E123	Base flow	UF	Dioxin	3	1	8.35E-08	8.35E-08	µg/L
E121	Base flow	UF	Indeno(1,2,3-cd)pyrene	3	1	0.441	0.441	µg/L
E121	Storm water	F	Lead	1	1	0.500 (non-detect)	0.500 (non-detect)	µg/L
E122	Storm water	F	Lead	2	1	0.540	0.540	µg/L
E123	Storm water	F	Lead	1	1	0.563	0.563	µg/L
E121	Storm water	UF	Total PCB	1	1	1.26	1.26	µg/L
E122	Storm water	UF	Total PCB	2	2	0.085	0.113	µg/L
E123	Storm water	UF	Total PCB	1	1	0.806	0.806	µg/L
E121	Base flow	UF	Total PCB	3	2	0.0101	0.0101	µg/L
E122	Base flow	UF	Total PCB	3	2	0.000942	0.000942	µg/L
E123	Base flow	UF	Total PCB	3	3	0.00671	0.00732	µg/L
E121	Storm water	F	Zinc	1	1	36.6	36.6	µg/L
E122	Storm water	F	Zinc	2	2	78.0	101	µg/L

[a] F10µ = Filtered to 10 µm.
[b] F = Filtered to 0.45 µm.
[c] UF = Unfiltered.
[d] The dioxin criteria apply to the sum of the dioxin toxicity equivalents expressed as tetrachlorodibenzo-p-dioxin(2,3,7,8-). The exceedances are driven by PCB concentrations.

Table 3.4-1
Analytical Exceedances in the Alluvial System

Location	Date	Analyte	Field Prep Code	Sample Usage Code	Sample Purpose	Report Result	Units	Screening Value	Screening Value Type
SWA-1-1	10/20/2020	Iron	F[a]	INV	REG	5650	µg/L	1000	NM GW STD[b]
SWA-1-1	10/20/2020	Manganese	F	INV	REG	1260	µg/L	200	NM GW STD
SWA-1-2	10/20/2020	Chromium	F	INV	REG	73.4	µg/L	50	NM GW STD
SWA-1-2	10/20/2020	Iron	F	INV	REG	1620	µg/L	1000	NM GW STD
SWA-1-2	10/20/2020	Manganese	F	INV	REG	229	µg/L	200	NM GW STD
SWA-2-4	10/21/2020	Iron	F	INV	REG	1300	µg/L	1000	NM GW STD
SWA-2-4	10/21/2020	Manganese	F	INV	REG	462	µg/L	200	NM GW STD
SWA-2-6	10/21/2020	Arsenic	F	INV	REG	10.8	µg/L	10	NM GW STD
SWA-2-6	10/21/2020	Iron	F	INV	REG	6000	µg/L	1000	NM GW STD
SWA-2-6	10/21/2020	Manganese	F	INV	REG	1230	µg/L	200	NM GW STD
SWA-4-10	10/22/2020	Iron	F	INV	REG	4500	µg/L	1000	NM GW STD
SWA-4-10	10/22/2020	Iron	F	QC	FD	3070	µg/L	1000	NM GW STD
SWA-4-10	10/22/2020	Manganese	F	INV	REG	560	µg/L	200	NM GW STD
SWA-4-10	10/22/2020	Manganese	F	QC	FD	440	µg/L	200	NM GW STD
SWA-4-11	10/22/2020	Iron	F	INV	REG	1780	µg/L	1000	NM GW STD
SWA-4-11	10/22/2020	Manganese	F	INV	REG	330	µg/L	200	NM GW STD
SWA-4-12	10/22/2020	Iron	F	INV	REG	5460	µg/L	1000	NM GW STD
SWA-4-12	10/22/2020	Manganese	F	INV	REG	1190	µg/L	200	NM GW STD

Note: All results have a dilution factor of 1.0.

[a] F = Filtered.

[b] NM GW STD = New Mexico groundwater standard.

Appendix A

Acronyms and Abbreviations,
Metric Conversion Table, and Data Qualifier Definitions

A-1.0 ACRONYMS AND ABBREVIATIONS

AAL	acute aquatic life
As(III)	arsenite
As(V)	arsenate
amsl	above mean sea level
bgs	below ground surface
bTOC	below top of casing
CAL	chronic aquatic life
cfs	cubic foot per second
Cr(III)	trivalent chromium
Cr(VI)	hexavalent chromium
CY	calendar year
DC	direct current
DEM	digital elevation model
DOC	dissolved organic carbon
DOE	Department of Energy (U.S.)
DOECAP	Department of Energy Consolidated Audit Program
DQO	data quality objective
EMCA	essential mission critical activities
EM-LA	Environmental Management Los Alamos Field Office (DOE)
EPA	Environmental Protection Agency (U.S.)
F	filtered
Fe(III)	ferric oxide
Fe(II)	ferrous oxide
GC/MS-SIM	gas chromatography/mass spectrometry–selective ion monitoring
GCS	grade-control structure
gpd	gallons per day
gpm	gallons per minute
HH-OO	human health-organism only
IC-ICPMS	ion chromatography inductively coupled plasma mass spectrometry
IFGMP	Interim Facility-Wide Groundwater Monitoring Plan
IR	investigation report
LANL	Los Alamos National Laboratory

LiDAR	light detection and ranging
LW	livestock watering
MCL	maximum contaminant level
MDL	method detection limit
mgd	million gallons per day
Mn(IV)	manganese dioxide
MY	monitoring year
N3B	Newport News Nuclear BWXT-Los Alamos, LLC
NA	not analyzed
ND	no data
NDVI	Normalized Difference Vegetation Index
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NMWQCC	New Mexico Water Quality Control Commission
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
ppb	parts per billion
PQL	practical quantitation limit
PVC	polyvinyl chloride
redox	oxidation-reduction
RTK	real-time kinematic
SCC	Strategic Computing Complex
SERF	Sanitary Effluent Reclamation Facility
SSC	suspended sediment concentration
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWQC	surface water quality criteria
SWWS	Sanitary Waste Water System
TA	technical area
TAL	target analyte list
TOC	total organic compound
TSS	total suspended sediment

UF	unfiltered
USGS	U.S. Geological Survey
VE	vertical exaggeration
VNIR	visible and near-infrared
WH	wildlife habitat

A-2.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain U.S. Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-3.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B

2020 Watershed Mitigation Inspections

B-1.0 INTRODUCTION

Watershed storm water controls and grade-control structures (GCSs) are inspected biannually and after greater than 50 cubic per second (cfs) flow events. After large disturbance events (approximately 100 cfs at gaging station E123), additional inspections and monitoring will occur, including a walkdown of the channel. No large disturbance events occurred in 2020.

Inspections are completed to ensure watershed mitigations are functioning properly and to determine if maintenance is required. Examples of items evaluated during inspections include

- debris/sediment accumulation that could impede operation;
- water levels behind retention structures;
- physical damage of structure or failure of structural components;
- undermining, piping, flanking, settling, movement, or breeching of structure;
- vegetation establishment and vegetation that may negatively impact structural components;
- rodent damage;
- vandalism; and
- erosion.

The photographs in this appendix show the first and second 2020 inspections of watershed mitigations in Sandia Canyon. Each group of photographs is associated with a specific feature (e.g., standpipe, weir, upstream, downstream, vegetated cover) that could develop issues. Photographs of features were taken to replicate previous inspection photos as closely as possible.

In 2020, the Sandia GCS downstream gage did not record significant flow events. Two regular inspections were conducted in September and November of 2020. At the site visit, undercutting erosion to a side drainage log check dam that had been previously noted was not observed. The inspections revealed that a third control, a coir log installed downstream of the log check dams, was leading to localized scour. The project engineer recommended that the coir log be removed to allow natural infilling. The coir log was scheduled to be removed and its contents dispersed within the area in the spring of 2020. This activity was delayed due to a partial stop-work order that restricted operations to essential mission critical activities in response to the COVID-19 pandemic (DOE 2020, 700826). The coir log removal has been rescheduled for spring 2021.

The post-monsoon walkdown of the Sandia wetland that was scheduled to occur with the New Mexico Environment Department in October 2020 did not take place. Both NMED and N3B agreed that a walkdown was not advisable because of the COVID-19 pandemic. It was also agreed that, due to drought conditions during the 2020 monitoring season, there were unlikely to be any major changes to the area.

The photographs in this appendix illustrate the health of the wetland in and around the GCS, revegetation of adjacent slopes, and the best management practices put in place to help maintain the integrity of the GCS and its associated wetland vegetation.

Additional data on the position of the channel thalweg in the area of the GCS can be found in Appendix B of the 2019 Sandia Wetland Performance Report, along with quantitative data from vegetation perimeter mapping in and around the GCS (N3B 2020, 700810).

B-2.0 MAINTENANCE ON SIDE-DRAINAGE CONTROLS UPSTREAM OF GCS

Photo B-2.0-1 November 4, 2020 – channel upgradient of upper log check dam, view looking west

Photo B-2.0-2 November 4, 2020 – upper log check dam

Photo B-2.0-3 November 4, 2020 – lower log check dam, log check dam 2, view looking south

Photo B-2.0-4 September 4, 2020 – coir log, view looking south, recommend removal to address local scour

Photo B-2.0-5 September 4, 2020 – flow spreader, view looking east

B-3.0 SANDIA CANYON GCS INSPECTION PHOTOGRAPHS

B-3.1 GCS South Bank—Upper Structure

Photo B-3.1-1 September 4, 2020 – south bank of vegetation, view looking upstream

B-3.2 GCS North Bank—Upper Structure

Photo B-3.2-1 September 4, 2020 – north bank, view looking north at upper GCS

B-3.3 GCS Wetland – Upper Structure

Photo B-3.3-1 September 4, 2020 – wetland upstream of upper GCS, view looking northeast

B-3.4 GCS Wetland—Middle Structure

Photo B-3.4-1 September 4, 2020—middle GCS concrete wall looking south

Photo B-3.4-1 November 4, 2020— wetland upstream of middle GCS, view looking west

B-3.5 GCS South Bank—Lower Structure

Photo B-3.5-1 September 4, 2020—lower GCS, view looking south

Photo B-3.4-1 September 4, 2020— wetland upstream of lower GCS, view looking southwest

B-3.6 GCS Cascade Structure

Photo B-3.6-1 September 4, 2020—cascade structure looking upstream

B-3.7 GCS Upper Run-On Defense Cell Barriers

Photo B-3.7-1 September 4, 2020—Upper run-on cell barrier looking east. Sediment level at 1 ft below top of spillway.

B-3.8 GCS Lower Run-On Defense Cell Barriers

Photo B-3.8-1 September 4, 2020—slope downgradient of lower cell barrier, view looking west

Photo B-3.8-2 September 4, 2020—lower run-on cell barrier, looking southwest, sediment level 4–5 ft below top of spillway

B-3.9 Energy Dissipater

Photo B 3.9-1 November 4, 2020—log flow spreader looking east

B-4.0 REFERENCES

The following reference list includes documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ERID, ESHID, or EMID. This information is also included in text citations. ERIDs were assigned by the Laboratory's Associate Directorate for Environmental Management (IDs through 599999); ESHIDs were assigned by the Laboratory's Associate Directorate for Environment, Safety, and Health (IDs 600000 through 699999); and EMIDs are assigned by N3B (IDs 700000 and above). IDs are used to locate documents in N3B's Records Management System and in the Master Reference Set. The NMED Hazardous Waste Bureau and N3B maintain copies of the Master Reference Set. The set ensures that NMED has the references to review documents. The set is updated when new references are cited in documents.

DOE (U.S. Department of Energy), March 31, 2020. "U.S. Department of Energy Environmental Management Los Alamos Field Office Transition to Essential Mission Critical Activities Notification," U.S. Department of Energy letter (EMLA-2020-1393-02-001) to K. Pierard (NMED-HWB) from A. Duran (EM-LA), Los Alamos, New Mexico. (DOE 2020, 700826)

N3B (Newport News Nuclear BWXT-Los Alamos, LLC), March 2020. "2019 Sandia Wetland Performance Report," Newport News Nuclear BWXT-Los Alamos, LLC, document EM2020-0020, Los Alamos, New Mexico. (N3B 2020, 700810)

Appendix C

Analytical Data and 5-Min Stage,
Discharge, and Precipitation Data
(on CD included with this document)