4. ETTP Environmental Monitoring Programs

The ETTP, formerly known as the Oak Ridge Gaseous Diffusion Plant or K-25 Site, was originally built as part of the Manhattan Project. Uranium was enriched for weapons and nuclear reactor fuel elements and included recycling of reactor return fuel elements. Other activities included research and support operations. After the enrichment operations ceased in 1985, the primary focus of the plant shifted to environmental restoration, reindustrialization, and reuse of the facilities.

Environmental monitoring remains a major activity on the ETTP. Environmental monitoring encompasses two activities: effluent monitoring and environmental surveillance. Effluent monitoring consists of the collection and analysis of samples or measurements of liquid or gaseous effluents at the point of emission to determine and quantify contaminants released. Environmental surveillance consists of the collection and analysis of samples of air, water, soil, vegetation, biota, and other media from the ETTP and its surroundings. External direct radiation is also measured. Data from environmental monitoring activities are used to assess exposures to members of the public and the environment, to assess the effects of ETTP operations on the public and the environment, to help plan remediation projects, and to evaluate the efficacy of these projects.

In 2005, the emissions of radionuclides from ETTP operations were well within the allowable derived concentration guides (DCGs) published in DOE Order 5400.5 and were similar in most respects to 2004 emissions. Potential direct radiation to the public from uranium hexafluoride cylinder storage yards and the K-770 scrap metal yard at ETTP remained below the requirements in DOE Orders. Nonradiological emissions were also within limits, and compliance with permit limits was better than 99%.

4.1 ETTP Radionuclide Airborne Effluent Monitoring

To demonstrate compliance with DOE Order 5400.5 and Tennessee Rule 1200-3-11-.08, "Emission Standards for Emission of Radionuclides Other than Radon from Department of Energy Facilities" [i.e., National Emission Standards for Hazardous Air Pollutants (NESHAP)], all airborne radionuclide emissions from DOE sources at ETTP must be determined for purposes of estimating dose to the most exposed member of the public.

Locations of airborne radionuclide point sources at the ETTP are shown in Fig. 4.1. Radionuclide emission information for these release points is compiled under the direction of Bechtel Jacobs Company LLC (BJC) from operators subject to NESHAP regulations. Point sources shown in Fig. 4.1 include both individual point sources and grouped point sources, such as laboratory hoods. Radionuclide emissions data were determined from either EPA-approved sampling results or Environmental Protection Agency (EPA)-approved calculation methods.

4.1.1 Radionuclide Emissions Monitoring Approach

4.1.1.1 Minor Sources

The number of minor sources in 2005 varied from the previous year's total because of fluctuations in site operations. For this reporting period, a total of five point sources and one grouped minor source subject to NESHAP regulations operated. Minor sources are grouped if they have similar characteristics (e.g., general location, type of activity, or type of control) and provided that any one group does not have potential radionuclide emissions that would cause a dose in excess of 0.1-mrem/year effective dose equivalent (EDE) as defined under the rule. An example of a minor source is the TSCA Incinerator tank farm with 15 emission points.

Emissions from the various minor sources located at the ETTP were estimated by means of one of the following EPA-approved methods:

- radionuclide inventory (i.e., material balance)—five point sources and one grouped source, health physics air measurements where room ventilation emissions exceeded 10% of derived air concentration worker protection guidelines—no sources,

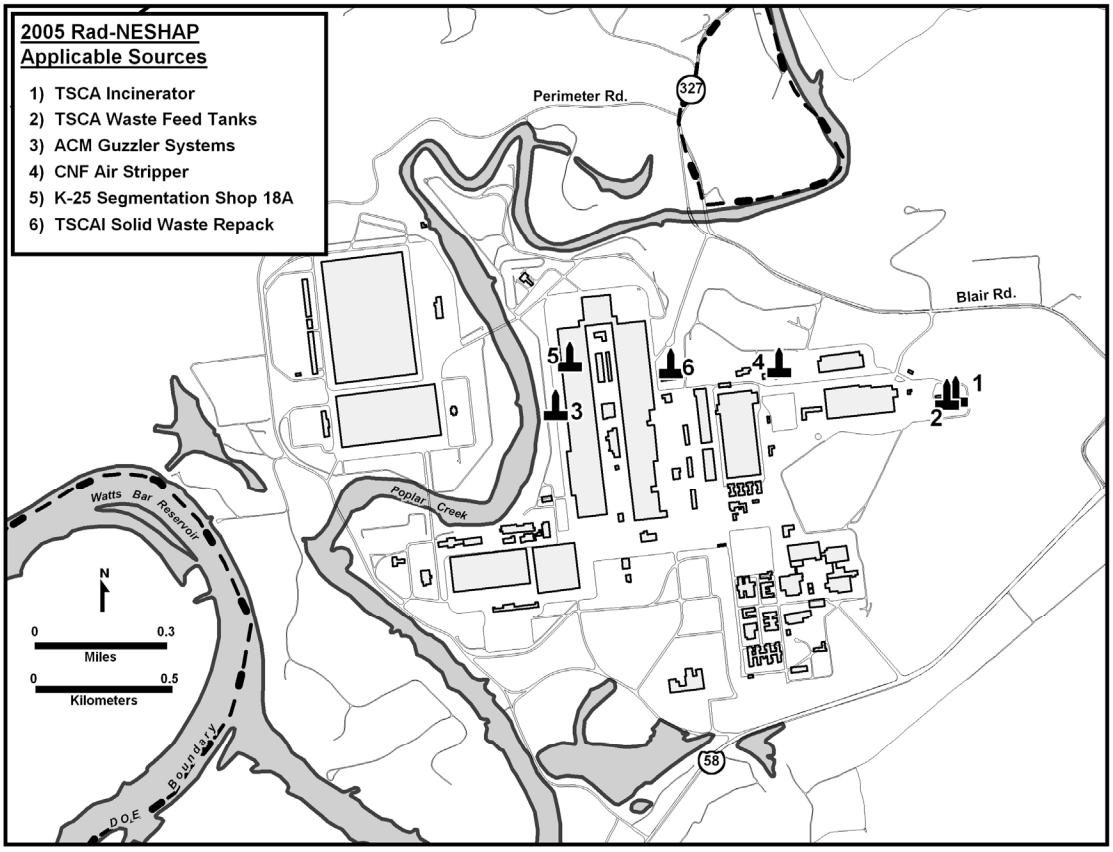


Fig. 4.1. Locations of airborne radionuclide point sources at the ETTP.

- surrogate emission data from similar sources—no sources, and
- evaporative emissions—one grouped source.

All techniques are conservative methods of estimating emissions based on the physical form of the radionuclides and the maximum operating temperature of the process or activity.

Any remaining emissions were classified as major sources or diffuse/fugitive sources that are spatially distributed in nature or that were not emitted with forced air from a stack, vent, or other confined conduit. Typical examples of diffuse/fugitive sources include

- emissions from shutdown buildings;
- resuspension of contaminated soils, debris, or other materials;
- unventilated tanks;
- wastewater treatment systems;
- outdoor storage and processing areas;
- emissions from piping, valves, or other piping equipment and pump components; and
- decontamination and demolition activities.

Fugitive emission sources are monitored by way of the ORR and ETTP ambient air surveillance programs.

4.1.1.2 Major sources

One ETTP major source operated during 2005. Radionuclide emission measurements from the Toxic Substances Control Act (TSCA) Incinerator were determined by means of a continuous stack-sampling system. The system is designed to automatically adjust sample flow rate to maintain near-isokinetic sampling conditions at the stack. The effluent is passed through filter media to collect particulate matter and through impingers with absorbing and adsorbing media to collect gaseous radionuclides. Measurements of TSCA Incinerator emissions were based on monthly composites of weekly stack samples.

4.1.2 Results

The ETTP 2005 radionuclide emissions from the major and minor emission sources are shown in Table 4.1. Additionally, Figs. 4.2 and 4.3 show a comparison of the total discharges of uranium with those of previous years. The total curies and mass of uranium discharged to the air can vary from year to year. The variations are attributable to changes in project activities and source process rates. The resulting airborne dose from all ETTP radionuclide emissions was less than the reservation maximum limit of 10 mrem/year.

4.2 ETTP Nonradiological Airborne Emissions Monitoring

Under an application shield granted by the Tennessee Department of Environment and Conservation, (TDEC) Division of Air Pollution Control, the ETTP has five major air emission sources listed as subject to Tennessee Title V Major Source Operating Permit program rules as of the end of this reporting period.

No direct monitoring of airborne emissions is required for nonradionuclide air contaminants from permitted sources. Instead, monitoring of key process and air pollution control device parameters is performed to ensure compliance with all permitted emission limits.

The ETTP is required to pay a major source emission fee each year for all regulated pollutants, excluding carbon monoxide and pollutants from exempt emission sources. To verify the air emission fee that is based on a combination of permitted allowable and actual emissions for air pollutants, an inventory of regulated emissions from the permitted sources at the ETTP is updated annually. Table 4.2 shows the results of the annual inventory of emissions of criteria pollutants from ETTP operations for the past 5 years. In June 2004 the ETTP steam plant was permanently shut down, and the associated air permits were surrendered. The ETTP paid an annual fee in 2005 amounting to $3500 based on the fee rate of $19.50 per ton of emissions but not less than $3500 during that period for a facility subject to Title V Major Source Operating Permit requirements. Table 4.3 shows the inventoried regulated emissions during the 2005 reporting period from the ETTP.

The TSCA Incinerator is permitted as a major source of air emissions from the ETTP. Emissions from the incinerator are controlled by extensive exhaust-gas treatment. For fee-reporting purposes, permitted allowable limits are used to determine the total potential emissions from the incinerator. A comparison of actual and allowable TSCA Incinerator emissions is presented in Table 4.4. All other permitted sources have emissions inventoried based on permit allowable limits.

4.3 Liquid Discharges—ETTP Radiological Monitoring Summary

The ETTP conducts radiological monitoring of liquid effluent and storm water discharges to determine compliance with applicable dose standards. It also applies the "as low as reasonably achievable" (ALARA) process to minimize potential exposures to members of the public.

4.3.1 Sample Collection and Analytical Procedure

The ETTP monitored the treated effluent from the K-1407-J Central Neutralization Facility (CNF) (outfall 001). Weekly samples were collected from the CNF and were composited into monthly samples. The samples were then analyzed for radionuclides. Results of these sampling efforts were compared with the DCGs listed in DOE Order 5400.5.

The Storm Water Pollution Prevention Program, which is described in more detail in Sect 4.5, included sampling for gross alpha and beta radioactivity as well as specific radionuclides at selected storm water outfalls. Results were used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system. Figure 4.4 shows the location of the major National Pollutant Discharge Elimination System (NPDES) outfalls.

4.3.2 Results

The sum of the fractions of the DCGs at the CNF was calculated at 14.8% for 2005, slightly down from 17.2% in 2004. Table 4.5 lists radionuclides discharged from the ETTP CNF to

Table 4.1. ETTP radionuclide air emission totals, 2005 (Ci)[a]

Radionuclide	Total major	TSCAI (major)[b]	Total minor	Total ETTP
^{228}Ac	–	–	2.19E–08	2.19E–08
^{241}Am	–	–	4.95E–07	4.95E–07
^{243}Am	–	–	5.87E–10	5.87E–10
^{207}Bi	–	–	7.61E–09	7.61E–09
^{14}C	6.19E–05	6.19E–05	1.43E–04	2.05E–04
^{137}Cs	1.22E–04	1.22E–04	1.13E–05	1.34E–04
^{57}Co	5.23E-08	5.23E-08	–	5.23E–08
^{60}Co	–	–	1.05E–10	1.05E–10
^{244}Cm	–	–	1.54E–08	1.54E–08
^{245}Cm	–	–	5.91E–10	5.91E–10
^{247}Cm	–	–	8.31E–10	8.31E–10
^{248}Cm	–	–	3.79E–10	3.79E–10
^{152}Eu	–	–	7.85E–07	7.85E–07
^{154}Eu	–	–	6.38E–07	6.38E–07
^{85}Kr	2.76E–03	2.76E–03	2.18E–09	2.76E–03
^{210}Pb	–	–	1.19E–07	1.19E–07
^{212}Pb	–	–	7.12E–09	7.12E–09
^{237}Np	4.36E–07	4.36E–07	2.46E–07	6.82E–07
^{238}Pu	4.57E–07	4.57E–07	1.04E–07	5.61E–07
^{239}Pu	8.00E–06	8.00E–06	6.62E–07	8.66E–06
^{242}Pu	–	–	1.27E–08	1.27E–08
^{244}Pu	–	–	9.30E–11	9.30E–11
^{231}Pa	–	–	2.67E–08	2.67E–08
^{234m}Pa	8.61E–03	8.61E–03	1.53E–06	8.61E–03
^{226}Ra	–	–	1.68E–06	1.68E–06
$^{89/90}$Sr	3.43E–06	3.43E–06	2.10E–06	5.53E–06
^{99}Tc	2.73E–03	2.73E–03	3.98E–04	3.12E–03
^{208}Tl	–	–	5.90E–09	5.90E–09
^{228}Th	3.06E–05	3.06E–05	1.18E–07	3.07E–05
^{230}Th	1.75E–04	1.75E–04	9.07E–07	1.76E–04
^{232}Th	3.15E–05	3.15E–05	4.25E–05	7.40E–05
^{234}Th	1.20E–03	1.20E–03	8.13E–05	1.28E–03
^{3}H	1.61E+02	1.61E+02	6.41E–07	1.61E+02
^{232}U	–	–	1.11E–10	1.11E–10
^{233}U	–	–	1.01E–05	1.01E–05
^{234}U	5.21E–04	5.21E–04	5.64E–05	5.77E–04
^{235}U	1.44E–04	1.44E–04	4.07E–06	1.48E–04
^{236}U	–	–	5.04E–07	5.04E–07
^{238}U	8.64E–04	8.64E–04	1.04E–04	9.68E–04
Totals	1.61E+02	1.61E+02	8.61E–04	1.61E+02

[a] 1 Ci = 3.7×10^{10} Bq.

[b] Toxic Substances Control Act Incinerator.

off-site surface waters in 2005. Total uranium discharges from the CNF were 0.0058 Ci in 2005. Total discharge of transuranics was 0.0000052 Ci, which is three orders of magnitude less than the contribution from uranium.

In terms of total activity of the discharges, ^{3}H, ^{14}C, and ^{99}Tc were the greatest contributors. However, their allowable DCGs are greater than those for the uranium isotopes, so their contribution to the sum of the fractions of the DCGs is relatively small. Technetium-99 accounted for just under 2% of the sum of the fractions, ^{14}C for 3%, while ^{3}H accounted for 0.077%. Uranium discharges from the CNF during a 5-year period were investigated to observe their trend (Fig. 4.5). Uranium isotopes were the major con-

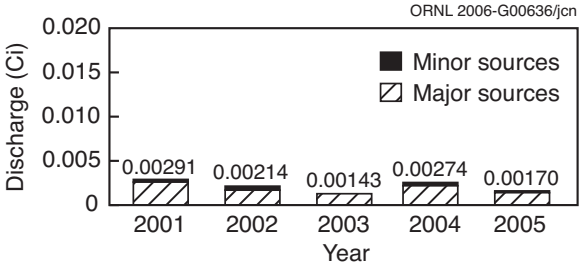


Fig. 4.2. Total curies of uranium discharged from the ETTP to the atmosphere, 2001–2005. (1 Ci = 3.7×10^{10} Bq.)

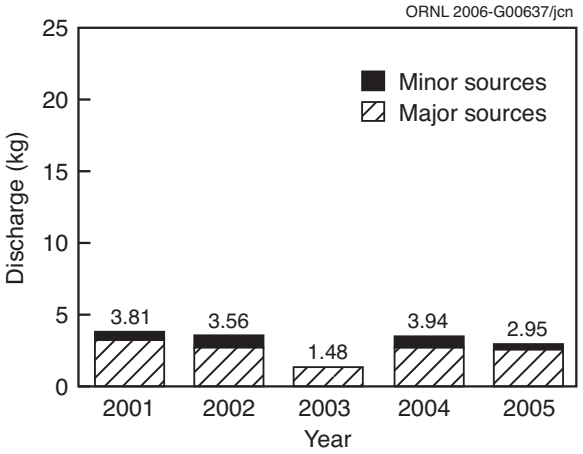


Fig. 4.3. Total kilograms of uranium discharged from the ETTP to the atmosphere, 2001–2005.

tributors to the fraction of the DCG, contributing two-thirds of the sum of the fraction of the DCG (Fig. 4.6). All of the remaining isotopes cumulatively accounted for less than 1% of the allowable DCG. TSCA Incinerator wastewater, which is sent to the CNF for treatment before being discharged to the Clinch River, is a major contributor of uranium; other operations contribute smaller amounts.

4.4 Nonradiological Liquid Discharges—ETTP Surface Water Effluents

The current ETTP NPDES permit (Permit Number TN0002950) for storm water discharges went into effect on April 1, 2004. This permit authorizes the ETTP to discharge storm water runoff, groundwater infiltration, groundwater from sumps, noncontact cooling water, and steam condensate to the Clinch River, Poplar Creek, and Mitchell Branch through 121 storm water outfalls. The 121 outfalls were divided into four groups based on the volume and nature of the monitored discharge. Of the 121 total outfalls, 39 are monitored as being representative of the four outfall groups. Samples from these outfalls are collected and analyzed as specified in NPDES permit TN0002950.

The current NPDES permit (Permit Number TN0074255) for the CNF went into effect on November 1, 2003. This permit authorizes treated industrial effluent from outfall 001 to be discharged to the Clinch River. Table 4.6 details the requirements and compliance records for the two NPDES permits for 2005. The table provides a list of the discharge points, effluent parameters, effluent limits, number of noncompliances, and the percentage of compliance for 2005. Samples from this outfall are collected and analyzed as specified in NPDES permit TN0074255.

4.4.1 Results

The ETTP had one NPDES noncompliance in 2005 under NPDES Permit No. TN0002950. On January 24, 2005, sampling personnel were performing the weekly sampling at storm water outfall 100 as required by NPDES permit TN0002950. At the time the samples were being collected, sampling personnel noticed that the flow in the outfall was elevated above normal levels, despite the absence of a recent rainfall event. A small amount of foam was also observed on the surface of the discharge. All required samples were collected from the outfall, including a sample for total residual chlorine (TRC). Because of the short holding time for this sample, it was immediately taken to an onsite laboratory for analysis. The laboratory determined that the TRC level in the sample was 1.25 mg/L. This result exceeded the NPDES permit requirement of 0.14 mg/L for this outfall.

Upon verification of the elevated TRC result, an investigation into the source of the chlorine was conducted. It was determined that utility subcontractor personnel had identified a sanitary water line break near building K-1004-L. Sanitary water was observed by utilities subcontractor personnel to be bubbling up from beneath a sidewalk in this area. The discharge from the broken water line entered a portion of the storm drain system that discharged through storm water outfall 100. The broken sanitary

Table 4.2. Allowable emissions of criteria pollutants from the ETTP, 2001–2005

Pollutant	Allowable emissions (tons/year)[a]				
	2001	2002	2003	2004	2005
Particulate matter	13	13	13	13	14
Volatile organic compounds	14	14	14	14	11
Sulfur dioxide	39	39	39	39	39
Nitrogen oxides	20	20	20	20	20
Carbon monoxide	19	19	19	19	19
Hazardous air pollutants	20	21	21	21	21
Miscellaneous	0	0	0	0	0
Total	125	126	126	126	124

[a]1 ton = 907.2 kg.

Table 4.3. Actual emissions of criteria pollutants from permitted ETTP sources, 2005

Pollutant	Actual emissions	
	lb/year[a]	tons/year[b]
Particulate matter	333.7	0.167
Volatile organic compounds	625.8	0.313
Sulfur dioxide	7.2	0.004
Nitrogen oxides	20,872	10.44
Carbon monoxide	5,218	2.61

[a]1 lb = 2.205 kg.
[b]1 ton = 907.2 kg.

water line was immediately valved off immediately after it was discovered. There was no way of estimating the amount of sanitary water discharged from the broken water line before the flow could be shut off.

The K-1007-P1 pond receives discharges from storm water outfall 100. Environmental compliance subcontractor personnel inspected in the K-1007-P1 pond to determine if any environmental impact had occurred as a result of this discharge of sanitary water. No dead fish were noted, and no impact to other biota in the pond was observable. No threat to human health or the environment is believed to have occurred as a result of this discharge of sanitary water.

4.5 Storm Water Pollution Prevention Program

4.5.1 Storm Water Monitoring Strategy

Development and implementation of the ETTP Storm Water Pollution Prevention Program is required by Part IV of ETTP NPDES Permit No. TN0002950. The objective of the program is to minimize the discharge of pollutants in storm water runoff from the ETTP.

The purpose of the ETTP Storm Water Pollution Prevention Program is to assess the quality of storm water discharges from ETTP, determine potential sources of pollutants affecting storm water, and provide effective controls to reduce or eliminate these pollutant sources. It provides a means whereby sources of pollutants that are likely to affect the quality of storm water discharges are identified, best management practices to control the entry of pollutants into storm water discharges are developed, and methods for implementing pollution prevention practices are devised.

During 2005, the ETTP Storm Water Pollution Prevention Program sampling was conducted in support of two primary goals:

- **Sampling** for the ETTP Water Quality Program (EWQP)—Surface water samples were collected at locations that are exit pathways for contaminants from ETTP. The locations have a direct discharge or potential for direct discharge to Poplar Creek or the Clinch River.
- Sampling in preparation for the application for ETTP NPDES permit renewal—Selected

Table 4.4. Actual vs allowable air emissions from the Toxic Substances Control Act Incinerator at the ETTP, 2005

Pollutant	Emissions (tons/year)[a]		Percentage of allowable
	Actual[b]	Allowable	
Semivolatile metals	0.0045	0.04	
Beryllium	0.00005	0.004	1.3
Low-volatile metals	0.0013	0.004	32.5
Mercury	0.00081	0.02	4.1
Hydrogen fluoride	0.0031	3.0	0.1
Hydrogen chloride	0.122	15.7	0.8
Sulfur dioxide	0.0036	38.5	<0.1
Volatile organic compounds	0.313	5.0	6.3
Dioxin/furan	*c*	*c*	1.0
Particulate matter	0.167	5.64	3.0

[a]1 ton = 907.2 kg.

[b]Actual emissions based on removal efficiencies measured during permit required air emission tests conducted during 2005.

[c]The criterion for dioxin and furan is the "destruction/removal efficiency." Actual: 99.999%; allowable: 99.99%.

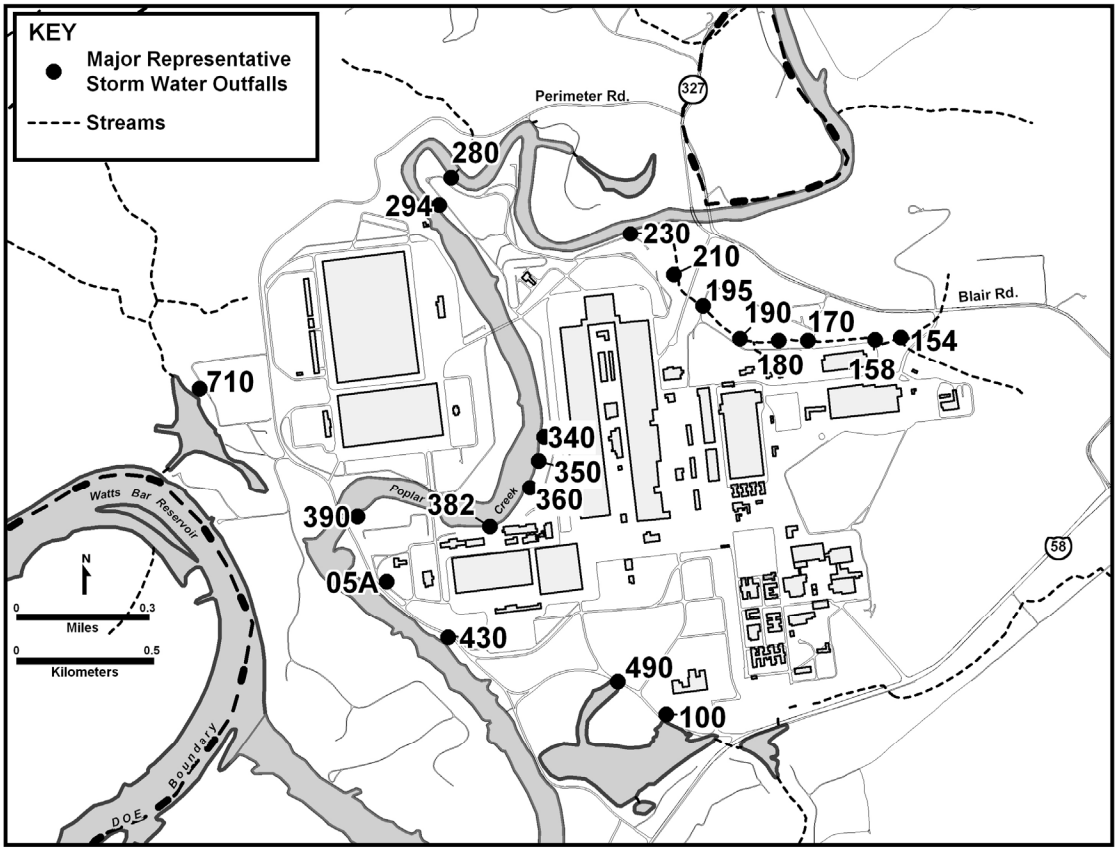


Fig. 4.4. ETTP National Pollutant Discharge Elimination System major representative storm water outfalls.

Table 4.5. Radionuclides released to off-site surface waters from the ETTP, 2005

Effluent discharge location: Central Neutralization Facility

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{14}C	2.3E–1	^{234}U	1.5E–3
^{3}H	1.5E–1	^{235}U	1.4E–4
^{239}Pu	5.2E–6	^{236}U	4.1E–5
^{99}Tc	2.0E–1	^{238}U	4.1E–3

[a] 1 Ci = 3.7×10^{10} Bq.

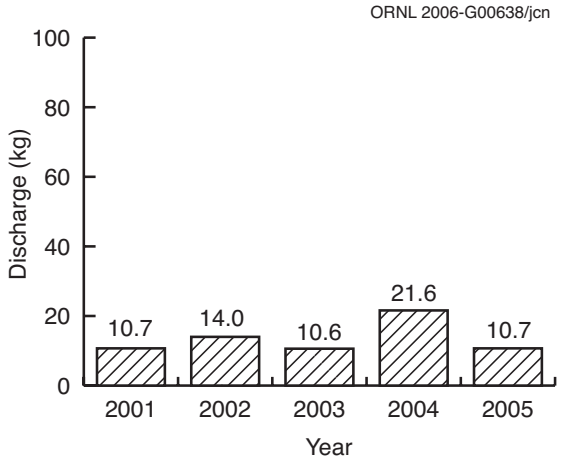


Fig. 4.5. Five-year trend of uranium releases to surface waters from the K-1407-J Central Neutralization Facility.

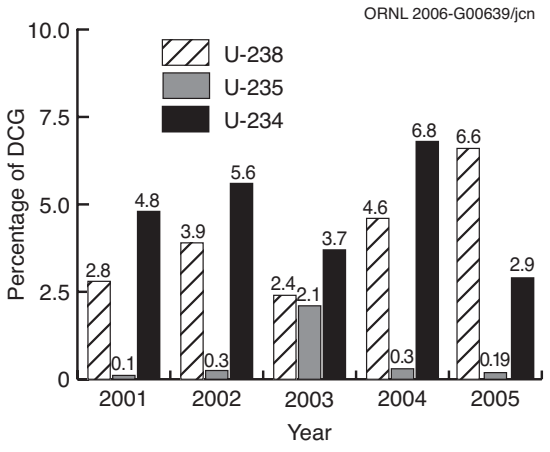


Fig. 4.6. Percentage of DOE derived concentration guides for uranium isotopes from the K1407-J Central Neutralization Facility.

outfalls that were designated as group representatives in the reissued ETTP NPDES Permit Number TN0002950 were sampled, and the results will be incorporated in the ETTP NPDES permit renewal application. The current ETTP NPDES permit expires on March 31, 2008; the permit renewal application must be submitted to Tennessee Department of Environment and Conservation (TDEC) 180 d prior to permit expiration.

4.5.2 ETTP Water Quality Program Monitoring Program Results

In 2005, surface water samples were collected at locations that are exit pathways for contaminants from ETTP as part of the Storm Water Pollution Prevention Program and in association with the ETTP Water Quality Program (EWQP) monitoring program. These locations have a direct discharge or potential for direct discharge to Poplar Creek or the Clinch River. Data from the analysis of these samples will be used to identify areas where contaminants may be discharging directly to surface waters located outside the ETTP boundaries. In addition, surface water samples were collected at interior locations within ETTP. The data from these samples will be used to evaluate changes in contaminant concentrations near potential contaminant sources and to identify contaminants that may be discharging to surface waters within the boundaries of ETTP.

In CY 2005, gross alpha radiation was detected above screening levels at storm water outfalls 180 and 190. These measurements exceeded the screening level of 15 pCi/L for this analyte. No gross alpha or gross beta contamination above the screening levels was found at any of the other storm water outfalls that were sampled in CY 2005 as part of the EWQP sampling

Table 4.6. National Pollutant Discharge Elimination System compliance at the ETTP, 2005

Effluent parameter	Effluent limits[a]		Number of noncompliances	Compliance (%)
	Monthly average	Daily maximum		
Outfall 001 (K-1407-J Central Neutralization Facility to the Clinch River)				
Benzene		0.005		100
Cadmium	0.18	0.69		100
Carbon tetrachloride	0.5	0.5		100
Chloride, total	35,000	70,000		100
Chloroform	0.5	0.5		100
Chromium	1.71	2.77		100
Copper	1.34	2.15		100
Cyanide, total	0.650	1.200		100
Ethylbenzene		0.01		100
Lead	0.38	0.69		100
Nickel	2.38	3.98		100
Oil and grease	26	30		100
PCB	0.00022	0.00045		100
pH, standard units		6.0–9.0		100
Silver	0.24	0.43		100
Suspended solids	31	40		100
Tetrachloroethylene		0.7		100
Toluene		0.01		100
Total toxic organics		2.13		100
Trichloroethylene	0.5	0.5		100
Vinyl chloride	0.2	0.2		100
Zinc	1.48	2.61		100
Group I storm water outfalls				
pH, standard units		4.0–9.0		100
Group II storm water outfalls				
pH, standard units		4.0–9.0		100
Group III storm water outfalls				
pH, standard units		4.0–9.0		100
Group IV storm water outfalls				
Chlorine, total residual		0.140	1	98
pH, standard units		6.0–9.0		100

[a]Units are mg/L unless otherwise stated.

effort. In addition, no levels of transuranics or isotopic uranium exceeding 4% of the DCG level were detected in samples from any of the other storm water outfalls sampled in CY 2005 as part of the EWQP sampling effort. Volatile organic compounds including 1,2-dichloroethene, cis-1,2-dichloroethene, tri-chloroethene, and vinyl chloride were found at levels above screening criteria at storm water outfall 190 in samples collected as part of the EWQP sampling effort during CY 2005. Field measurements for dissolved oxygen were below the screening level of 6.0 mg/L at outfalls 170, 180, and 190 during EWQP monitoring performed during CY 2005. No polychlorinated biphenyls (PCBs) were detected at levels above detection limits at any of the locations sampled as part of the EWQP monitoring effort during CY 2005. Analytical results for the EWQP this sampling effort are presented in Tables 4.7 and 4.8.

4.5.3 Radiological Monitoring of Storm Water Discharges

In 2005, radiological monitoring of storm water discharges was performed as part of the Storm Water Pollution Prevention Program

Table 4.7 EWQP storm water monitoring—radiological monitoring results that exceeded screening criteria, 2005[a]

Storm water outfall	Gross alpha radiation (pCi/L)
180[b]	16.6
190[b]	56.1
190[c]	24.5

[a]Screening levels are 15 pCi/L alpha radiation and < 6.0 mg/L dissolved oxygen.
1 pCi = 3.7×10^{-2} Bq.

[b]Sample collected during first quarter of 2005.

[c]Sample collected during third quarter of 2005.

NPDES permit renewal sampling effort. Analytical results above screening criteria for the radiological monitoring are presented in Table 4.9. A synopsis of the results from radiological monitoring at all the storm water outfalls is given in Table 4.10.

4.5.4 Nonradiological Monitoring of Storm Water Discharges

Storm water from several outfalls that were sampled in 2005 contained metals and organic compounds that were present in concentrations above the screening criteria levels. The exact sources of the materials are unknown. It is likely that some are the results of natural components of the soils and sediments in the area. Analytical results above the screening criteria for the nonradiological parameters are presented in Table 4.11.

4.6 ETTP Biological Monitoring and Abatement Program

BMAP is a requirement of the NPDES permit. Its purpose is to assess the ecological health of the ETTP's receiving streams and ponds. In 2005, the BMAP consists of four tasks:

- toxicity monitoring,
- bioaccumulation monitoring,
- ecological surveys of instream communities (both fish and benthic macroinvertebrates), and
- waterfowl monitoring.

The BMAP is conducted by the ORNL Environmental Sciences Division under the direction of the ETTP Environmental Compliance and Protection Organization.

4.6.1 BMAP Toxicity Monitoring

The toxicity monitoring task for BMAP includes semiannual tests of effluent from storm water outfalls 170 and 190 concurrently with surface water from ambient sites in Mitchell Branch. These sites are Mitchell Branch kilometer (MIK) 0.12 (beginning in October), 0.45, 0.71, and 0.78. The number following "MIK" indicates the distance in kilometers from the mouth of Mitchell Branch on Poplar Creek. *Ceriodaphnia dubia* were used to evaluate effluent from storm water outfalls 170 and 190, and the ambient monitoring locations, for toxicity.

In June and October, survival and reproduction toxicity tests using *Ceriodaphnia dubia* on water from storm water outfall 170 and all ambient locations revealed no toxicity (Table 4.12). However, effluent from storm water outfall 190 reduced both reproduction and survival in the June test, and reproduction in the October test. Interestingly, in the June test, effluent from storm water outfall 190 reduced reproduction at all tested concentrations and survival in all but the lowest (6%) tested concentration. However, the October test was one of only three tests since 1999 that did not reduce survival. Thus, the overall trend is one of some level of toxicity to *Ceriodaphnia* from storm water outfall 190, with no or very infrequent toxicity from the ambient locations and occasional toxicity at storm water outfall 170. Although the source of the problem at storm water outfall 190 was not positively identified, the data gathered in previous studies indicated that groundwater was percolating through waste in the K-1070-B Burial Ground and leaching out small quantities of metals. Some of this groundwater was then flowing into the storm drain system and could contribute to the toxicity. Nickel and zinc are present in water collected from the storm drain system near K-1070-B, at levels that have been shown to be toxic to *Ceriodaphnia*.

4.6.2 BMAP Bioaccumulation Studies

In June and July 2005, caged clams *(Corbicula fluminea)* were placed at several locations around ETTP. The clams were allowed to remain in place for 4 weeks, then were analyzed

Table 4.8. EWQP storm water monitoring—nonradiological monitoring results that exceeded screening criteria

Storm water outfall	Dissolved oxygen	1,2 Dichloroethene (μg/L)	*cis*-1,2 Dichloroethene (μg/L)	Trichloroethene (μg/L)	Vinyl chloride (μg/L)
170[a]	5.8				
180[a]	5.3				
190[b]		510	510	120	210
190[a]	3.8	800	810	150	370

[a]Sample collected during third quarter of 2005.
[b]Sample collected during first quarter of 2005.

Table 4.9. Maximum exceedances of radiological screening criteria for storm water outfalls, 2005 (pCi/L)[a]

Storm water outfall	Alpha	Beta	U-233/234	U-238
180	26.3			
190	28.4			
350	242	76.5	139	106
360	52.9		28.8	
724	99.4		77.3	59.8

[a]Screening levels are 15 pCi/L alpha radiation, 50 pCi/L beta radiation, 20 pCi/L ^{234}U, and 24 pCi/L ^{238}U. 1 pCi = 3.7×10^{-2} Bq.

Table 4.10. Radionuclides released to off-site surface waters from the ETTP storm water system, 2005[a]

Radionuclide	Amount (Ci)	Radionuclide	Amount (Ci)
^{237}Np	1.7E–5	^{234}U	5.6E–3
^{238}Pu[a]	2.2E–6	^{235}U	2.7E–4
^{239}Pu	–3.5E–6	^{236}U	1.9E–5
^{99}Tc	3.6E–2	^{238}U	3.1E–3

[a]All results less than or equal to laboratory error values. 1 Ci = 3.7×10^{10} Bq.

for uptake of PCBs. Results from the 2005 monitoring were similar in most respects to the results of earlier monitoring. The highest concentrations (7.3 μg/g) were found in the clams from storm water outfall 100, with lesser concentrations found in clams from other locations in the P1 pond. Clams from the Mitchell Branch and K-901-A locations also exhibited elevated levels of PCBs in comparison to the clams from the reference stream, with clams from Mitchell Branch accumulating more significant concentrations. Mitchell Branch clams averaged 2.4 ppm, while clams from the K-901-A Pond outfall contained concentrations an order of magnitude lower (0.25 ppm). Also, the composition of the PCBs from the three locations differ in that the PCBs from the Mitchell Branch clams are almost entirely Aroclor-1254, while the K-1007-P1 Pond clams contain both Aroclor-1254 and Aroclor-1248, and the K-901-A Pond clams contain Aroclor-1254 and Aroclor-1260. In Mitchell Branch, the concentration of PCBs in clams increases downstream of storm water outfall 190. In the K-901-A Pond, clams from near the two major storm water outfalls that discharge into the pond (storm water outfalls 700 and 710) contain higher concentrations than in the clams from the K-901-A Pond outfall, indicating that these two storm water outfalls may be the proximate source of PCB contamination in the pond. Clams from the K-725 Slough and K-1007-P3 Pond exhibit levels (0.07 and 0.04 ppm, respectively) that are roughly consistent with those in clams from the reference stream (0.06 ppm).

Fish were collected from Mitchell Branch, K-1007-P1 Pond, and K-901-A Pond in May 2005. Largemouth bass were collected from the pond sites, and redbreast sunfish were collected from Mitchell Branch. Game fish of a size large enough to be taken by sports fishermen were selected both to provide more accurate data of potential human health concerns and to reduce the amount of variation in contamination levels in the individual fish due to age and size differences. Fillets were taken from each game fish

Table 4.11. Maximum exceedances of nonradiological screening criteria for each storm water outfall, 2005 (µg/L)

Outfall	Parameter	Monitoring result	Criteria
180	Aluminum	931	750
180	Iron	10100	1000
180	Manganese	5120	1000
180	Zinc	115	65
190	Aluminum	769	750
190	Iron	3180	1000
190	Zinc	102	65
190	Aroclor-1260	0.9	0.5
195	Aluminum	1930	750
195	Iron	21900	1000
195	Manganese	2710	1000
195	Zinc	244	65
280	Aluminum	7560	750
280	Iron	10200	1000
280	Zinc	192	65
280	Aroclor-1254	0.68	0.5
294	Zinc	68	65
340	Zinc	237	65
350	Aluminum	1640	750
350	Iron	3020	1000
382	Aluminum	2630	750
382	Iron	4370	1000
382	Zinc	310	65
510	Bis(2-ethylhexyl)phthalate	200	100
510	Zinc	115	65
890	Aluminum	937	750
890	Iron	1670	1000
900	Aluminum	1720	750
900	Iron	1920	1000
992	Aluminum	1580	750
992	Iron	9990	1000
992	Manganese	1820	1000

Table 4.12. Mitchell Branch and associated storm water outfall toxicity test results, 2005[a]

Test	MIK 0.78	SD 170	MIK 0.71	SD 190	MIK 0.45	MIK 0.12
Second quarter, June						
Ceriodaphnia survival	NR	NR	NR	R	NR	NS
Ceriodaphnia reproduction	NR	NR	NR	R	NR	NS
Fourth quarter, October						
Ceriodaphnia survival	NR	NR	NR	NR	NR	NR
Ceriodaphnia reproduction	NR	NR	NR	R	NR	NR

[a]NR: No significant reduction compared with the control population. R: Significant reduction compared with the control population. NS: Not sampled.

and analyzed for PCBs. Table 4.13 gives a synopsis of the results. Results from the Mitchell Branch and K-901-A Pond monitoring are similar to historical results, with fish from both locations containing concentrations (an average of 2.2 and 0.9 ppm, respectively) near or above the State of Tennessee posting limit of 1 ppm. In the bass from K-1007-P1 pond, the 2004 results showed a significant decrease in PCB concentrations when compared to previous year's monitoring results. Results from the 2005 monitoring (an average of 16.1 ppm) returned to the range of historical levels.

4.6.3 BMAP Ecological Surveys of Instream Communities

Although past ETTP operations had adversely affected the communities of Mitchell Branch, and although there continue to be some impacts, the results to date overall indicate that the institution of best management practices and remediation efforts have resulted in gradual, but more or less continuous, improvement of conditions in the stream.

In April 2005, the benthic macroinvertebrate community was sampled at four Mitchell Branch locations (MIK 0.45, 0.71, 0.78, and 1.43). MIK 1.43 serves as the reference location. Except for short-term negative impacts to benthic macroinvertebrate communities at MIK 0.45 and 0.71 in 1998 (associated with stream relining) and 2003, the benthic macroinvertebrate community at all locations in lower Mitchell Branch has generally increased in species richness and numbers of pollution-intolerant species over approximately the last 10 years (Figs. 4.7 and 4.8). The results from the 2003 sampling showed declines in species richness and richness of the pollution-intolerant species in Mitchell Branch. However, the results of the 2004 and 2005 sampling at MIK 0.71 and MIK 0.45 show a strong increase in these parameters to levels more typical of the previous sampling events, and the levels at MIK 0.78 even exceeded those of the reference locality. Community differences between the reference site (MIK 1.43) and MIKs 0.45 and 0.71 are still apparent in 2005, with the persistence of lower densities of stoneflies at the downstream sites (i.e., 5 to >20 times lower than at MIKs 1.43). Overall, however, it appears that past actions taken to improve water quality (e.g., effluent dechlorination) have provided significant ecological benefits.

Fish communities in Mitchell Branch (MIK 0.45 and 0.71) were sampled in April. Species richness, density, and biomass were examined. The communities at both MIK 0.45 and MIK 0.71 showed a significant increase in both density and biomass. Density at MIK 0.71 was the highest recorded for that location, and the density at MIK 0.45 was the second highest. Species richness in the 2005 sampling was similar to or slightly better than recent years' results at both locations. The stream is still dominated by more tolerant fish species, so although the conditions and fish community structure are improving they have not yet reached a stable community structure typical of less impacted streams in the area.

4.6.4 BMAP Waterfowl Surveys

Waterfowl surveys were conducted twice per year in 2004 and the first half of 2005, but as of October 2005 they will no longer be conducted as part of the BMAP. During the waterfowl survey conducted in April 2005, the following species were observed at ETTP: the osprey (*Pandion haliateus*), common loon (*Gavia immer*), double-crested cormorant (*Phalacrocorax auritus*), great blue heron (*Ardea herodius*), American coot (*Fulica americana*) killdeer (*Charadrius vociferous*) belted kingfisher (*Ceryle alcyon*), American kestrel (*Falco sparverius*), and the Canada goose (*Anser canadensis*). During the last several years, the number of species of waterfowl, as well as the number of individuals, has fluctuated. It is not clear at this time whether or not the fluctuations represent a temporary plateau on the route to recovery, or whether the avian community has more or less reached a steady state.

4.7 ETTP Ambient Air Monitoring

DOE Order 450.1 requires surveillance of ambient air to assess the impact of DOE operations on air quality. In addition, airborne radionuclide monitoring is required for compliance with radionuclide NESHAP regulatory agreements. DOE Order 5400.5 also specifies requirements for airborne radionuclide surveillance. The ETTP ambient air monitoring program is designed to monitor selected air con-

Table 4.13. PCB concentrations in biota at ETTP, 2005

Location	Species	Mean concentration (ppm)[a]	Range	Number >1 ppm/N
MIK 0.2	Redbreast sunfish (*Lepomis auritus*)	2.2	0.74–3.5	5/6
K-1007-P1	Largemouth bass (*Micropterus salmoides*)	16	7.5–29	6/6
K-901-A	Largemouth bass (*Micropterus salmoides*)	0.88	0.58–1.6	1/6
Hinds Creek (reference)	Rockbass (*Ambloplites rupestris*)	<0.03	<0.03–0.04	0/6
MIK 0.78	Asiatic clams (*Corbicula fluminea*)	0.1	N/A	N/A
MIK 0.71 (SD170)	Asiatic clams (*Corbicula fluminea*)	0.1	N/A	N/A
MIK 0.45 (SD190)	Asiatic clams (*Corbicula fluminea*)	1.2	N/A	N/A
MIK 0.2	Asiatic clams (*Corbicula fluminea*)	2.4	N/A	N/A
SD100 (inside drain)	Asiatic clams (*Corbicula fluminea*)	4.7	N/A	N/A
SD100 (discharge to P1 Pond)	Asiatic clams (*Corbicula fluminea*)	7.3	N/A	N/A
SD120	Asiatic clams (*Corbicula fluminea*)	1.5	N/A	N/A
K-1007P3	Asiatic clams (*Corbicula fluminea*)	0.04	N/A	N/A
SD490	Asiatic clams (*Corbicula fluminea*)	0.78	N/A	N/A
K-1007P1	Asiatic clams (*Corbicula fluminea*)	3.9	N/A	N/A
K-901-A	Asiatic clams (*Corbicula fluminea*)	0.25	N/A	N/A
SD700	Asiatic clams (*Corbicula fluminea*)	0.71	N/A	N/A
SD710	Asiatic clams (*Corbicula fluminea*)	0.61	N/A	N/A
Little Sewee Creek (reference)	Asiatic clams (*Corbicula fluminea*)	0.06	N/A	N/A
SD930	Asiatic clams (*Carbicula fluminea*)	0.07	N/A	N/A

[a]1 ppm = 1 mg/L.

taminants for the ongoing monitoring of the impact of plant operations on the immediate environment. Specific locations were selected to determine air contaminant concentrations in the prevailing directions, upwind and downwind of the site, and to obtain airborne radiological measurements in the direction of both the nearest and most exposed member of the public. The current locations of these monitoring stations are shown in Fig. 4.9. The ETTP ambient air monitoring program complies with all requirements of DOE Orders. One new station was activated in November of 2005 due to planned DOE facility access changes that would require on-site monitoring of radiological emissions. This station will ensure compliance with NESHAP regulations and will be consistent with previously approved sampling methodologies defined in the ORR NESHAP Compliance Plan (DOE 1994).

National ambient air quality standards are referenced by DOE Orders as guidance with respect to ambient air concentrations of certain air contaminants. These regulations specify 24-h, quarterly, and annual standards for specific or criteria pollutants. Additionally, results are compared with any applicable risk-specific dose and reference air concentration listed in 40 CFR 266, Subpart H.

The ambient air sampling schedule and monitored parameters are listed in Table 4.14. All parameters were chosen with consideration of existing and proposed regulations and the nature of operations in and around the ETTP. Changes in emissions, wind profile, site activities, or any other parameter that may alter the potential impact of ETTP activities within the facility, on nearby communities, or the environment may warrant periodic changes of air contaminants measured, number of stations, or relocation of existing stations. The principal parameters monitored during 2005 were arsenic, beryllium, cadmium, chromium, lead, and uranium. Uranium was analyzed by both inorganic and radiochemical methods. Radiochemical analyses included isotopes of uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U), ^{99}Tc, ^{237}Np, ^{238}Pu, and ^{239}Pu.

During this reporting period, the ambient air monitoring network consisted of four ETTP sampling stations and utilized information obtained from two ORR perimeter air monitoring (PAM) stations. Samples were collected weekly from the following stations: K2, K6, K9, K11,

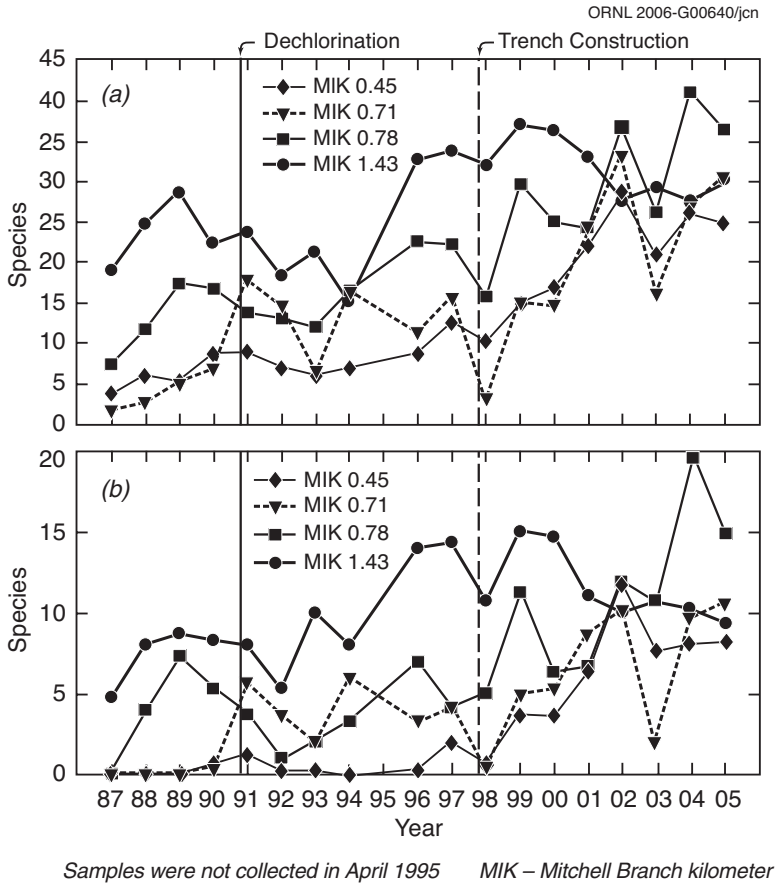


Fig. 4.7. Total taxonomic richness (a) and richness of pollution-sensitive taxa (b) in Mitchell Branch.

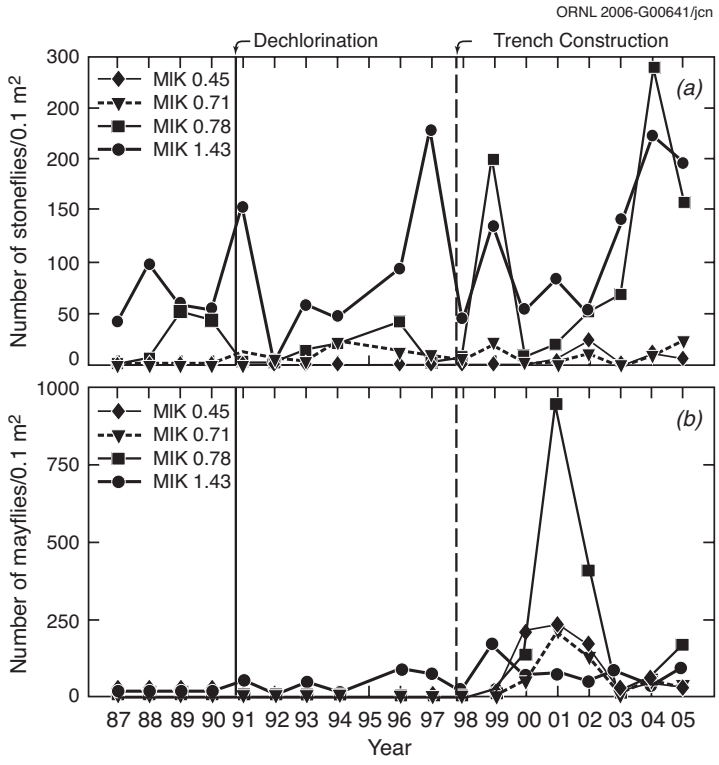
and PAM 35 and 42. During 2005, sample compositing was performed quarterly (every 3 months) prior to analysis for all pollutant analyses.

4.7.1 Results

No standards were exceeded, and, with the exception of uranium levels, there were no significant variations of annual pollutant concentrations associated with site operations when compared with data from the previous year. Sampling results assessing the impact of specific site activities on air quality show that the ETTP, including project-specific measurements, did not have any impact of concern on local air quality. Also, radiochemical analyses of ambient air samples confirm low radiological emissions from the ETTP.

4.7.2 Criteria Pollutant Levels

Lead results were determined from analyses of quarterly composites of continuous weekly samples from stations K2, K6, and K9. Station K11 results consisted of only 2 months of sampling. The total mass quantities of lead for each sample were determined by the inductively coupled plasma mass spectrometry (ICP-MS) analytical technique. Lead analytical results are summarized in Table 4.15 and are compared with the Tennessee and national quarterly ambient air quality standard of 1.5 $\mu g/m^3$. There are no 24-h, monthly, or annual ambient air quality standards for lead. The maximum individual lead result was 0.0012 $\mu g/m^3$. This value was only 0.08% of the quarterly standard for lead. No lead concentrations of environmental concern were measured (see Fig. 4.10 for a 5-year lead trend).



There was no monitoring conducted during 1995.

Fig. 4.8. Density of pollution-intolerant stoneflies (a) and pollution-tolerant mayflies (b) in Mitchell Branch.

4.7.3 Hazardous Air Pollutant Carcinogenic Metal Levels

Analyses of hazardous air pollutant carcinogenic metals (arsenic, beryllium, cadmium, and chromium) were performed on quarterly composite samples of continuous weekly samples from stations K2, K6, and K9. Station K11 results consisted of only 2 months of sampling. Total mass of each selected metal was determined by the ICP-MS analytical technique.

There are no Tennessee or national ambient air quality standards for these hazardous air pollutant carcinogenic metals. However, comparisons have been made against risk-specific doses and reference air concentrations.

The annual average arsenic concentration for all measurement sites was 0.00019 μg/m^3, well below the risk-specific dose of 0.0023 μg/m^3. The individual maximum measured result was 0.00036 μg/m^3. Annual beryllium measurements were at or near the minimum detectable concentrations of the analytical method, orders of magnitude below the risk-specific dose of 0.0042 μg/m^3. The combined beryllium average for all sites was < 0.000005 μg/m^3 with the individual maximum result of 0.000055 μg/m^3. The maximum cadmium concentration result was 0.00008 μg/m^3. The cadmium annual average was 0.00004 μg/m^3. Both results are well below the risk-specific dose of 0.0056 μg/m^3. Individual chromium measurements ranged from approximately < 0.00001 to 0.00015 μg/m^3. The annual average result for chromium was 0.00006 μg/m^3, well below the risk-specific dose of 0.00088 μg/m^3 for chromium VI. The form of chromium was not determined, and therefore the most conservative risk-specific dose (chromium VI) was used. A summary of the hazardous air pollutant carcinogenic metals measurements is presented in Table 4.16

Table 4.14. Summary of types and frequencies of samples collected at ETTP perimeter ambient air monitoring stations, 2005

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
Criteria pollutants				
Lead	K2, K6, K9, K11	Continuous	Weekly	Quarterly
Hazardous air pollutants carcinogen metals				
Arsenic	K2, K6, K9, K11	Continuous	Weekly	Quarterly
Beryllium	K2, K6, K9, K11	Continuous	Weekly	Quarterly
Cadmium	K2, K6, K9, K11	Continuous	Weekly	Quarterly
Chromium	K2, K6, K9, K11	Continuous	Weekly	Quarterly
Organic compounds				
Polychlorinated biphenyls	TSCAI[b] 1, 2	*c*	*c*	*c*
Furan	TSCAI 1, 2	*c*	*c*	*c*
Dioxin	TSCAI 1, 2	*c*	*c*	*c*
Hexachlorobenzene	TSCAI 1, 2	*c*	*c*	*c*
Radionuclides (by inorganic analysis)				
Uranium (total)	TSCAI 1, 2	*c*	*c*	*c*
Radionuclides (by radiochemical analysis)				
^{99}Tc, ^{237}Np, $^{238,239}Pu$, $^{234,235,236,238}U$	K2, K6, K9, K11	Continuous	Weekly	Quarterly

[a] Quarterly frequencies are composite sample analyses of all weekly samples collected over the identified period.

[b] Toxic Substances Control Act (TSCA) Incinerator.

[c] Stations are activated automatically only if a TSCA Incinerator operational upset occurs. Identified samples are then immediately submitted for analysis.

Table 4.15. Lead concentrations in ambient air at the ETTP, 2005

Annual average for all stations = 0.00057 μg/m^3

Station	Quarterly averages of monthly composites (μg/m^3)				Maximum quarterly result (μg/m^3)	Maximum percent of quarterly standard[a]
	1	2	3	4		
K2	0.00108	0.00042	0.00019	0.00041	0.00108	0.07
K6	0.00089	0.00025	0.00012	0.00036	0.00089	0.06
K9	0.00118	0.00048	0.00039	0.00047	0.00118	0.08
K11[b]	—	—	—	0.00071	0.00071	0.05
Quarterly average	0.00105	0.00038	0.00023	0.00041	0.00105	0.07
Quarterly maximum	0.00118	0.00048	0.00039	0.00071	0.00118	0.08

[a] Tennessee and national air quality standard for lead is 1.5 μg/m^3 quarterly arithmetic average.

[b] New station activated during the fourth quarter of 2005.

4.7.4 Radionuclide Levels

Total uranium metal was measured as quarterly composites from stations K2, K6, and K9. Station K11 results consisted of only 2 months of sampling. The total uranium mass for each sample was determined by the ICP-MS analytical technique. The annual uranium averages and maximum individual concentration measurements for all sites are presented in Table 4.17. The average annual results for each station ranged from a minimum of approximately 0.00001 to 0.00005 μg/m^3. The highest single quarterly result, 0.00014 μg/m^3, was measured at Station K2, which is in one of the prevailing wind directions from the TSCA Incinerator. The annual average value for all stations due to uranium was 0.00003 μg/m^3. The ICP-MS results are compared with a dose based on the DCG for natural uranium. (The DCG is based on an annual air concentration exposure that would give a dose of 100 mrem.) The sampling location with the highest annual average concentration of uranium was at K9. The annual result was only 0.00005 μg/m^3, which corresponds to 0.03% of the DCG (see Fig. 4.11 for 5-year uranium trend).

Periodic radiochemical analyses were initiated during 2000 on selected monthly composite samples collected at Stations K2, K6, and K9. For 2004, analyses were based on quarterly composite samples from these stations. The selected isotopes of interest were ^{237}Np, ^{238}Pu, ^{239}Pu, ^{99}Tc, and isotopic uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U). The resulting annual concentrations for all nuclides measured are presented in Table 4.18. Results from stations K2, K6, and K9 are averages of four quarterly composite sample analyses and represent an annual average for this report. Station K11 results consisted of only 2 months of sampling. For comparison, the total uranium results associated with ICP-MS analyses of composite samples are comparable with the uranium results determined by radiochemical techniques.

4.7.5 Organic Compound Levels

Currently, measurements of selected semivolatile organics are performed only during an operational upset of the TSCA Incinerator. The incinerator experienced one automatic thermal relief vent opening during 2005 due to a power loss in the ETTP distribution grid. This event occurred during the incineration of solid wastes. If an unplanned release occurred, organic compound ambient air sampling stations TSCA1 and TSCA2 (see Fig. 4.9) would be activated automatically or manually. However, the potential release of organic compounds from this event was established to be below levels that would be detectable by ambient air monitoring. This decision was based on the characterizations of the wastes being processed at that time of the event and on the current inventory in the incinerator. The calculated waste inventory could not produce a detectable off-site impact. Additionally, meteorological conditions would not carry any potential release from the vent in the direction of either sampling station. Therefore, the samplers were not activated for this event.

4.7.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 4.10 and 4.11 for lead and uranium, respectively. Variations of lead measurements were insignificant and most likely reflect background concentration variations of air quality. Uranium levels reflect typical levels that can be associated with normal ETTP operations.

Arsenic, beryllium, and cadmium measurements were initiated in 1993, and chromium measurements were initiated in 1986. Over the last 5 years, arsenic, cadmium, and chromium have been typically indistinguishable from background levels except during specific projects that have included major demolition activities. All beryllium measurements, historical and current, have been at or near analytical minimum detectable concentrations. During the 5-year period, no ambient air measurements have indicated any level of concern based on comparisons with any applicable standards.

4.8 ETTP Surface Water Monitoring

Surface water surveillance was conducted at nine locations at the ETTP (Fig. 4.12). Stations K-1710, MIK 1.4, and Clinch River kilometer (CRK) 23 provide information on conditions

Table 4.16. Hazardous air pollutant concentrations in ambient air at the ETTP, 2005

Parameter	Ambient air concentration ($\mu g/m^3$)			Percentage of standard[a]
	Annual average (all stations)	Quarterly maximum	Maximum station	
Arsenic	0.00019	0.00036	K2	8.2
Beryllium	0.000005	0.000055	K9	<0.1
Cadmium	0.00004	0.00008	K2	0.7
Chromium	0.00006	0.00015	K2	
Cr-111				<0.1
Cr-VI				6.4

[a]There are no Tennessee or national ambient air quality standards; however, annual averages are compared to risk-specific doses for As, Be, Cd, and Cr-VI and the reference air concentration for Cr-III as listed in 40 CFR 266.

Table 4.17. Total uranium in ambient air by inductively coupled plasma mass spectrometry analysis at the ETTP, 2005

Station	Samples	Concentration[a] ($\mu g/m^3$)		Concentration[a] ($\mu Ci/mL$)		Percent of DCG[b] (%)	
		Average	Maximum[c]	Average	Maximum[c]	Average	Maximum[c]
K2	4	0.000046	0.000140	3.09E-17	9.36E-17	0.03	0.09
K6	4	0.000008	0.000025	5.38E-18	1.69E-17	<0.01	0.02
K9	4	0.000050	0.000075	3.39E-17	4.99E-17	0.03	0.05
K11	1	0.000008	0.000008	5.35E-18	5.35E-18	<0.01	<0.01
ETTP total	13	0.000028	0.000140	1.87E-17	9.36E-17	0.02	0.09

[a]Mass-to-curie concentration conversions assume a natural uranium assay of 0.717% ^{235}U.
1 $\mu Ci = 3.7 \times 10^4 Bq$.

[b]DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1×10^{-13} $\mu Ci/mL$, which is equivalent to a 100-mrem annual dose.

[c]Maximum individual sample analysis result with dose calculations conservatively assuming the value to be an annual concentration.

Table 4.18. Radionuclides in ambient air by radiochemistry at the ETTP, 2005

Station	Concentration ($\mu Ci/mL$)[a]								
	^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{234}U	^{235}U	^{236}U	^{238}U	Total U
K2	ND	ND	5.28E-19	1.24E-15	2.17E-17	2.12E-18	2.18E-18	5.22E-17	7.82E-17
K6	ND	ND	1.13E-18	5.15E-16	9.36E-18	2.95E-18	7.89E-19	9.50E-18	2.26E-17
K9	4.58E-19	3.49E-18	1.75E-18	8.79E-16	8.19E-17	6.70E-18	5.84E-18	6.68E-17	1.61E-16
K11	ND	ND	ND	2.34E-16	4.23E-18	ND	ND	3.48E-18	7.71E-18

[a]K2, K6, K9 annual results are the average of four quarterly composite analyses. New station K11 was activated during the fourth quarter of 2005, and the result is based on a single composite sample.
1 $\mu Ci = 3.7 \times 10^4$ Bq.

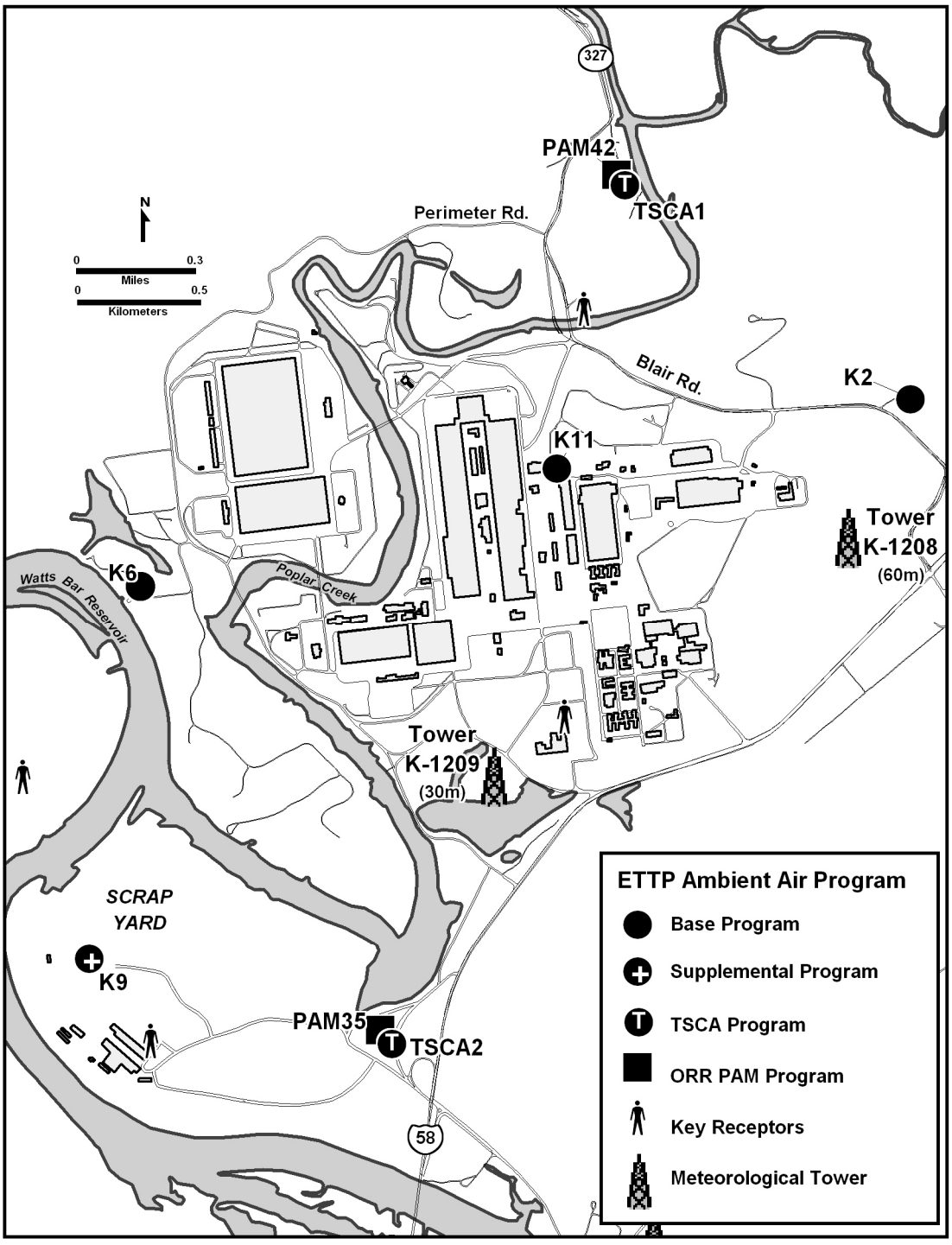


Fig. 4.9. Locations of ambient air monitoring stations at the ETTP.

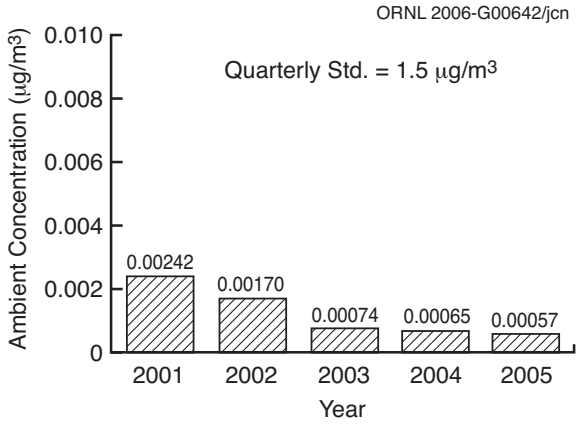


Fig. 4.10. Ambient air monitoring 5-year trend results for lead at the ETTP.

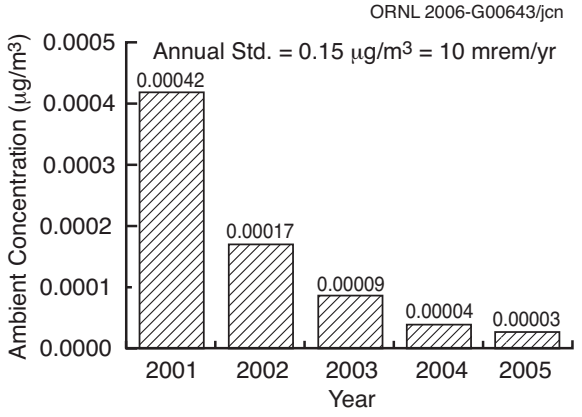


Fig. 4.11 Ambient air monitoring 5-year trend results for uranium at the ETTP.

upstream of the ETTP. Stations K-716 and CRK 16 are located downstream from most ETTP operations and provide information on the cumulative effects of the ETTP activities as well as those upstream. The remaining sampling locations are at points where drainage in the major surface water basins converges before discharging to Poplar Creek (Stations K-1007-B, K-700 Slough, and K-1700) or to the Clinch River (Station K-901-A). In 2005, the K-700 Slough was dropped from the monitoring program, and CRK 23 was added.

At most surveillance stations, semiannual sampling and analyses for radionuclides, metals, and field readings (dissolved oxygen, temperature, and pH) were conducted. At the Clinch River sites (CRK 16 and 23) volatile organic compounds were also monitored semiannually. Quarterly monitoring for volatile organics, metals, radionuclides and field readings, is conducted at the K-1700 and MIK 1.4 locations. Radionuclide results are compared with the DCGs. Nonradiological results are compared with Tennessee water quality standards for fish and aquatic life. The water quality standards use the numeric values given in the Tennessee general water quality criteria (TDEC 2004), which are a subset of the water quality standards.

In most instances, results of the monitoring for nonradiological parameters are well within the applicable standards. Heavy metals were often detected at CRK 16, K-901-A, and K-1700 (barium was the most common heavy metal detected), and certain volatile organics (primarily trichloroethane, vinyl chloride, and 1,2-dichloroethane) were regularly detected at K-1700, but in all instances the results were below the applicable water quality standard. Dissolved oxygen measurements at K-901-A fell below the minimum water quality standard of 5.0 mg/L during two summer sampling events, and once at K-1700, due to a combination of elevated temperatures and the stagnation due to very low flows at that location. Water bodies in the vicinity of the ETTP are regularly inspected for signs of stress on aquatic organisms during low-flow periods. For the remaining analyses, results were within the reference standards or below detection limits for the instrument and method. Moreover, analytical results for samples collected upstream of the ETTP were chemically similar in most respects to those collected below the ETTP.

The sum of the fractions of the DCGs for most stations remained below 1% of the DCG values for ingestion (Fig. 4.13). The highest sum of the fractions, 1.8% of the DCGs, was reported for sampling location K-1700. The results at the other surface water surveillance locations are all below 1% of the DCGs. These data are consistent with the historical results. Due to this stasis, monitoring at the surveillance locations will continue to be maintained at the reduced frequency until significant changes are detected or until ETTP operations change to include activities with the potential to affect discharges.

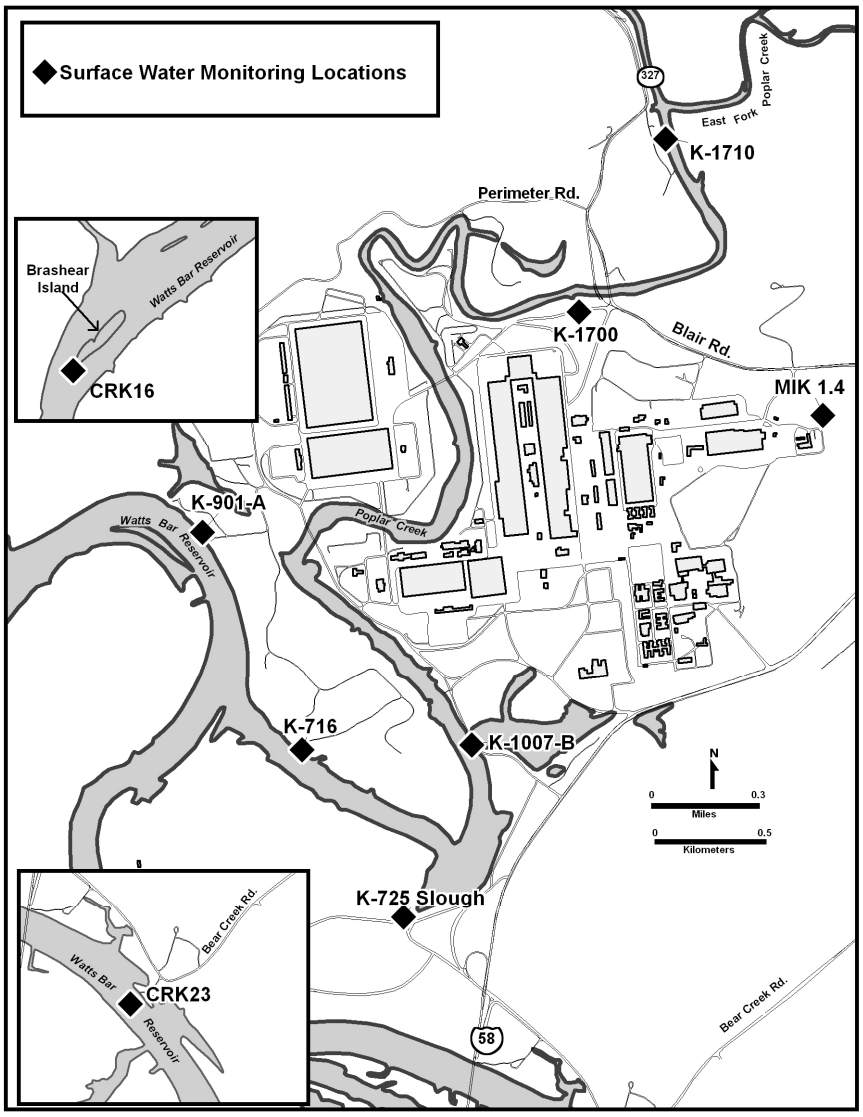


Fig. 4.12. Monitoring locations for surface water at the ETTP.

4.9 ETTP Groundwater Monitoring

Groundwater monitoring at the ETTP is focused primarily on investigating and characterizing sites for remediation under CERCLA. As a result of the Federal Facility Agreement and certification of closure of the K-1407-B and K-1407-C Ponds, the principal driver at the ETTP is CERCLA.

The cleanup strategy described in *Accelerating Cleanup: Paths to Closure* (DOE 1999a) has been developed to accelerate the transition of areas of concern from characterization to remediation by making decisions at the watershed scale based on recommended land use. The watershed is a surface-drainage basin that includes an area of concern (AOCs) or multiple AOCs to be investigated and/or remediated. This approach allows for the systematic monitoring and evaluation of contaminant sources and migration through the use of integrated surface-water and groundwater monitoring.

ETTP Groundwater Protection Program requirements are incorporated into the Water Resources Restoration Program. The Water Resources Restoration Program, which was established to provide a consistent approach to watershed monitoring across the ORR, is responsible for conducting groundwater surveillance monitoring at the ETTP, including exit pathway monitoring wells. Groundwater dis-

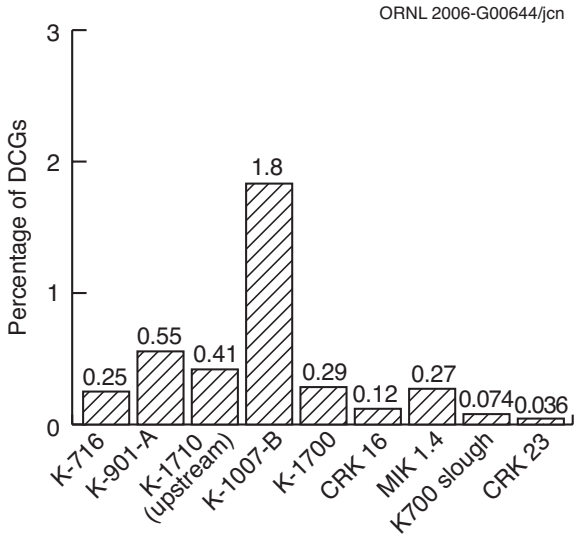


Fig. 4.13. Percentage of DOE derived concentration guides for ETTP surface water monitoring locations.

charges into Poplar Creek, the Clinch River, and the three main surface water bodies at ETTP (the K-901 Pond, K-1007 Pond, and Mitchell Branch). Many of the contaminants at ETTP migrate toward one of these surface water bodies, which are monitored by the ETTP Environmental Monitoring Plan surface water surveillance program. The 2005 *Remediation Effectiveness Report* (DOE 2006b) includes summaries of groundwater monitoring actions required for individual cleanup actions at the ETTP, along with recommendations to modify any requirements that would further ensure protection of human health and the environment.

4.10 ETTP Direct Radiation

The UF_6 cylinder storage yards and K-770 Scrap Yard at ETTP are potential sources of direct gamma and neutron radiation exposure to the public. Measured exposure rates and a hypothetical model of a maximally exposed individual were used to calculate theoretical doses. The calculated effective dose equivalents (EDEs) were based on gamma and neutron dose rates measured at the K-1066-J and K-1066-E Cylinder Yards along the near bank of Poplar Creek, the parking lot adjacent to the K-1066-K Cylinder Yard, and the near bank of the Clinch River in the vicinity of the K-770 Scrap Yard. The dose levels to the public calculated from the measured exposure rates are less than the 100-mrem/year limit established by DOE Order 5400.5.

Gamma and neutron dose rates from each area were measured in February 2005 with tissue-equivalent dose rate meters. Background readings were established at the ambient air monitoring stations north and northeast of ETTP off Blair Road, south and southwest of ETTP in the Powerhouse Area, and west of ETTP at the K-901 pumping station. The average gamma background was 0.004 mrem/h. The average neutron background was 0.002 mrem/h.

The potential maximally exposed individual model used for exposure from the K-1066-J or K-1066-E Cylinder Yard is a hypothetical fisherman who was assumed to have spent 250 h/year near the point of average exposure. This hypothetical individual could have received an EDE above background of about 0.25 mrem from gamma radiation and 0.25 mrem from neutron radiation along the bank of Poplar Creek near the K-1066-J Cylinder Yard, or 0.75 mrem from gamma radiation and 0.50 mrem from neutron radiation along the bank of Poplar Creek near the K-1066-E Cylinder Yard during 2005. This section of the creek runs through the ETTP plant and is used at times by fishermen; however, it is very unlikely that anyone would fish this stretch of Poplar Creek for 250 h/year.

General area dose rates were recorded in the vicinity of the K-770 Scrap Yard, along the near bank of the Clinch River. A hypothetical fisherman who was assumed to have spent 250 h/year near the point of average exposure could have received an EDE above background of about 0.25 mrem from gamma radiation and 0.25 mrem from neutron radiation along the bank of the Clinch River near the K-770 Scrap Yard during 2005.

The parking lot adjacent to the K-1066-K Cylinder Yard is used by workers and the public; therefore, it was included in the survey. This parking lot is intended for employees and has no public facilities. A potential maximally exposed individual is someone assumed to have spent 30 min per work day (125 h/year) waiting in the parking lot at the point of average exposure along the edge closest to the K-1066-K Cylinder Yard. This hypothetical individual could have received an EDE above background of about 0.75 mrem from gamma radiation and 0.25 mrem from neutron radiation during 2005.

4.11 Modernization and Reindustrialization

DOE-ORO established the Reindustrialization Program in 1996 as an innovative way to address some of the environmental and financial challenges left at the end of the Cold War. Under the program, transfers of excess or underutilized land and facilities are made available. The goal is to accelerate cleanup by reducing costs, while allowing for the productive use of the assets by the private sector. The process helps to offset negative impacts on the community caused by DOE downsizing, facility closeouts, and workforce restructuring. DOE-ORO worked with local officials and business leaders to establish the Community Reuse Organization of East Tennessee (CROET). Through CROET, the Reindustrialization Program has successfully leased land and facilities at the ETTP. DOE-ORO has transitioned to an accelerated cleanup of ETTP in preparation for its closure as a DOE site. ETTP will then be available for use as a private-sector industrial park. As part of this accelerated process, the emphasis is on facility transfer of ownership (title transfer).

In 2003, DOE-ORO completed a "finding of no significant impact" (FONSI) to allow the transfer of property to Horizon Center LLC. The property, in the past known as Parcel ED-1, only consists of the portions suitable for development. The remainder of the property, known as the Natural Area, will continue to be leased by Horizon Center LLC and owned by DOE.

DOE has been working with the state of Tennessee to grant the state an indefinite-term conservation easement of approximately 1,214 hectares to be located on the west end of the ORR. This action, the result of an agreement-in-principle related to the Natural Resources Damage Act affecting the ORR, was granted in early 2005.