Effluent Monitoring

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Effluent monitoring at the Savannah River Site (SRS) is conducted to demonstrate compliance with applicable standards and regulations. Site effluent monitoring activities are divided into radiological and nonradiological programs. The monitoring is conducted by the Environmental Monitoring Services group of the site's Regulatory Integration & Environmental Services organization—following specific sampling and analytical procedures. A summary of data results is presented in this chapter; more complete data can be found in tables on the CD housed inside the back cover of this report.

Radiological Monitoring

The U.S. Environmental Protection Agency's National Emission Standards for Hazardous Air Pollutants (NESHAP) establish the requirements and limits that regulate radionuclide emissions from facilities owned or operated by the U.S. Department of Energy (DOE). The methods for estimating and reporting radioactive emissions are detailed in these regulations. The South Carolina Department of Health and Environmental Control (SCDHEC) regulates both radioactive and nonradioactive air pollutant emissions from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the SRS Part 70 Air Quality Permits (issued in 2003 and 2007), with specific limitations and monitoring requirements identified. This section of the chapter will cover the radioactive emissions.

Radiological effluent monitoring results are a major component in determining compliance with applicable dose standards. SRS works to ensure that radiation exposures to employees and releases of radioactivity to the environment are maintained below regulatory limits, and deliberate efforts are taken to further reduce exposures and releases.

SRS airborne and liquid effluents that potentially contain radionuclides are monitored at their points of discharge by a combination of direct measurement and/or sample extraction and analysis. Each operating facility maintains ownership of, and is responsible for, its radiological effluents.

Brief summaries of analytical results are presented in this chapter; complete data sets, as well as maps showing applicable sampling locations, can be found in tables on the CD housed inside the back cover of this report. Tables on the CD (see "Environmental Data/ Maps – 2010") are referred to in this chapter as "data table 4–X." Tables in the chapter itself are referred to simply as "table 4–X."

Data tables 4–1 through 4–4 provide analytical results for radioactive air and liquid effluent measurements taken at SRS in 2010.

Unspecified alpha and beta radiation releases (the measured gross activity minus the identified individual radionuclides) in airborne and liquid releases are large contributors—on a percentage basis—to offsite doses, especially for the airborne pathway from diffuse and fugitive releases (see definitions below).

The unspecified alpha and beta radiation releases are listed separately in data tables 4–3 and 4–4. They conservatively include naturally occurring radionuclides—such as uranium, thorium, and potassium-40—and small amounts of unidentified manmade radionuclides. For dose calculations, the unspecified alpha releases were assigned the plutonium-239 dose factor, and the unspecified beta releases were assigned the strontium-90 dose factor (chapter 6, "Potential Radiation Doses").

Airborne Emissions

Process area stacks that release, or have the potential to release, radioactive materials are monitored continuously by online monitoring and/or sampling systems.

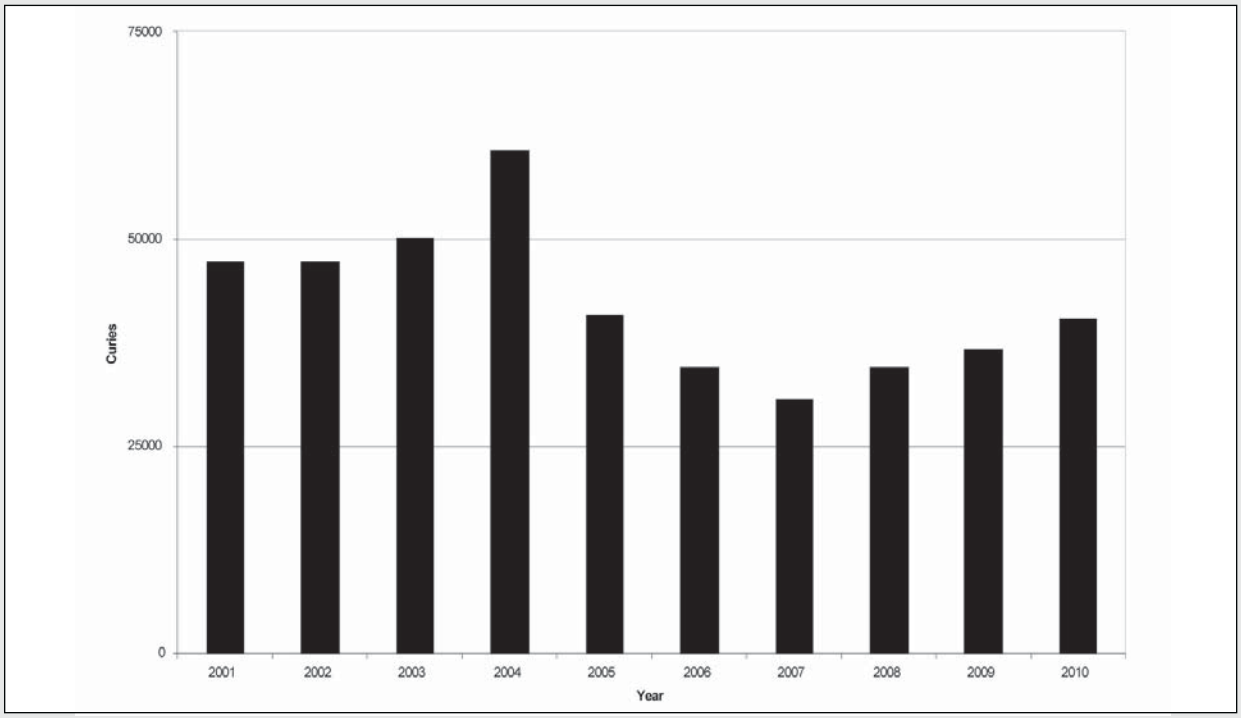

Figure 4–1 Ten-Year History of SRS Annual Atmospheric Tritium Releases

Depending on the processes involved, discharge stacks also may be monitored with real-time instrumentation to determine instantaneous and cumulative atmospheric releases to the environment. Tritium is one of the radionuclides monitored with continuous real-time instrumentation.

Sampling was discontinued at P Area and R Area Reactors during June 2010 because of the demolition of the main stacks and the removal of monitoring equipment. These areas have been removed permanently from service.

Diffuse and Fugitive Sources

Estimates of radionuclide releases from unmonitored diffuse and fugitive sources are calculated on an annual basis and are included in the SRS radioactive release totals. A diffuse source is defined as an area source, such as a pond or disposal area. A fugitive source is defined as an undesignated localized source, such as an open tank or naturally ventilated building.

Diffuse and fugitive releases are calculated using EPA's recommended methods [EPA, 2002a]. Because these methods employ conservative assumptions, they generally lead to overestimates of actual emissions. Though these releases are not monitored at their source, onsite and offsite environmental monitoring stations are in place to quantify unexpectedly large diffuse and fugitive releases (chapter 5, "Environmental Surveillance").

Monitoring Results Summary

The total amount of radioactive material released to the environment is quantified by using (1) data obtained from continuously monitored airborne effluent release points and (2) estimates of diffuse and fugitive sources.

Tritium Tritium in elemental and oxide forms accounted for more than 99 percent of the total radioactivity released to the atmosphere—and more than 90 percent of the estimated NESHAP compliance dose—from SRS operations in 2010. Approximately 40,500 Ci of tritium were released from the site in 2010—compared with about 36,900 Ci in 2009. Approximately 66 percent of the releases came from the site's tritium facilities, and about 32 percent were estimated diffuse releases from the Mixed Waste Management Facility Phytoremediation Unit and the P-Reactor Disassembly Basin Decommissioning Project (evaporation of Disassembly Basin water).

The amount of tritium released from SRS fluctuates because of changes in the site's missions and in the annual Tritium Facility production schedules. For the past 10 years, the amount has ranged from about 30,000 to 60,000 Ci per year (figure 4–1).

Comparison of Average Concentrations in Airborne Emissions to DOE Derived Concentration Guides Average concentrations of radionuclides in airborne emissions are calculated by dividing the amount of each radionuclide released annually from each stack by the respective yearly stack-flow volumes. These average concentrations then can be compared to the DOE derived concentration guides (DCGs) in DOE Order 5400.5, "Radiation Protection of the Public and the Environment," as a screening method to determine if existing effluent treatment systems are proper and effective. Data table 4–5 provides the 2010 atmospheric effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided by discharge point.

DCGs are used as reference concentrations for conducting environmental protection programs at all DOE sites. DCGs are applicable at the point of discharge (prior to dilution or dispersion) under conditions of continuous exposure.

Most of the SRS radiological stacks/facilities release small quantities of radionuclides at concentrations below the DOE DCGs. However, because of the nature of the operations, tritium DCGs are exceeded routinely at K Area and L Area. Plutonium-239 exceeded the DCG at the F Area Main Stack during 2010 for the first time since 2006. This exceedance is due to transuranic waste repacking activities. The offsite dose from all atmospheric releases, however, remained well below the DOE and EPA annual atmospheric pathway dose standard of 10 mrem (0.1 mSv), as discussed in chapter 6.

Liquid Discharges

Each process area liquid effluent discharge point that releases, or has potential to release, radioactive materials is sampled routinely and analyzed for radioactivity.

Depending on the processes involved, liquid effluents also may be monitored with real-time instrumentation to ensure that releases are managed within established limits. Because the instruments have limited detection sensitivity, online monitoring systems are not used to quantify SRS liquid radioactive releases at their current low levels. Instead, samples are collected for more sensitive laboratory analysis.

Monitoring Results Summary

Data from continuously monitored liquid effluent discharge points are used in conjunction with site seepage basin and Solid Waste Disposal Facility (SWDF) migration release estimates to quantify the total radioactive material released to the Savannah River from SRS operations. Data table 4–4 provides SRS liquid radioactive releases for 2010. These data are a major component in the determination of offsite dose consequences from SRS operations.

Direct Discharges of Liquid Effluent Direct discharges of liquid effluents are quantified at the point of release to the receiving stream, prior to dilution by the stream. The release totals are based on measured concentrations and flow rates.

Tritium accounts for nearly all the radioactivity discharged in SRS liquid effluents. The total amount of tritium released directly from process areas—i.e., reactor, separations, Effluent Treatment Project (ETP)—to site streams during 2010 was 227 Ci. Direct releases of tritium to site streams for the years 2001–2010 are shown in figure 4–2.

D Area and TNX operations were discontinued in 2000 and 2001, respectively. A Area releases represent only a small percentage of the total direct releases of tritium to site streams. The reactor area releases include overflows from PAR Pond and L Lake.

Groundwater migration and transport of radionuclides from site seepage basins and the SWDF are discussed in chapter 5.

Comparison of Average Concentrations in Liquid Releases to DOE Derived Concentration Guides In addition to dose standards, DOE Order 5400.5 imposes other control considerations on liquid releases. These considerations are applicable to direct discharges but not to seepage basin and groundwater discharges. The DOE order lists DCG values for most radionuclides.

DCGs are applicable at the point of discharge from the effluent conduit to the environment (prior to dilution or dispersion). According to DOE Order 5400.5, exceedance of the DCGs at any discharge point may require an investigation of "best available technology" (BAT) waste treatment for the liquid effluents. Tritium in liquid effluents is specifically excluded from BAT requirements; however, it is not excluded from other ALARA considerations. DOE DCG compliance is demonstrated when the sum of the fractional DCG values for all radionuclides detectable in the effluent is less than 1.00, based on consecutive 12-month-average concentrations. Data

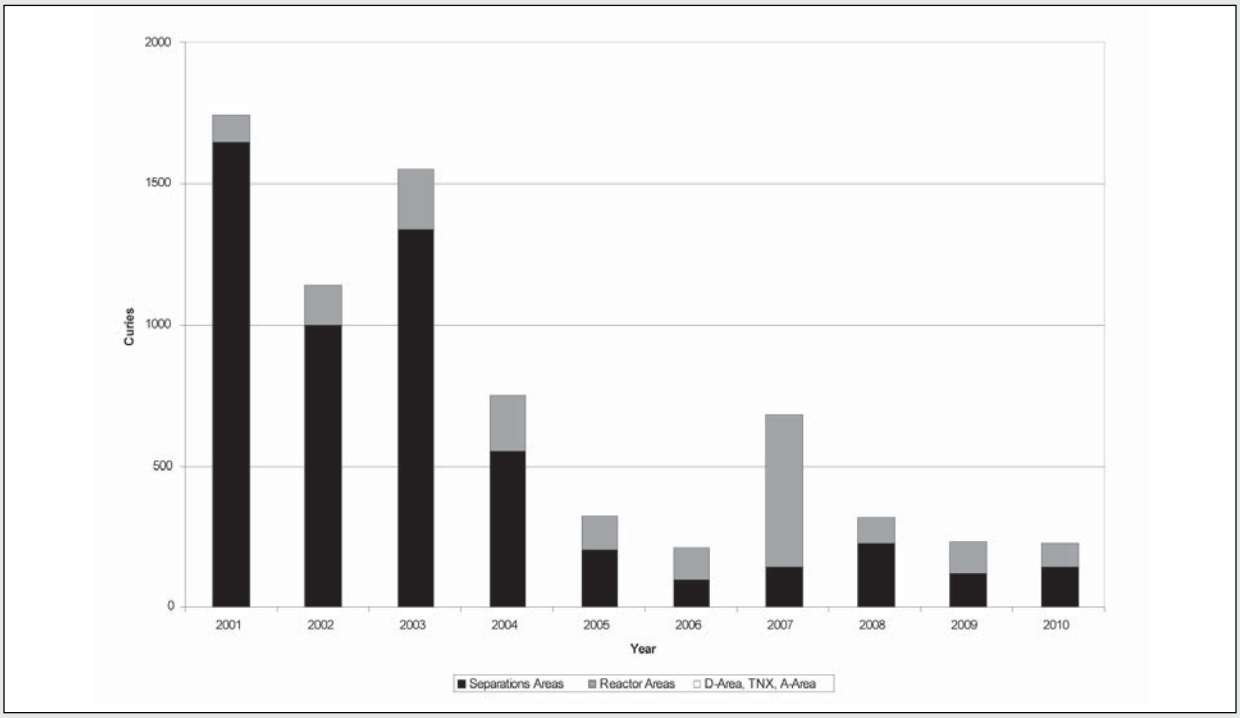

Figure 4–2 Ten-Year History of Direct Releases of Tritium to SRS Streams

table 4–6 provides the 2010 liquid effluent annual-average concentrations, their comparisons against the DOE DCGs, and the quantities of radionuclides released are provided by discharge point. No liquid discharge points exceeded the DOE DCGs during 2010.

Nonradiological Monitoring

Airborne Emissions

SCDHEC regulates both radioactive and nonradioactive criteria and toxic air pollutant emissions from SRS sources. Each source of air emissions is permitted or exempted by SCDHEC on the SRS Part 70 Air Quality Permits, with specific limitations and monitoring requirements identified. This section will cover only nonradioactive emissions.

The bases for the limitations and monitoring requirements specified in the Part 70 Air Quality Permits are outlined in various South Carolina and federal air pollution control regulations and standards. Many of the applicable standards are source dependent, i.e., applicable to certain types of industries, processes, or equipment. However, some standards govern all sources for criteria pollutants, toxic air pollutants, and ambient air quality. Air pollution control regulations and standards applicable to SRS sources are discussed briefly in appendix A, "Applicable Guidelines, Standards, and Regulations," of this report. The SCDHEC air standards for toxic air pollutants can be found at http://www.scdhec.gov/environment/baq/docs/regs/.

Description of Monitoring Program

Major nonradiological emissions of concern from SRS facility stacks include sulfur dioxide, carbon monoxide, oxides of nitrogen, particulate matter smaller than 10 micrometers and smaller than 2.5 micrometers, volatile organic compounds (VOCs), and toxic air pollutants. With issuance of the Part 70 Air Quality Permits, SRS has several continuous and periodic monitoring requirements; only the most significant are discussed below.

The primary method of source monitoring at SRS is the annual air emissions inventory. Actual emissions from SRS sources are determined during this inventory from standard calculations using source operating parameters, such as hours of operation, process throughput, and emission factors provided in the EPA "Compilation of Air Pollution Emission Factors," AP–42. Many of the SRS processes, however, are unique sources requiring nonstandard, complex calculations. The hourly and total actual annual emissions for each source then can be compared against their respective permit limitations.

At the SRS A Area biomass boiler and D Area Powerhouse facility, airborne emission specialists under contract to the site perform stack compliance tests every two years. The tests include sampling of boiler exhaust gases to determine particulate matter. In addition, opacity emissions are monitored weekly by visual inspection.

For the steam-generating fuel oil-fired boiler in A Area and fuel oil-fired water heaters in B Area—and for diesel-powered equipment—compliance with sulfur dioxide standards is determined by analysis of fuel oil purchased from offsite vendors. Sulfur content of the fuel oil must be below 0.05 percent—and must be certified by the fuel supply vendor and reported to SCDHEC semiannually.

The monitoring of SRS diesel-powered equipment includes tracking fuel oil consumption monthly and calculating a 12-month rolling total for determining permit compliance with a site consumption limit.

SRS has several soil vapor extraction units and two air strippers that are sources of toxic air pollutants and VOCs. These units must be sampled monthly for VOC concentrations, and the total VOC emissions must be calculated for comparison against a 12-month rolling limit. The VOC emissions are reported to SCDHEC on a quarterly basis.

Several SRS sources have pollutant control devices—such as, electrostatic precipitators, baghouse dust collectors, or condensers—whose parameters must be monitored continuously or whenever the system is operated. The operating parameters must be recorded and compared against specific operating ranges.

Compliance by all SRS permitted sources is evaluated during annual compliance inspections by the local SCDHEC district air manager. The inspections include a review of each permit condition; i.e., daily monitoring readings, equipment calibrations, control device inspections, etc. SCDHEC performed an air compliance inspection on March 17, 2010 and found no instances of noncompliance.

Monitoring Results Summary

SRS is required to report its emissions inventory for all site air emission sources annually. Operating data are compiled and emissions calculated for each calendar year. Data table 4–7 provides a list of the 2006–2010 estimated emissions.

The total SCDHEC air emission estimates for all SRS permitted sources, as determined by the air emissions inventory conducted in each of the past five years, are provided in table 4–1. A review of the calculated emissions for each source for each calendar year determined that SRS sources had operated in compliance with permitted emission rates. Some toxic air pollutants (e.g., benzene) regulated by SCDHEC also are, by nature, VOCs. As such, the total for VOCs in table 4–1 includes toxic air pollutant emissions.

Four pulverized coal-fired boilers are maintained by SRS at the D Area Powerhouse facility. Each of the boilers

Table 4–1 SRS Estimated SCDHEC Standard 2 Pollutant Air Emissions, 2006–2010

Pollutant Name	Emissions (Tons/Year)				
	2006	2007	2008	2009	2010
Sulfur dioxide (SO_x)	5.10E+03	4.25E+03	4.07E+03	4.00E+03	4.11E+03
Total particulate matter (PM)	5.04E+02	4.17E+02	4.59E+02	3.99E+02	8.03E+02
Particulate matter <10 micrometers (PM_{10})	3.82E+02	2.45E+02	3.13E+02	2.64E+02	6.37E+02
Particulate matter <2.5 micrometers ($PM_{2.5}$)	3.19E+02	2.20E+02	2.65E+02	2.22E+02	1.36E+02
Carbon monoxide (CO)	7.83E+01	7.62E+01	6.73E+02	4.07E+01	4.46E+01
Volatile organic compounds (VOCs)(Ozone Precursors)	1.69E+01	1.61E+01	6.53E+01	4.88E+00	4.88E+00
Gaseous fluorides (as hydrogen fluoride)	1.42E+01	1.27E+01	1.22E+01	1.22E+01	1.22E+01
Nitrogen dioxide (NO_x)	3.15E+03	2.63E+03	1.89E+03	1.79E+03	2.06E+03
Lead (lead components)	7.60E-02	1.91E-02	2.67E-02	3.40E-02	3.91E-02

Table 4–2 2010 Boiler Stack Test Results[a]

Boiler	Pollutant	Emission Rates Lb/10^6Btu	Lb/hr
D Area Boiler #1	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.2598 1.52 Avg. 13.7%	113.28 413.83
D Area Boiler #2	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.258 1.17 Avg. 13.2%	86.89 336.13
D Area Boiler #3[d] (Did not operate during 2010)			
D Area Boiler #4	Particulate matter[b] Sulfur dioxide[b] Opacity[c]	0.189 1.54 Avg. 6.3%	95.11 482.00

[a] Boiler #1 source test October 22, 2010; Boiler #2 source test February 3, 2010; Boiler #4 source test December 9, 2010

[b] SCDHEC's Title V permitted emission limits are 0.6 lb/million BTU for particulates and 3.5 lb/million BTU for sulfur dioxide.

[c] Opacity limit 40%

[d] Not stack tested during 2010

has a steam generation rating of 330,000 lbs per hour (396.0E+06 Btu/hr capacity).

SRS began operation of a biomass boiler and an oil-fired backup boiler in 2008, replacing the old A Area coal fired boilers. Known as the 784–7A Steam Facility, these two boilers are substantially smaller and burn cleaner than the two coal-fired boilers they replaced. The biomass boiler and oil-fired backup boiler each produce significantly less particulate matter, sulfur dioxide, and nitrogen dioxide emissions than the two coal-fired boilers.

The D Area Powerhouse has four coal-fired boilers—each on a biennial stack test schedule required by the D Area Part 70 Air Quality Permit. D Area Powerhouse boilers D#1, D#2, and D#4 were source tested in 2010; the test results are shown in table 4–2. The particulate matter, sulfur dioxide, and visible emissions of these boilers were found to be in compliance with their permitted limits.

The three H Area Powerhouse boilers have not operated since 2000–2001.

SRS also operates one package steam-generating boiler in K Area, fired by No. 2 fuel oil. The percent of sulfur in the fuel oil must be vendor certified semiannually to ensure that the fuel meets permit specifications; the certification was documented twice during 2010. Biomass boilers in K Area and L Area began operations in December 2010; initial monitoring data from these units will be incorporated into the *SRS Environmental Report for 2011.*

The total diesel fuel consumption for portable air compressors, generators, emergency cooling water pumps, and fire water pumps was found to be well below the SRS limit for the entire reporting period. As reported to SCDHEC during 2010, the calculated annual VOC emissions were well below the permit limit for each unit.

Ambient Air Quality

Under existing regulations, SRS is not required to conduct onsite monitoring for ambient air quality; however, the site is required to show compliance with various air quality standards. To accomplish this, air dispersion modeling is conducted as required as part of the Title V and construction permitting process. Additional information about ambient-air-quality regulations at the site can be found in appendix A of this report.

Liquid Discharges

Description of Monitoring Program

SRS monitors nonradioactive liquid discharges to surface waters through the National Pollutant Discharge Elimination System (NPDES), as mandated by the Clean Water Act. As required by EPA and SCDHEC, SRS has NPDES permits in place for discharges to the waters of the United States and South Carolina. These permits establish the specific sites to be monitored, parameters to be tested, and monitoring frequency—as well as analytical, reporting, and collection methods. Detailed requirements for each permitted discharge point can be found in the individual permits, which are available to the public through SCDHEC's Freedom of Information office at 803–898–3882.

In 2010, SRS discharged water into site streams under three NPDES permits: two for industrial wastewater, SC0047431 (covers D Area) and SC0000175 (covers remainder of site), and one for stormwater runoff, SCR000000 (industrial discharge). A fourth permit, SCR100000, does not require sampling unless requested by SCDHEC to address specific discharge issues at a given construction site; SCDHEC did not request such sampling in 2010.SRS submitted a permit application in 2006 for each of nine individual stormwater outfalls for which the average of any four consecutive analyses exceeded the proposed EPA Multisector General Permit benchmarks. These outfalls are expected to be covered under the upcoming new Industrial Stormwater General Permit rather than the individual permits.

Permit ND0072125 is a "no discharge" permit regulating the land application of biosolids (dried sludge) from onsite sanitary wastewater treatment facilities. One application (approximately 76 cubic yards) of air-dried sludge was performed in June 2010. All sample results were within permit limits for metals and nutrients. SRS had applied to SCDHEC (in August 2009) for a 10-year renewal of the permit; SCDHEC subsequently issued the renewal for an additional 10 years, effective December 1, 2010.

NPDES samples are collected in the field according to 40 CFR 136 ("Guidelines Establishing Test Procedures for the Analysis of Pollutants"), the federal document that lists specific sample collection, preservation, and analytical methods acceptable for the type of pollutant to be analyzed. Chain-of-custody procedures are followed after collection and during transport to the analytical laboratory. The samples then are accepted by the laboratory and analyzed according to procedures listed in 40 CFR 136 for the parameters required by the permit.

Monitoring Results Summary

SRS reports industrial wastewater analytical results to SCDHEC through a monthly discharge monitoring report (EPA Form 3320–1). Results of 5,059 sample analyses performed during 2010 indicated that no NPDES permit exceptions occurred. Data table 4–8 provides a compilation of industrial waterwater analytical data for 2010.

Sixteen stormwater outfalls were scheduled for compliance sampling in 2010. Due to various factors—including a 2-month delay in the issuance of a sampling plan, fewer rain events during normal business hours, and associated drought-like conditions—only 13 of the stormwater outfalls could be sampled. Data table 4–9 provides a compilation of stormwater analytical data for 2010.