4. ETTP Environmental Monitoring Programs

The East Tennessee Technology Park (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 their emission points 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 2002, the emissions of radionuclides from ETTP operations were well within the allowable derived concentration guides published in DOE Order 5400.5, and were similar in most respects to 2001emissions. Potential direct radiation to the public from uranium hexafluoride cylinder storage yards 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

In order 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., 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 from operators subject to NESHAP regulations. For 2002, other prime contractors working directly for DOE at ETTP were also subject to NESHAP; data were obtained from the applicable sources and are reported here. 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 EPA-approved calculation methods.

4.1.1 Radionuclide Emissions Monitoring Approach

4.1.1.1 Minor sources

The number of minor sources in 2002 varied from the previous year's total because of fluctuations in site operations. For this reporting period, a total of eight 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. The one grouped minor source is the TSCA Incinerator tank farm, a group of 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)—six point sources and one grouped source,
- health physics air measurements where room ventilation emissions exceeded 10% of

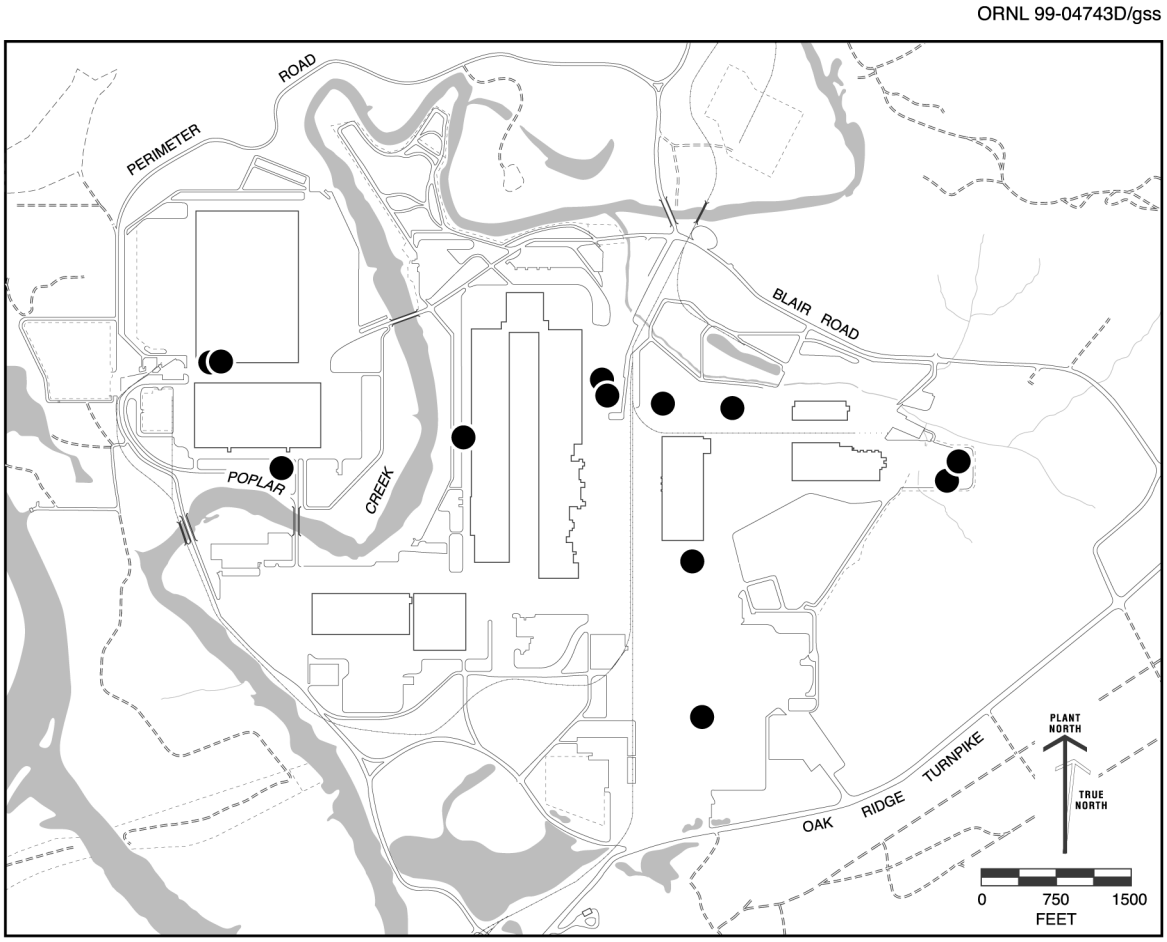


Fig. 4.1. Locations of airborne radionuclide point sources at the ETTP.

derived air concentration worker protection guidelines—no sources,
- surrogate emission data from similar sources—one point source, 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

1. emissions from shutdown buildings;
2. resuspension of contaminated soils, debris, or other materials;
3. unventilated tanks;
4. wastewater treatment systems;
5. outdoor storage and processing areas;
6. emissions from piping, valves, or other piping equipment and pump components; and
7. 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

Three ETTP major sources operated during 2002. Radionuclide emission measurements from the 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.

BNFL, Inc., operated two sources in the K-33 building requiring the continuous monitoring of radiological emissions. The decontamination and decommissioning workshop has two identical atmospheric release points, each equipped with a particulate filtration system and a continuous sampling device. The supercompactor vent continuous sampling system is the same design as the decontamination and decommissioning workshop units.

4.1.2 Results

The ETTP 2002 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 TDEC Division of Air Pollution Control, the ETTP has eight major air emission sources listed as subject to Tennessee Title V Major Source Operating Permit program rules. 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. Beginning in 1999, the ETTP steam plant was transferred to CROET and is no longer included in the ASER. The ETTP paid an annual fee in 2002 amounting to $13,800.50 and represents an increase in the fee rate from $13.00 to $17.50 per ton of emissions from the previous payment period. Table 4.3 shows the inventoried regulated emissions during 2002 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. Thus, actual emissions from the incinerator are inventoried with respect to determining the ETTP annual fee. 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 (Outfall 014). Weekly samples were collected from the Central Neutralization Facility and were composited into monthly samples. These samples were then analyzed for radionuclides. Results of these sampling efforts were compared with the derived concentration guides (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

Table 4.1. East Tennessee Technology Park radionuclide air emission totals, 2002 (Ci)[a]

Radionuclide	Total major	TSCAI (major)[b]	Total minor	Total ETTP
^{228}Ac	–	–	3.00E–09	3.00E–09
^{241}Am	–	–	6.02E–07	6.02E–07
^{214}Bi	–	–	3.07E–09	3.07E–09
^{109}Cd	–	–	1.00E–09	1.00E–09
^{14}C	3.78E–05	3.78E–05	8.28E–05	1.21E–04
^{144}Ce	–	–	6.26E–14	6.26E–14
^{134}Cs	–	–	7.35E–10	7.35E–10
^{137}Cs	1.52E–04	1.52E–04	1.73E–05	1.70E–04
^{57}Co	–	–	5.00E–09	5.00E–09
^{60}Co	–	–	2.15E–06	2.15E–06
^{244}Cm	–	–	5.14E–19	5.14E–19
^{152}Eu	–	–	8.00E–09	8.00E–09
^{154}Eu	–	–	4.00E–09	4.00E–09
^{131}I	–	–	8.70E–08	8.70E–08
^{85}Kr	1.79E–03	1.79E–03	1.96E+02	1.96E+02
^{210}Pb	–	–	1.34E–06	1.34E–06
^{214}Pb	–	–	4.02E–09	4.02E–09
^{237}Np	5.58E–07	5.58E–07	8.65E–07	1.42E–06
^{93m}Nb	–	–	2.67E–15	2.67E–15
^{95}Nb	–	–	9.00E–09	9.00E–09
^{238}Pu	9.55E–05	9.55E–05	4.72E–07	9.60E–05
^{239}Pu	2.69E–05	2.69E–05	3.78E–07	2.73E–05
^{40}K	–	–	2.27E–07	2.27E–07
^{233}Pa	–	–	3.00E–09	3.00E–09
^{234}Pa	–	–	2.00E–09	2.00E–09
^{234m}Pa	4.61E–03	4.61E–03	2.37E–08	4.61E–03
^{226}Ra	–	–	7.35E–07	7.35E–07
^{103}Ru	–	–	1.53E–14	1.53E–14
^{110m}Au	–	–	7.66E–14	7.66E–14
^{89}Sr	4.44E–06	4.44E–06	6.56E–11	4.44E–06
^{90}Sr	–	–	6.68E–07	6.68E–07
^{99}Tc	3.53E–04	3.53E–04	4.97E–05	4.03E–04
^{125m}Te	–	–	1.11E–15	1.11E–15
^{208}Tl	–	–	1.86E–13	1.86E–13
^{228}Th	4.35E–05	4.35E–05	1.33E–07	4.36E–05
^{230}Th	1.72E–04	1.72E–04	3.09E–07	1.73E–04
^{231}Th	–	–	2.11E–07	2.11E–07
^{232}Th	6.99E–05	6.99E–04	1.12E–07	7.00E–05
^{234}Th	2.37E–03	2.37E–03	1.79E–04	2.55E–03
^{3}H	7.52E+01	7.52E+01	2.88E–01	7.55E+01
^{233}U	–	–	6.26E–06	6.26E–06
^{234}U	5.59E–04	5.34E–04	1.45E–04	7.05E–04
^{235}U	2.65E–04	2.64E–04	7.72E–06	2.73E–04
^{236}U	–	–	2.35E–06	2.35E–06
^{238}U	8.67E–04	8.64E–04	2.88E–04	1.16E–03
^{65}Zn	–	–	2.16E–14	2.16E–14
Totals	7.52E+01	7.52E+01	1.97E+02	2.72E+02

[a]1 Ci = 3.7E+10 Bq.
[b]Toxic Substances Control Act Incinerator.

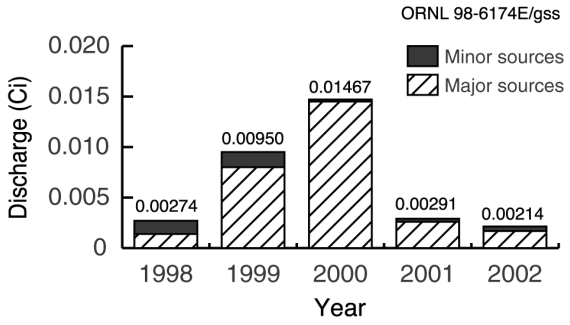


Fig. 4.2. Total curies of uranium discharged from the ETTP to the atmosphere, 1998–2002.

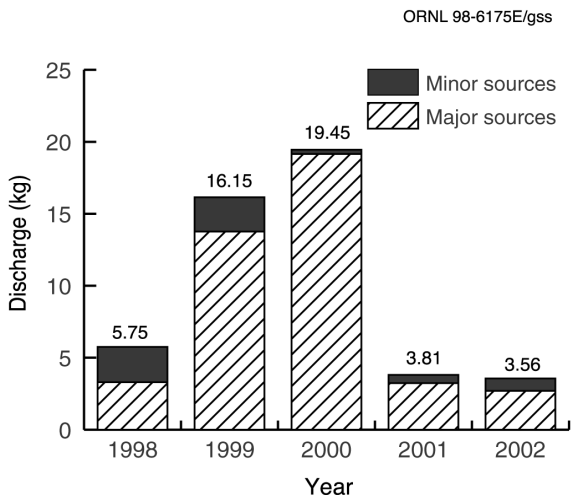


Fig. 4.3. Total kilograms of uranium discharged from the ETTP to the atmosphere, 1998–2002.

Table 4.2. Allowable emissions of criteria pollutants from the East Tennessee Technology Park, 1998–2002

Pollutant	Allowable emissions (tons/year)				
	1998	1999	2000	2001	2002
Particulate matter	192	13	13	13	13
Volatile organic compounds	122	14	14	14	14
Sulfur dioxide	427	39	39	39	39
Nitrogen oxides	185	20	20	20	20
Carbon monoxide	147	20	19	19	19
Hazardous air pollutants	24	21	20	21	21
Miscellaneous	0	0	0	0	0
Total	1097	127	125	126	126

Table 4.3. Actual emissions of criteria pollutants from permitted East Tennessee Technology Park sources, 2002

Pollutant	Actual emissions	
	lb/year	tons/year
Particulate matter	248.5	0.124
Volatile organic compounds	679.9	0.34
Sulfur dioxide	4.7	0.002
Nitrogen oxides	24,857	12.43
Carbon monoxide	5,711	2.86

Table 4.4. Actual vs allowable air emissions from the Toxic Substances Control Act Incinerator at the East Tennessee Technology Park, 2002

Pollutant	Emissions (tons/year)		Percentage of allowable
	Actual[a]	Allowable	
Lead	0.006	0.575	1.0
Beryllium	0.00003	0.00037	8.5
Mercury	0.0003	0.088	0.3
Hydrogen fluoride	0.003	2.98	0.1
Hydrogen chloride	0.056	16.12	0.3
Sulfur dioxide	0.002	38.5	>0.1
Particulate matter	0.124	13.1	0.9

[a]Actual emissions based on removal efficiencies measured during the permit-required air emission test conducted during 2000 with the exception of hydrogen fluoride, which is based on the CY 1995 test.

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 NPDES outfalls.

4.3.2 Results

The sum of the fractions of the DCGs at the Central Neutralization Facility was calculated at 18.8% for 2002, up from 14.6% in 2001. Table 4.5 lists radionuclides discharged from the ETTP Central Neutralization Facility to off-site surface waters in 2002. Total uranium discharges from the Central Neutralization Facility were 0.007 Ci in 2002. Total discharge of transuranics was 0.000057 Ci, which is more than two 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, the allowable DCGs for these isotopes are greater than for the uranium isotopes, so their contribution to the sum of the fractions of the DCG is relatively small. Uranium discharges from the Central Neutralization Facility during a 5-year period were investigated to observe their trend (Fig. 4.5). Uranium isotopes were the major contributors to the fraction of the DCG, contributing half of the sum of the fraction of the DCG (Fig. 4.6). Lead-210 accounted for approximately one-third of the total fraction of the DCGs, although it was only detected in a single month's sample. The total activity level of the ^{210}Pb was only moderate, but the allowable DCG for this isotope is very small (only 30 pCi/L). Each of the remaining isotopes individually accounted for less than one percent of the allowable DCG. TSCA Incinerator wastewater, which is sent to the Central Neutralization Facility for treatment before discharging at Outfall 014, 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) went into effect on October 1, 1992, and a major modification was issued effective June 1, 1995. The modification included removal of inactive outfalls, addition of effluent limits for new treatment technologies at the Central Neutralization Facility, addition of new storm drains, and clarification of various requirements.

In accordance with this NPDES permit, the ETTP is authorized to discharge process wastewater, cooling water, storm water, steam condensate, and groundwater to the Clinch River, Poplar Creek, and Mitchell Branch. The permit currently includes 2 process outfalls and 136 storm water outfalls. Compliance with the permit for the last 5 years is summarized in Fig. 4.7. Table 4.6 details the permit requirements and compliance records for all of the outfalls that discharged during 2002. The table provides a list of the discharge points, effluent analytes, permit limits, number of noncompliances, and the percentage of compliance for 2002. Samples from these outfalls are collected and analyzed as specified in the NPDES permit.

The two permitted outfalls on the ETTP are Outfall 005, the permitted outfall for discharge of treated effluent from the K-1203 Sewage Treatment Plant to Poplar Creek, and Outfall 014,

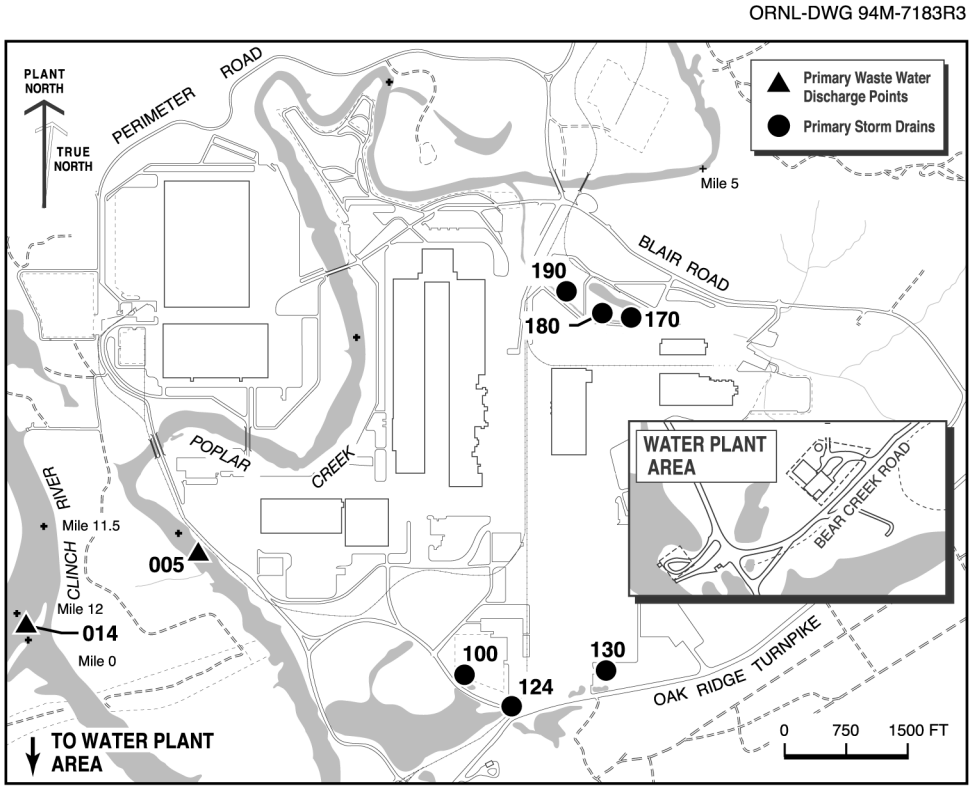


Fig. 4.4. ETTP National Pollutant Discharge Elimination System major outfalls and Category IV storm water outfalls.

Table 4.5. Radionuclides released to off-site surface waters from the East Tennessee Technology Park, 2002
Effluent discharge location: Central Neutralization Facility

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{241}Am	2.9E–5	^{239}Pu	6.5E–6
^{14}C	3.6E–2	^{90}Sr	4.1E–5
^{137}Cs	9.7E–4	^{99}Tc	2.0E–2
^{60}Co	8.2E–6	^{228}Th	4.6E–6
^{3}H	8.8E–2	^{230}Th	8.3E–5
^{131}I	7.4E–5	^{234}Th	6.1E–4
^{40}K	5.0E–4	^{234}U	2.5E–3
^{237}Np	1.7E–5	^{235}U	1.9E–4
^{210}Pb	2.0E–4	^{236}U	1.2E–4
^{238}Pu	4.3E–6	^{238}U	4.3E–3

[a]1 Ci = 3.7E+10 Bq.

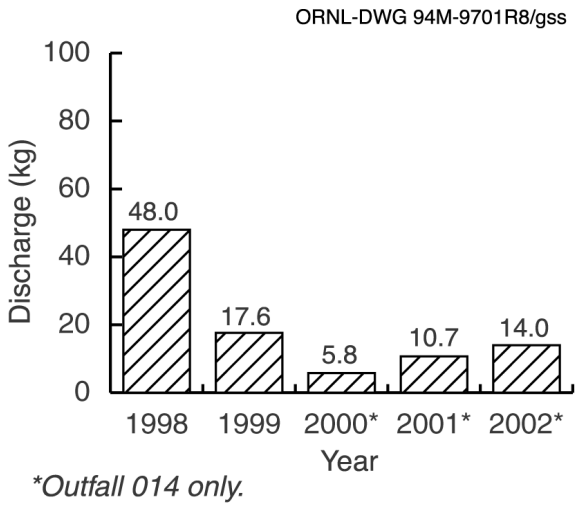


Fig. 4.5. Five-year trend of uranium releases to surface waters from the ETTP (Outfalls 005 and 014).

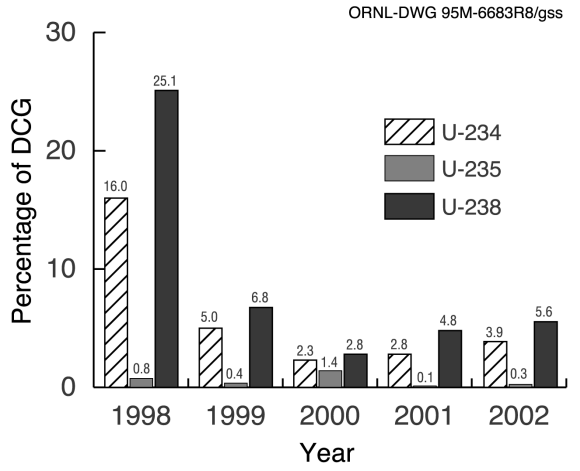


Fig. 4.6. Percentage of DOE derived concentration guides for uranium isotopes from K-1407-J (Outfall 014).

the permitted outfall for the discharge of effluent from the Central Neutralization Facility to the Clinch River.

The current ETTP NPDES Permit expired on September 29, 1997. An application for renewal of this permit was submitted to TDEC in March 1997. To facilitate the transfer of ownership and operation of ETTP facilities to other parties, it was determined that separate NPDES permits would be required for each of the ETTP treatment facilities. In addition, it was determined that a separate NPDES permit for the storm water drainage system would be necessary. A general NPDES

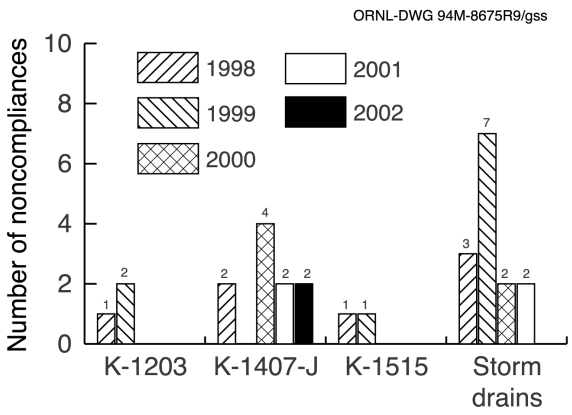


Fig. 4.7. ETTP National Pollutant Discharge Elimination System compliance history by source of noncompliance.

permit for former outfalls 009 (K-1515 Sanitary Water Plant) and 013 (K-1513 Sanitary Water Intake Backwash Filter) was issued on January 14, 2000, and became effective on March 1, 2000. The issuance of this permit (Permit Number TN0074233) allowed outfalls 009 and 013 to be removed from ETTP NPDES Permit Number TN0002950. The K-1203 Sewage Treatment Plant, the Central Neutralization Facility, and the ETTP storm water outfalls will continue to discharge under NPDES Permit Number TN0002950 until new NPDES permits for these outfalls are issued.

4.4.1 Results

The ETTP had two NPDES noncompliances in 2002, both at the Central Neutralization Facility (NPDES outfall 014). The total suspended solids concentration was measured at 43 mg/L in a sample collected from outfall 014 on June 19, 2002. This measurement exceeded the ETTP's NPDES permit limit for total suspended solids at outfall 014, which is 40 mg/L. An investigation of the noncompliance was conducted, but no root cause could be identified. Samples collected from outfall 014 on June 17, 2002 and June 20, 2002 had nondetectable levels of total suspended solids.

On November 12, 2002, the required monthly NPDES permit compliance grab sample for total petroleum hydrocarbons was collected from outfall 014. The result, 2.5 mg/L, exceeded ETTP's NPDES permit limit for total petroleum hydrocarbons at outfall 014, which is a daily maximum concentration of 0.1 mg/L. A duplicate

Table 4.6. National Pollutant Discharge Elimination System compliance at the ETTP, 2002

Discharge point	Effluent parameter	Effluent limits				No. of noncompliances	Percentage of compliance
		Monthly avg[a]	Daily max[a]	Monthly avg (lb/day)	Daily max (lb/day)		
Outfall 005 (K-1203 Sewage Treatment Facility)	Ammonia nitrogen	5	7	27	38		100
	Biochemical oxygen demand	15	20	81	109		100
	Chlorine, total residual	0.14	0.24				100
	Dissolved oxygen		5[b]				100
	Fecal coliform, col/100 mL	200[c]	1,000				100
	LC_{50}, *Ceriodaphnia*, %		14.6[d]				100
	LC_{50}, *Pimephales*, %		14.6[d]				100
	NOEL,[e] *Ceriodaphnia*, %		4.2[d]				100
	NOEL,[e] *Pimephales*, %		4.2[d]				100
	pH, standard units		6.0–9.0				100
	Settleable solids, mL/L		0.5				100
	Suspended solids	30	45	27	244		100
Outfall 014 (K-1407-J Central Neutralization Facility to Clinch River)	Benzene	*d*	0.005				100
	Cadmium	0.18	0.69				100
	Carbon tetrachloride	0.5	0.5				100
	Chloride, total	35,000	70,000				100
	Chlorine, total residual		1.0				100
	Chloroform	0.5	0.5				100
	Chromium	1.71	2.77				100
	Copper	1.34	2.15				100
	Ethylbenzene		0.01				100
	Lead	0.38	0.69				100
	Nickel	2.38	3.98				100
	Oil and grease		30				100
	PCB	0.00022	0.00045				100
	Petroleum hydrocarbons		0.1			1	92
	pH, standard units		6.0–9.0				100
	Silver	0.24	0.43				100
	Suspended solids		40			1	99.5
	Tetrachloroethylene		0.7				100
	Toluene		0.01				100
	Total toxic organics		2.13				100
	Trichloroethylene	0.5	0.5				100[f]
	Vinyl chloride	0.2	0.2				100[f]
	Zinc	1.48	2.61				100[f]
	Unpermitted discharge	*f*	*f*				*f*
	Missed sample	*f*	*f*				*f*
Category I storm drains	pH, standard units		4.0–9.0				100
Category II storm drains	pH, standard units		4.0–9.0				100
Category III storm drains	pH, standard units		4.0–9.0				100
Category IV storm drains (to Poplar Creek)	Chlorine, total residual		0.14				100
	pH, standard units		6.0–9.0				100
Category IV storm drains (to Mitchell Branch)	Chlorine, total residual		0.019				100
	pH, standard units		6.0–9.0				100

[a]Units are mg/L unless otherwise stated.
[b]Daily minimum.
[c]Geometric mean.
[d]Toxic if LC_{50} <14.6% effluent or no observed effect level < 4.2%.
[e]No observable effect level.
[f]Not applicable.

grab sample collected on the same day was analyzed by the laboratory, and total petroleum hydrocarbons was not detected (<1.0 mg/L). In accordance with the NPDES permit, the average of the two sample results (<1.8 mg/L) was reported. An investigation of the noncompliance was conducted, but no root cause could be identified. Operational samples collected at various locations in the Central Neutralization Facility's carbon adsorption system did not indicate elevated levels of total petroleum hydrocarbons.

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.

Based on knowledge of past processes and activities at the ETTP, only parameters of particular concern were monitored during 2002. These parameters include gross alpha radioactivity, gross beta radioactivity, PCBs, mercury, metals, and volatile organic compounds. Gross alpha and gross beta radioactivity were monitored at those storm drain outfalls where they were detected at levels above screening criteria during more than one previous sampling effort. PCBs were monitored at those storm drain outfalls where they were detected above the detection limit of the analytical method. Metals were monitored at those locations where they were detected in amounts exceeding the screening criteria during more than one previous sampling effort and that may have received runoff from cooling tower areas. Volatile organics were monitored at those storm drain locations that are potentially affected by contaminated groundwater plumes and at locations where they were detected in amounts exceeding the screening criteria during more than one previous sampling effort.

All storm water samples were collected according to guidelines stated in Sect. 7.4 of the *ETTP Storm Water Pollution Prevention Program Baseline Document*, (BJC 2002a). Selected outfalls were sampled in both wet and dry weather conditions.

4.5.2 Storm Water Monitoring Results

4.5.2.1 Radiological Monitoring of Storm Water Discharges

The ETTP conducts radiological monitoring of storm water discharges to determine compliance with applicable dose standards. It also applies the ALARA process to minimize potential exposures to the public.

Sampling for gross alpha and gross beta radioactivity, as well as specific radionuclides, was conducted as part of the 2001–2002 Storm Water Pollution Prevention Program sampling effort. Analytical results were used to estimate the total discharge of each radionuclide from ETTP via the storm water discharge system.

The radionuclides discharged from the ETTP storm water system in 2002 are listed in Table 4.7. In the 2002 monitoring effort, exceedances of alpha/beta screening criteria were determined to be due to ^{99}Tc and uranium isotopes. Uranium discharges from ETTP storm water outfalls totaled 0.023 Ci in 2002. Technetium discharges from ETTP storm water outfalls totaled 0.037 Ci, while discharges of ^{40}K totaled 0.019 Ci in 2002. All other detected isotopes were at levels at least an order of magnitude less than these three elements. Table 4.8 summarizes the maximum exceedances

Table 4.7. Radionuclides released to off-site surface waters from the East Tennessee Technology Park storm water system, 2002

Radionuclide	Amount (Ci)[a]	Radionuclide	Amount (Ci)[a]
^{137}Cs[b]	–9.8E–5	^{99}Tc	3.7E–2
^{40}K	1.9E–2	^{234}U	1.6E–2
^{237}Np	2.9E–7	^{235}U	6.8E–4
^{238}Pu[b]	1.6E–5	^{236}U	1.9E–4
^{239}Pu	1.6E–5	^{238}U	6.1E–3

[a]1 Ci = 3.7E+10 Bq.
[b]All results less than or equal to laboratory error values.

Table 4.8. Maximum exceedances of radiological screening criteria for each storm water outfall (pCi/L)[a]

Storm water outfall	Alpha	Beta	$^{233/234}U$	^{235}U	^{238}U
160	1020	421	592	26.8	109
180	20.6				
190	105	87.6	49.6		28.2
292	227	116	121		72.9
350	25.2				
490	17.3	81.5			
724	119	441	53.6		38.4
760	33	64.3	21.4		

[a]Screening criteria are 15 pCi/L alpha radiation, 50 pCi/L beta radiation, 20 pCi/L ^{234}U, 24 pCi/L ^{235}U, and 24 pCi/L ^{238}U.

of storm water screening criteria for radionuclides for each outfall measured as part of the 2001–2002 Storm Water Pollution Prevention Program.

Sampling for gross alpha radiation, gross beta radiation, transuranics, and isotopic uranium was also performed at these storm water outfall locations: SD-124, SD-170, SD-297, SD-320, SD-332, SD-360, SD-380, SD-996.

No maximum contaminant levels for gross alpha or gross beta radiation were exceeded in samples from any of these locations. In addition, no levels of transuranics or isotopic uranium exceeding 4% of the DCG level were detected in samples from any of these outfalls.

4.5.2.2 Nonradiological Monitoring of Storm Water Discharges

Grab samples for PCBs were collected at SD-100, SD-350, and SD-710. No detectable PCBs were found in samples from any of these locations. Table 4.9 provides a summary of those sample results that exceeded the screening criteria for one or more of the nonradiological parameters of interest.

The presence of volatile organic compounds at SD-180 and SD-190 is believed to be due to the discharge of contaminated groundwater and not to the discharge of contaminated storm water runoff. The contaminated groundwater plumes will be addressed as part of the ETTP Sitewide Record of Decision.

4.5.2.3 Sump Data

Sump S-048 is located in Building K-1210. This sump collects groundwater from underneath the building and pumps it to the storm water system. Gross beta radiation was detected at a level of 57.9 pCi/L, which exceeds the maximum contaminant level of 50 pCi/L for this analyte. Additional efforts will be undertaken to identify potential sources of radioactive contamination in this sump.

No gross alpha or gross beta contamination above the maximum contaminant level was found at any of the other sumps that were sampled as part of the 2001–2002 Storm Water Pollution Prevention Program sampling effort. In addition, no levels of transuranics or isotopic uranium exceeding 4% of the DCG level were detected in samples from any of the sumps sampled as part of the 2001–2002 program.

Three sumps that were sampled for volatile organic compounds contained trichloroethene. No other volatile organics were detected at levels above the Tennessee water quality criteria at any of the other sumps sampled as part of the 2001–2002 Storm Water Pollution Prevention Program sampling effort.

PCBs were commonly used in electrical equipment until a few years ago and have been found in several components of the ETTP electrical power distribution system. In 2002, three sumps contained detectable levels of PCBs.

Table 4.9. Maximum exceedances of nonradiological screening criteria for each storm water outfall (µg/L)

Outfall	Parameter	Monitoring result	Criteria
160	Tetrachloroethene	7	5
180	Trichloroethene	12	5
180	Vinyl chloride	4	2
190	1,1-Dichloroethene	13	7
190	Trichloroethene	34	5
190	Vinyl chloride	180	2
190	PCB	0.8	Detection
190	Nickel	199	100
724	Aluminum	123	100

All three sumps discharge to an oil-water separator before discharging to the Clinch River through storm water outfall SD-440. PCBs were not found in detectable concentrations in any of the other sumps that were sampled as part of the 2001–2002 Storm Water Pollution Prevention Program sampling effort.

4.5.2.4 Sediment Monitoring at Storm Drains and Oil/Water Separators

As part of the 2001–2002 Storm Water Pollution Prevention Program sampling effort, sediment samples were collected and analyzed for PCBs at several oil/water separators and storm drain locations around ETTP. This sampling effort was performed in conjunction with the ongoing PCB bioaccumulation study in clams, which is being conducted by ORNL. Cages containing the clams were placed in several locations around ETTP in the month of June. The clams were removed and prepared for analysis in the month of July. The sediment sampling effort was conducted as soon as possible after the clams had been removed from the sampling locations.

All sediment samples were analyzed for PCBs. Sediment samples were collected near the terminus of storm water outfall pipes and near the discharge pipes inside the oil/water separators. All sediment samples were collected in accordance with accepted procedures and protocols. The screening level for all PCB aroclors is any amount that exceeds the detection limit for the compound. PCBs are generally reported as being undetected at levels below 1 µg/g. Table 4.10 provides a summary of the storm water outfall samples with detectable PCB results in the sediment.

PCBs were detected at only one of the six oil/water separators that were sampled as part of this effort. Aroclor-1260 was detected at a concentration of 7.8 µg/g in oil skimmer K-897-N. This area is no longer in operation, and all oil-filled equipment has been removed.

Table 4.10. PCBs detected in sediment at storm water outfalls

Arochlor	Results (µg/g)
Outfall 100	
1248	21
1254	15
1260	16
Outfall 190	
1254	7
1260	32
Outfall 490	
1260	1.4

4.6 ETTP TOXICITY CONTROL AND MONITORING PROGRAM

The NPDES permit requires that biannual toxicity testing be performed at Outfall 005 (the Sewage Treatment Plant). Operations Management International currently manages the water treatment plant and the sewage treatment plant as well as some aspects of the storm drain network. The results of the toxicity tests of wastewaters conducted during 2002 are given in Table 4.11, which also provides the wastewater's no-observed-effect concentration (NOEC) and lethal concentration for 50% of the test organisms (LC_{50}) for fathead minnows (*Pimephales promelas*) and *Ceriodaphnia dubia* for each test. Average water quality measurements obtained during each toxicity test are shown in Table 4.12.

Effluent from Outfall 005 was tested two times during 2002 with fathead minnows and *Ceriodaphnia*. In all tests, samples did not reduce survival, growth, or reproduction. Thus all NOEC and the LC_{50} results were within the permit limits.

4.7 ETTP BIOLOGICAL MONITORING AND ABATEMaENT PROGRAM

The 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. The BMAP consists of four tasks: (1) toxicity monitoring, (2) bioaccumulation monitoring, (3) ecological surveys of instream communities (both fish and benthic macroinvertebrates), and (4) waterfowl monitoring.

4.7.1 Toxicity Monitoring

The toxicity monitoring task for the BMAP includes tests of effluent from treatment facilities (see Sect. 4.6) and effluent from storm drains SD-170, SD-180, and SD-190 concurrently with surface water from six ambient sites in Mitchell Branch [Mitchell Branch kilometer (MIK) 0.12, MIK 0.45, MIK 0.54, MIK 0.71, MIK 0.78, and MIK 1.43]. (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 SD-170

Table 4.11. East Tennessee Technology Park National Pollutant Discharge Elimination System Permit Number TN 0002950 toxicity tests results, 2002

ETTP Outfall	Test date	Species	NOEC[a] (%)	LC_{50}[b] (%)	IWC[c] (%)
Outfall 005	April–May	Fathead minnow	4.2	>14.6	2.2
		Ceriodaphnia	4.2	>14.6	2.2
	November	Fathead minnow	4.2	>14.6	2.3
		Ceriodaphnia	4.2	>14.6	2.3

[a]No-observed-effect concentration.
[b]96-h lethal concentration for 50% of the test organisms.
[c]Instream waste concentration (based on critical low flow of Poplar Creek).

Table 4.12. East Tennessee Technology Park average water quality parameters measured during toxicity tests of Outfall 005 effluent, 2002
Values are averages of full-strength wastewater for each test (N = 6 or 7)

ETTP Outfall	Test date	pH (standard units)	Conductivity (μS/cm)	Alkalinity (mg/L $CaCO_3$)	Hardness (mg/L $CaCO_3$)
Outfall 005	April–May	8	230	90	140
	November	8.2	250	100	180

and SD-190 for toxicity four times during 2002. Full-strength effluent from SD-170 reduced *Ceriodaphnia* reproduction in two of four tests. In the tests of effluent from SD-190, full-strength concentrations resulted in the mortality of all of the test organisms in all four tests. Therefore, no evaluation of effects on reproduction was possible. This is consistent with the results for the last three years. However, tests of full-strength effluent using fathead minnows (*Pimephales promelas*) exhibited no reduction in either survival or growth in any of the four tests in 2002. Effluent from SD-180 was evaluated for toxicity two times in 2002; the effluent did not reduce *Ceriodaphnia* survival or reproduction in either test. In selected tests, water samples from storm water outfall 190 have been treated to remove metals. This treatment has decreased toxic effects, indicating that the primary source of toxicity is from metals. An analysis of water from the storm drain 190 network has indicated that both nickel and zinc are present at levels that have been shown to be toxic to *Ceriodaphnia*. Toxicity tests of surface water from the Mitchell Branch ambient sites and Mitchell Branch downstream of each storm drain were conducted four times in 2002. None of the ambient samples demonstrated toxicity in any of the tests. Any toxicity demonstrated at the storm water outfalls was not evident in the 2002 monitoring at the Mitchell Branch ambient sites.

4.7.2 Bioaccumulation Studies

In June and July, 2002, caged clams *(Corbicula fluminea)* were placed at numerous locations around ETTP, including five oil-water separators. The clams were allowed to remain in place for four weeks, then were analyzed for uptake of PCBs. Although clams from almost all of the ETTP monitoring locations accumulated some level of PCBs, results of this year's monitoring were generally slightly lower compared with the 2001 results. As before, the primary source of PCBs to the environment remains Storm Water Outfall 100. Both Mitchell Branch and the K-1007-P1 Pond receive effluent from other storm water outfalls that contain smaller amounts of PCBs. Levels in clams from Mitchell Branch progressively increase with the distance downstream. The PCBs in Mitchell Branch clams were primarily Arochlors 1254 and 1260, while in the K-1007-P1 Pond clams Arochlor 1248 predominates. As before, the concentration of PCBs in K-901-A clams was significantly lower than clams from K-1007-P1 Pond and Mitchell Branch.

In the case of the oil-water separators, the highest levels of PCBs were found in clams from near the K-33 building (separators K-897-P and K-897-N). PCBs were also accumulated in clams placed near the K-27 building (separators K-897-J and K-897-K). Clams from the oil-water separator near the K-31 building (K-897-M) were the only clams from ETTP monitoring that did not accumulate detectable levels of PCBs during the four weeks of monitoring.

Fish were collected from Mitchell Branch, K-1007-P1 Pond, and K-901-A Pond in April 2002. Largemouth bass were collected from the pond sites, and redbreast sunfish were collected from Mitchell Branch. Gamefish of a size large enough to be taken by sportfishermen 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 and were analyzed for PCBs. Figure 4.8 gives a synopsis of the results for the fish from K-1007-P1 pond. As in previous years, the fish from the K-1007-P1 pond contained the highest concentrations of PCBs, while those from Mitchell Branch contained lower concentrations, and the fish from K-901-A contained the lowest concentrations. Average levels at all sites were within historic ranges for the respective locations, although compared with last year's monitoring results, the averages had increased slightly in fish from K-901-A and had decreased slightly in fish from Mitchell Branch. The maximum concentration was found in a bass from K-1007-P1 (58 ppm), where average levels were essentially unchanged from those measured in 2001.

4.7.3 Ecological Surveys of Instream Communities

In April 2002, the benthic macroinvertebrate communities at four Mitchell Branch locations (MIKs 0.45, 0.71, 0.78, and 1.43) were sampled. MIK 1.43 serves as the upstream reference loca-

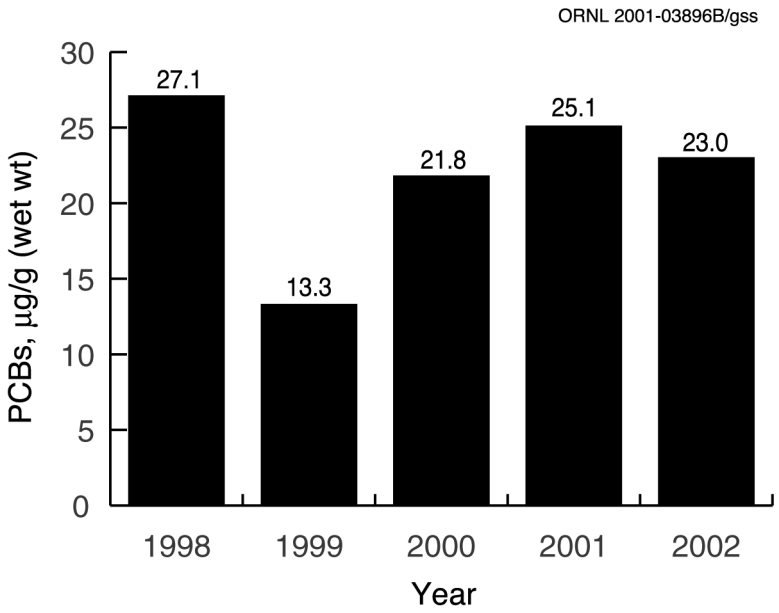


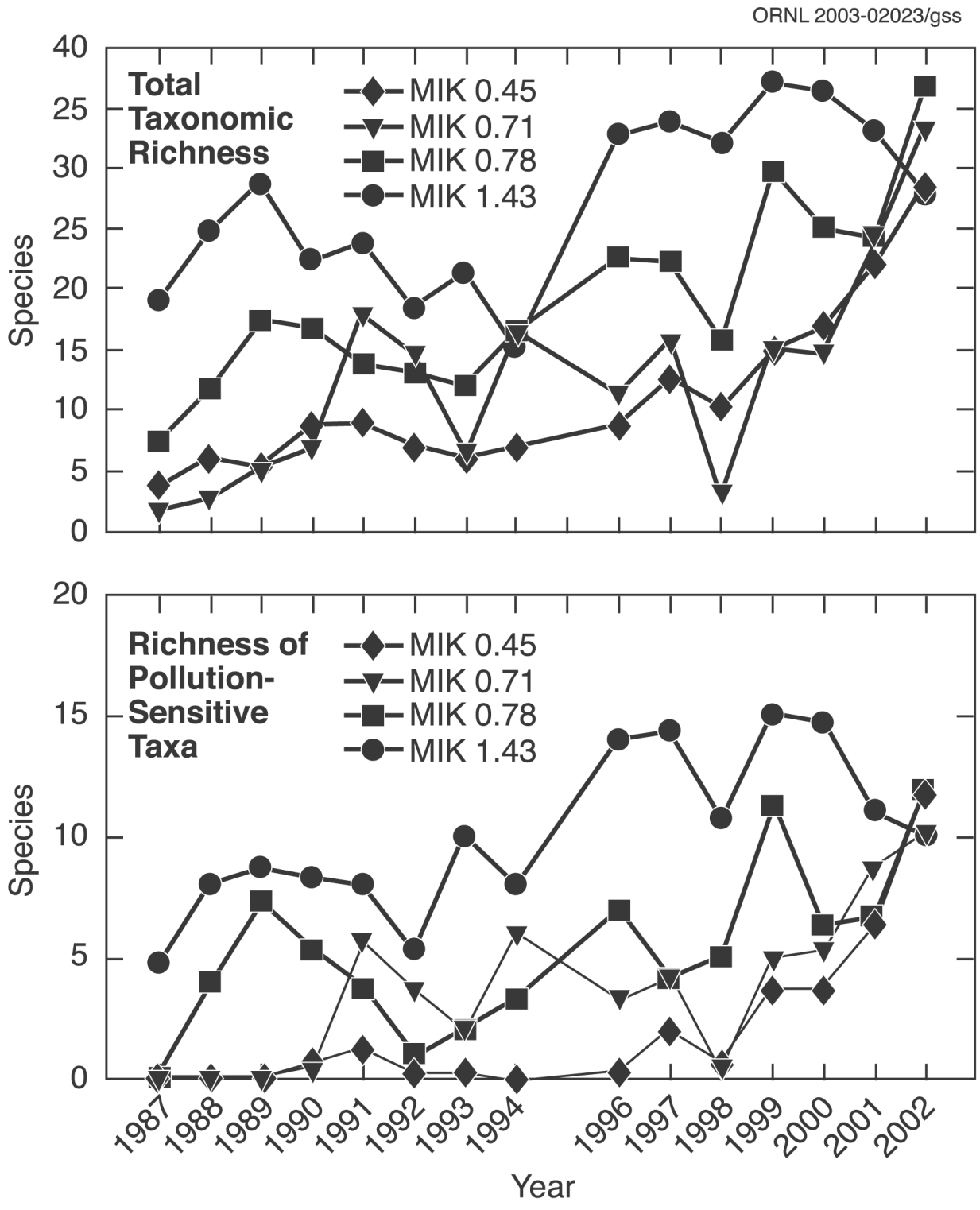
Fig. 4.8. Mean PCB concentrations in largemouth bass from the K-1007-P1 pond at the ETTP. Samples are fillets; N = 2–8 fish/year.

tion. Total taxonomic richness and richness of pollution-sensitive taxa continued their trend of increasing through time since the stream relining and groundwater interceptor trench project was completed in 1998 (Fig. 4.9). Taxonomic richness results at MIK 0.45, 0.71, and 0.78 were at the highest levels found so far in the 16-year monitoring effort; however, there continued to be differences in the abundances of key species at these downstream sites and MIK 1.43 that provide evidence of continued stress. For example, with few exceptions, the density of the stoneflies, an order of insects fairly intolerant of pollution, has been and continues to be considerably lower at the downstream sites than at MIK 1.43 (Fig. 4.10). Conversely, the density of midges (Chironomidae), a group of fairly pollution-tolerant insects, has generally been at least twofold or more higher at the downstream sites than at MIK 1.43. (Fig. 4.10). If improvement in water quality continues as it has in the last 3 to 4 years, the macroinvertebrate community in Mitchell Branch will become increasingly dominated by pollution-sensitive species, and the abundances of pollution-tolerant species will decline considerably.

Fish communities in Mitchell Branch (MIK 0.45 and 0.71) were sampled in April 2002. Species richness, density, and biomass were examined. The fish community at MIK 0.45 continues to show improvement from when monitoring began in the 1980s. Species richness (9), density (11.66 fish/m^2), and biomass (35.46 g/m^2) at MIK 0.45 in 2002 were at the highest levels ever recorded since monitoring began. The fish community at MIK 0.71 shows some improvements from 1998, when that area was extensively disturbed by the groundwater intercept trench project. Results at MIK 0.71 in 2002 were 5 species, 1.52 fish/m^2, and 3.11 g/m^2. The density and biomass values were higher than in 2001 sampling but remain well below the levels existing prior to the disturbance in 1998.

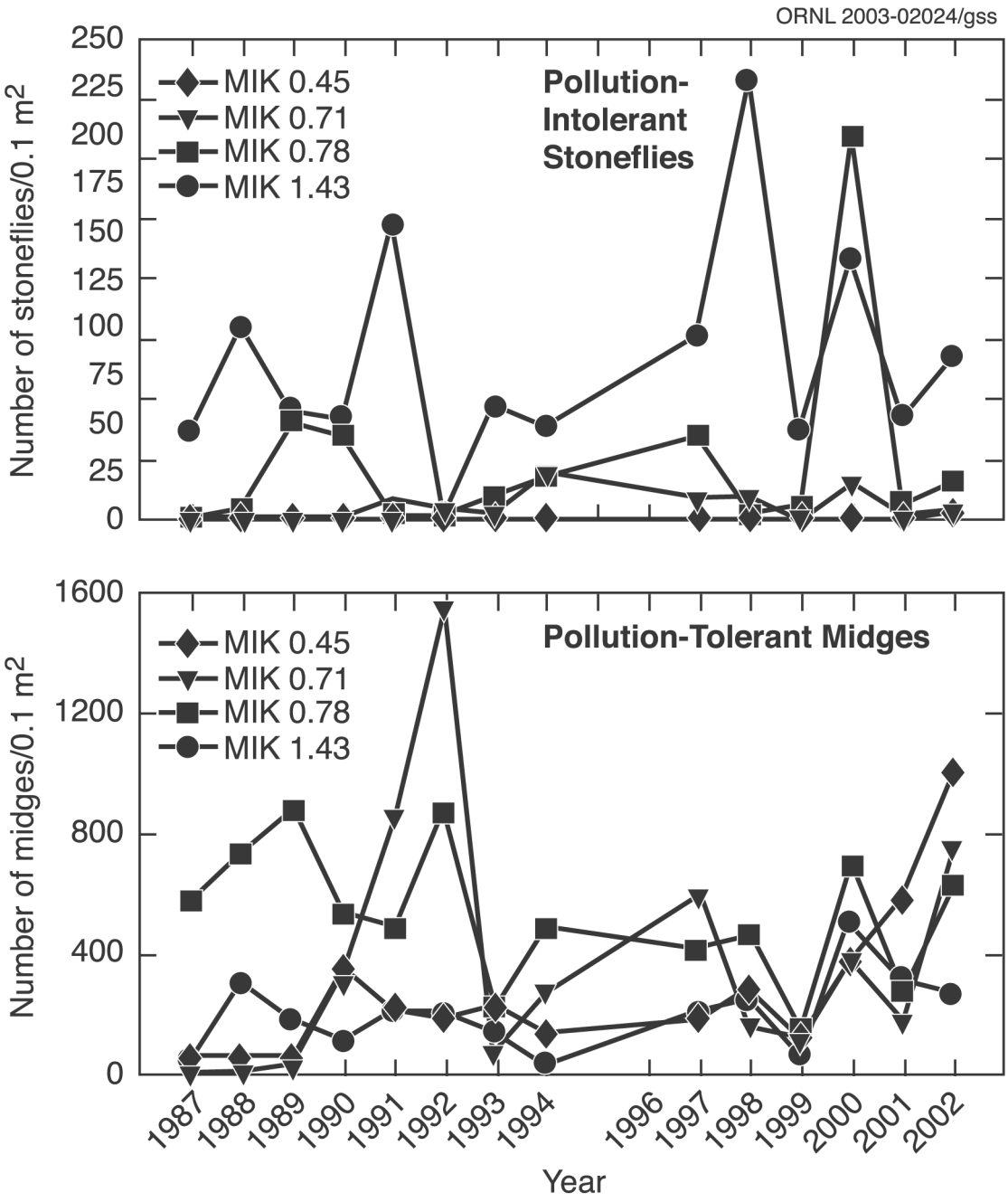
4.7.4 Waterfowl Surveys

Monthly waterfowl surveys were conducted at ETTP during 2002. Two observations were made at ETTP of the great egret (*Ardea alba*), a species listed as "In Need of Management" by the Tennessee Wildlife Resources Commission. A single observation was made at ETTP of a greater white-fronted goose (*Anser albifrons*), a species which appears to be previously undocumented on the ORR. A single observation was also made at ETTP of a semipalmated plover (*Charadrius semipalmatus*), a species which has not been reported on the ORR in recent decades. Sixty-nine Canada geese (*Branta canadensis*) were captured during the annual goose roundup at ETTP on



There was no monitoring conducted during 1995.

Fig. 4.9. Total taxonomic richness, pollution-sensitive taxa.



There was no monitoring conducted during 1995.

Fig. 4.10. Number pollution-intolerant and pollution-tolerant species.

June 20, 2002. Forty-six of the geese received new legbands, 31 were fitted with new neck collars, and 31 received whole-body gamma scans. All 31 scanned geese had whole-body gamma counts of less than 0.6 pCi/g ^{137}Cs.

4.8 ETTP AMBIENT AIR MONITORING

DOE Order 5400.1 requires surveillance of ambient air to assess the impact of DOE operations on air quality. In addition, airborne radionuclide monitoring is required for compliance

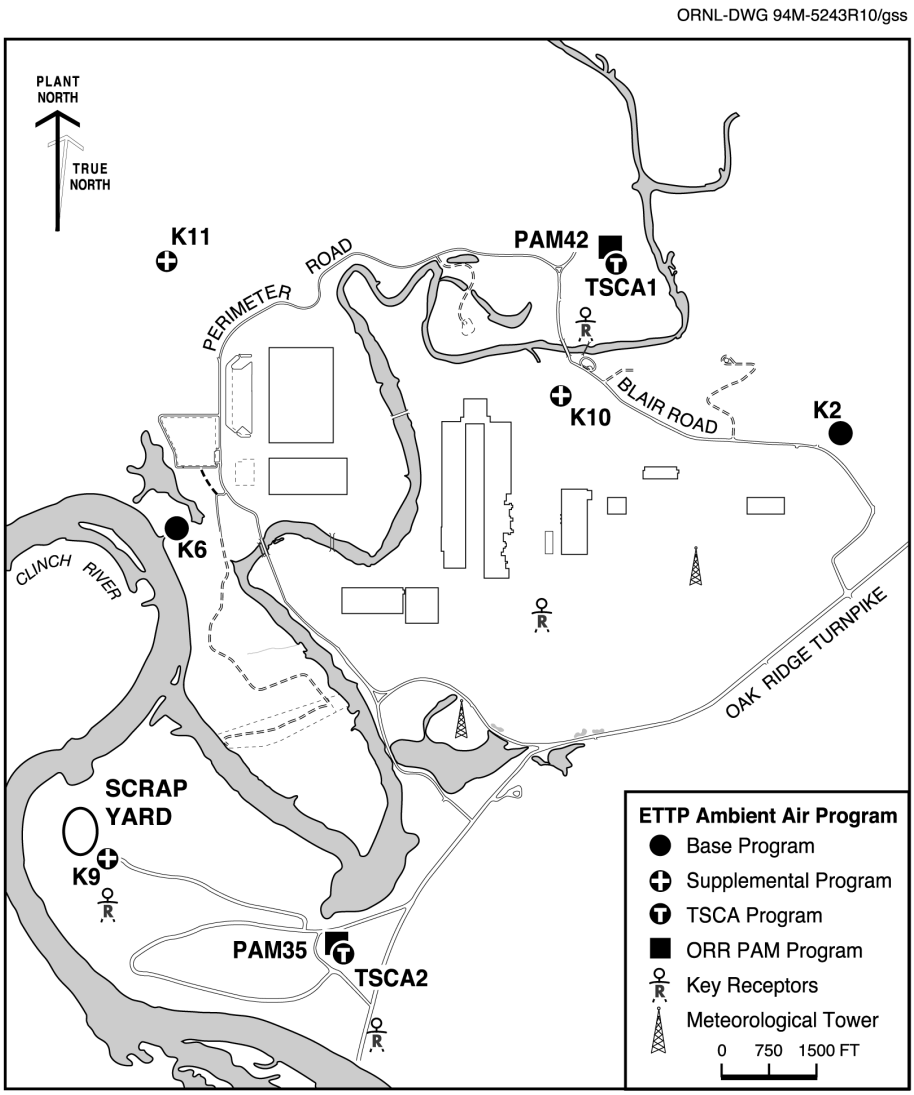


Fig. 4.11. Locations of ambient air monitoring stations at the ETTP.

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 contaminants 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. 4.11. The ETTP ambient air monitoring program complies with all requirements of DOE orders.

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 4.13. 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 on nearby communities or the

Table 4.13. Summary of types and frequencies of samples collected at East Tennessee Technology Park perimeter ambient air monitoring stations, 2002

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
Criteria pollutants				
Lead	K2, K6, K9,[b] K10[b]	Continuous	Weekly	Monthly
Hazardous air pollutants carcinogen metals				
Arsenic	K2, K6, K9	Continuous	Weekly	Monthly
Beryllium	K2, K6, K9	Continuous	Weekly	Monthly
Cadmium	K2, K6, K9, K10	Continuous	Weekly	Monthly
Chromium	K2, K6, K9	Continuous	Weekly	Monthly
Organic compounds				
Polychlorinated biphenyls	TSCAI[c] 1, 2	*d*	*d*	*d*
Furan	TSCAI 1, 2	*d*	*d*	*d*
Dioxin	TSCAI 1, 2	*d*	*d*	*d*
Hexachlorobenzene	TSCAI 1, 2	*d*	*d*	*d*
Radionuclides (by inorganic analysis)				
Uranium (total)	K2, K6, K9, K10	Continuous	Weekly	Monthly
	PAM 35, 42	Continuous	Weekly	Quarterly
	TSCAI 1, 2	*d*	*d*	*d*
Radionuclides (by radiochemical analysis)				
^{99}Tc, ^{237}Np, ^{238,239}Pu, ^{234,235,236,238}U	K2, K6, K9	Continuous	Weekly	Monthly
^{234,235,236,238}U	K10	Continuous	Weekly	Monthly
^{99}Tc, ^{237}Np, ^{228,230,232}Th, ^{234,235,236,238}U	K11[b]	Continuous	Weekly	Monthly

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

[b]Temporary sampling station.

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

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

environment may warrant periodic changes of air contaminants measured, number of stations, or relocation of existing stations. The principal parameters monitored during 2002 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, ^{228}Th, ^{230}Th, ^{232}Th, ^{237}Np, ^{238}Pu, and ^{239}Pu.

During this reporting period, the ambient air monitoring network was modified with respect to ETTP operations. Station K11 was established to cover potential fugitive airborne radiological emissions during the K-1070-A Burial Ground Remediation. The sampler was located on the northeast edge of the remediation area in the direction of the modeled maximally exposed member of the public as shown in Fig. 4.11. Measured parameters were selected based on a

radiological characterization of the project and the potential dose contribution of each radionuclide. No other sampling procedures or locations were changed from the previous year. Samples were collected weekly from the following stations: K2, K6, K9, K10, K11, and perimeter air monitors 35 and 42.

4.8.1 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.

4.8.2 Criteria Pollutant Levels

Quarterly lead results were determined from analyses of monthly composites of continuous weekly samples from stations K2, K6, K9, and K10. 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 4.14 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 0.0037 $\mu g/m^3$. This value was only 0.3% of the quarterly standard for lead. No lead concentrations of environmental concern were measured (see Fig. 4.12 for 5-year lead trend).

4.8.3 Hazardous Air Pollutant Carcinogenic Metal Levels

Analyses of hazardous air pollutant carcinogenic metals (arsenic, beryllium, cadmium, and chromium) were performed on one monthly composite per quarter of continuous weekly samples from stations K2, K6, and K9. All monthly composite samples from K10 were only analyzed for cadmium. 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.

Table 4.14. Lead concentrations in ambient air at the East Tennessee Technology Park, 2002

Station	Quarterly averages of monthly composites ($\mu g/m^3$)				Max quarterly result ($\mu g/m^3$)	Max monthly result ($\mu g/m^3$)	Max percent of quarterly standard[a]
	1	2	3	4			
K2	0.003237	*b*	0.003760	0.002891	0.003760	0.003760	0.25
K6	0.003023	*b*	0.002527	0.002343	0.003023	0.003023	0.20
K9[c]	0.002908	0.003386	0.002440	0.002512	0.003386	0.003386	0.23
K10[d]	0.000831	0.000587	0.000702	0.001481	0.001481	0.002483	0.10
Quarterly avg	0.002500	0.001986	0.002357	0.002307	0.002500	N/A	0.17
Quarterly max	0.003237	0.003386	0.003760	0.002891	0.003760	N/A	0.25
Annual average for all stations = 0.002425 $\mu g/m^3$							

[a]Tennessee and national air quality standard for lead is 1.5 $\mu g/m^3$ quarterly arithmetic average.
[b]No lead analysis performed.
[c]Conservative comparison of the maximum individual monthly result with the quarterly standard.
[d]ETTP temporary stations activated during 2000.

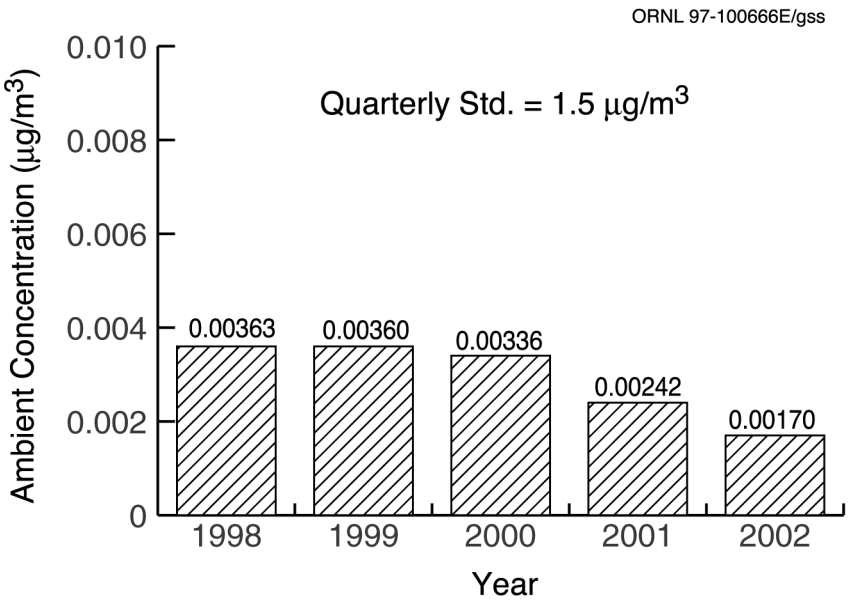


Fig. 4.12. Ambient air monitoring 5-year trend results for lead at the ETTP.

The annual average arsenic concentration for all measurement sites was 0.00075 μg/m^3, well below the risk-specific dose of 0.0023 μg/m^3. The individual maximum measured result was 0.00109 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 <0.000007 μg/m^3 with the individual maximum result of <0.000018 μg/m^3. Cadmium concentration results ranged from approximately 0.00012 to 0.00042 μg/m^3. The cadmium annual average was 0.00021 μg/m^3, well below the risk-specific dose of 0.0056 μg/m^3. Individual chromium measurements ranged from approximately 0.00014 to 0.00065 μg/m^3. The annual average result for chromium was 0.0003 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 4.15.

4.8.4 Radionuclide Levels

Total uranium metal was measured as a monthly composite of continuous weekly samples from stations K2, K6, K9, and K10. Analyses were performed on each weekly sample taken at station K11, and quarterly composites of weekly continuous samples were analyzed from perimeter air monitoring stations 35 and 42. The total uranium mass for each sample was determined by the ICP-MS analytical technique. The uranium annual averages and maximum individual concentration measurements for all sites are presented in Table 4.16. Results ranged from a minimum of approximately 0.00006 to 0.00122 μg/m^3. The highest monthly result was measured at Station K6, which is in one of the prevailing wind directions from the ETTP. The annual average value for all stations due to uranium was 0.00017 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 station K10. The annual result was only 0.00040 μg/m^3, which corresponds to 0.27% of the DCG (see Fig. 4.13 for 5-year uranium trend).

The highest recorded monthly uranium concentration for CY 2002 was measured at station K6, located near the K-901 area. The K6 May sample result of 0.00122 μg/m^3, if assumed to be the annual average concentration, would equate to only 0.81% of the DCG for an individual located at that station for the entire year. Figure 4.14 shows a comparison of monthly trends of total uranium data from K2 and TSCA

Table 4.15. Hazardous air pollutant concentrations in ambient air at the East Tennessee Technology Park, 2002

Parameter	Ambient air concentration (μg/m^3)			Percentage of standard[a]	
	Annual avg	Monthly max	Max location		
Arsenic	0.000750	0.001094	K9	32.6	
Beryllium	<0.000007	<0.000018	K9	<0.2	
Cadmium	0.000205	0.000422	K10	3.7	
				Cr-III	Cr-VI
Chromium	0.000299	0.000651	K9	<0.1	34.0

[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 4.16. Total uranium in ambient air by inductively coupled plasma mass spectrometry analysis at the East Tennessee Technology Park, 2002

Station	Samples	Concentration[a]				Percent of DCG[b] (%)	
		(μg/m^3)		(μCi/mL)			
		Avg	Max[c]	Avg	Max[c]	Avg	Max[c]
K2	12	0.000186	0.001094	1.25E–16	7.29E–16	0.13	0.73
K6	12	0.000257	0.001217	1.73E–16	8.11E–16	0.17	0.81
K9	12	0.000077	0.000190	5.18E–17	1.27E–16	0.05	0.13
K10	12	0.000401	0.000650	2.70E–16	4.34E–16	0.27	0.43
PAM35	4	0.000061	0.000099	4.12E–17	6.63E–17	0.04	0.07
PAM42	4	0.000061	0.000088	4.09E–17	5.85E–17	0.04	0.06
ETTP total	56	0.000174	0.001217	1.16E–16	8.11E–16	0.12	0.81

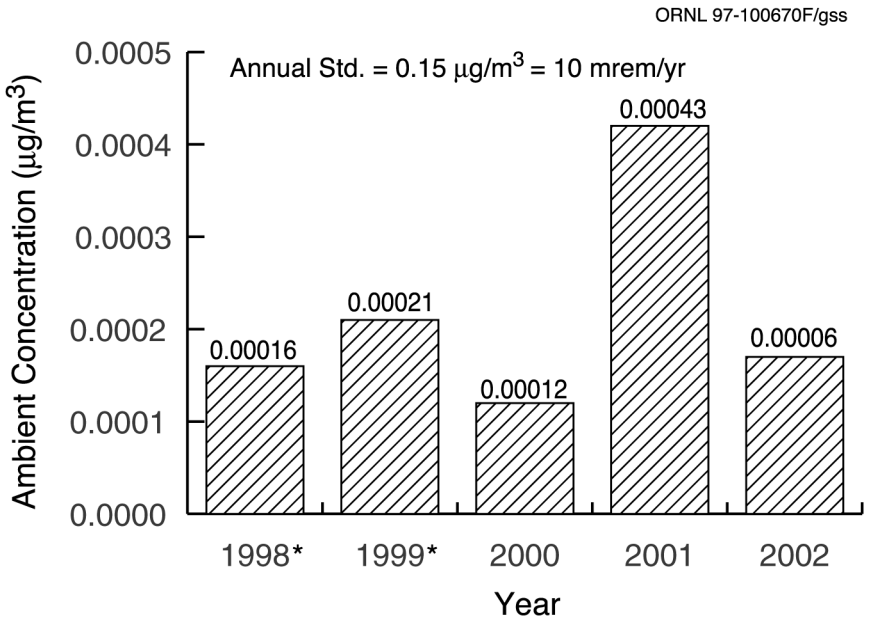
[a]Mass-to-curie concentration conversions assume a natural uranium assay of 0.717% ^{235}U.

[b]DOE Order 5400.5 Derived Concentration Guide (DCG) for naturally occurring uranium is an annual concentration of 1E–13 μCi/mL, which is equivalent to a 100 mrem annual dose.

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

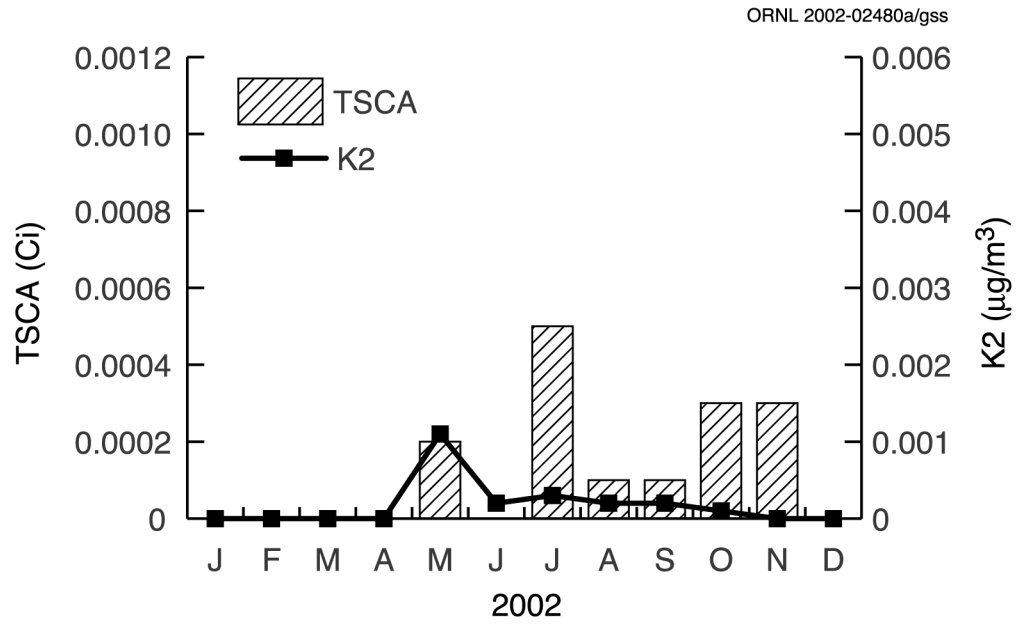
Incinerator stack emission data. The intent of this figure is only to show the relative trend of each measurement result. A significant factor that can affect a comparison between the two data sets is the meteorology during each month. Shorter reporting periods increase the potential that the plume from the incinerator may not be in the direction of K2 when operating. Another factor is the sensitivity of the analytical methods at these low levels of pollutants, which can introduce increased uncertainty in the data. The data show that K2 can detect airborne uranium during periods of waste incineration. All emission sources were operating within permitted limits and within all emission standards.

Periodic radiochemical analyses were initiated during 2000 on selected monthly composite samples collected at Stations K2, K6, K9, and K10. 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). Weekly analyses were initiated in June of 2002 at station K11. The selected isotopes were ^{237}Np, ^{228}Th, ^{230}Th, ^{232}Th, ^{99}Tc, and isotopic uranium (^{234}U, ^{235}U, ^{236}U, and ^{238}U). The resulting



**Site annual average modified from 1999 report to include all temporary station data.*

Fig. 4.13. Ambient air monitoring 5-year trend results for uranium at the ETTP.



NOTE: TSCAI did not operate during the following months: January, February, March, April, and December.

Fig. 4.14. Ambient air monitoring at ETTP Station K2 by ICP/MS vs TSCA Incinerator stack sampling results by radiochemistry.

annual concentrations for all nuclides measured are presented in Table 4.17. Three averaging techniques were used to establish annual results. This was due to measurement results that were for differing periods of sampling time during the year. Results from stations K2, K6, and K9 are averages of four monthly composite sample analyses. Due to ongoing activities at ETTP, this has been conservatively assumed to represent an annual average for this report. Station K10 sample results are based on 12 monthly composite analyses and are directly representative of an annual average. Station K11 began sampling in June, and all weekly samples were submitted for analysis. K11 averages were annualized by adjusting values by the ratio of the number of weeks of analyses and the total weeks in a year. For comparison, the total uranium results associated with ICP-MS analyses of composite samples are comparable with the uranium results determined by radiochemical techniques.

4.8.5 Organic Compound Levels

Currently, measurements of selected semivolatile organics are performed only during an operational upset of the TSCA Incinerator. There were no events that required the activation of sampling systems for organic pollutants in the ambient air during this reporting period. In the event that an unplanned release occurred, ambient air sampling stations would be activated automatically or manually.

4.8.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 4.12 and 4.13 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.

4.9 ETTP SURFACE WATER MONITORING

Surface water surveillance is currently conducted at eight locations at the ETTP (Fig. 4.15). Stations K-1710 and MIK 1.4 provide information on conditions upstream of the ETTP. Stations K-716 and Clinch River kilometer (CRK) 16 are located downstream from most ETTP operations

Table 4.17. Radionuclides in ambient air by radiochemistry at the East Tennessee Technology Park, 2002

Station	Concentration (μCi/mL)[a]									
	^{237}Np	^{238}Pu	^{239}Pu	^{99}Tc	^{228}Th	^{230}Th	^{232}Th	^{234}U	^{235}U	^{236}U
K2	1.11E–17	3.75E–17	1.73E–17	3.12E–15	*b*	*b*	*b*	2.86E–17	9.32E–1	1.60E–17
K6	2.05E–17	6.62E–18	4.72E–17	3.58E–15	*b*	*b*	*b*	1.03E–16	1.11E–17	1.26E–17
K9	1.27E–17	8.79E–18	1.64E–17	3.88E–15	*b*	*b*	*b*	6.54E–17	5.62E–18	9.46E–18
K10	*b*	*b*	*b*	*b*	*b*	*b*	*b*	1.18E–16	7.47E–18	5.88E–18
K11	8.06E–19	*b*	*b*	4.37E–16	1.63E–17	3.39E–17	5.58E–18	1.20E–16	4.83E–18	1.48E–16

[a]K2, K6, K9 results are the average of four monthly composite analyses and are assumed to represent an annual average value. K10 results are the average of the 12 monthly composite analyses. K11 results are based on the 25 weekly analyses, then mathematically annualized.

[b]Data not available or sample not taken.

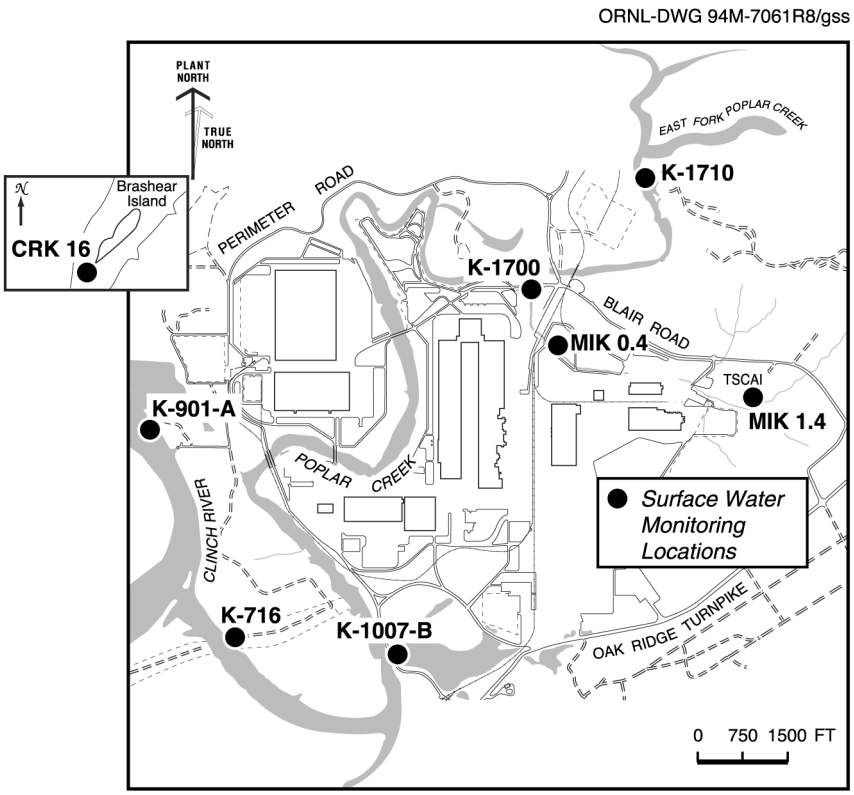


Fig. 4.15. Monitoring locations for surface water at the ETTP.

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 and K-1700) or to the Clinch River (Station K-901-A).

At most surveillance stations, semiannual sampling and analyses for radionuclides and field readings (dissolved oxygen, temperature, and pH) are conducted. At CRK 16, samples for radionuclides, volatile organic compounds, and selected metals are collected and analyzed on a monthly basis. Quarterly sampling for volatile organics, in addition to 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, 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 CRK16, K-901-A, MIK 0.4, 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 and MIK 0.4, but in all instances the results were below the applicable water quality standard. Dissolved oxygen measurements at K-901-A and MIK 0.4 fell below the minimum water quality standard during the summer months because of increased temperature (and therefore lower solubility of the gas) and increased biological activity. Water bodies in the vicinity of the ETTP are regularly inspected for signs of stress on aquatic organisms during these periods. For most of the remaining analyses, results are within the reference standards or below detection limits for the instrument and method. Moreover, analytical results for samples collected upstream of the ETTP are chemically similar in most respects to those collected below the ETTP.

The sum of the fractions of the DCGs for all stations remained below 4% of the DCG values for ingestion, which are the equivalent to the DOE

drinking water systems criterion of 4 mrem/year (Fig. 4.16). The highest sum of the fractions, 2.3% 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 results found throughout the 1990s. 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.

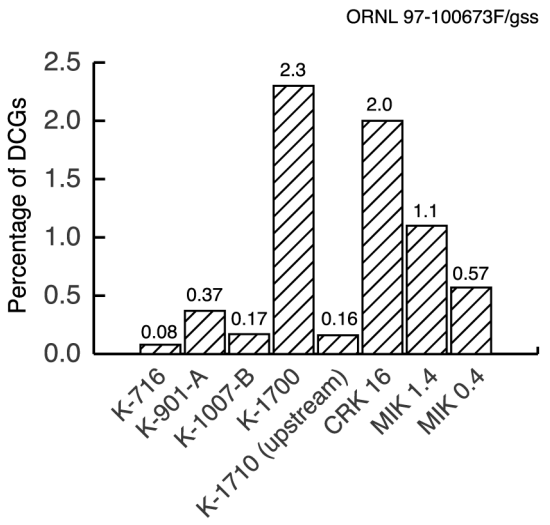


Fig. 4.16. Percentage of DOE derived concentration guides for ETTP surface monitoring locations.

4.10 ETTP SOIL AND SEDIMENT MONITORING

In 2001, soil monitoring was reinstated at ETTP. Due to the possibility of aerial deposition of contaminants, the soil monitoring locations are co-located with ambient air monitoring stations (K2, K6, K9, K10, and perimeter air monitors 35 and 42). Samples are collected and analyzed annually for selected radionuclides and metals. Results from the 2002 sampling indicate that ETTP operations have made some impacts on the environment, and comparison with ambient air monitoring results show that these impacts are ongoing. However, the results to date do not indicate that environmentally significant impacts are occurring at this time (for example, radionuclides other than ^{99}Tc and uranium were undetectable in the 2002 soil samples).

Currently, most sediment monitoring is conducted by the Water Resources Restoration Program in association with CERCLA remedial actions. Sediment monitoring is conducted both to provide a baseline for current conditions and to help gauge the effectiveness of the remedial actions. The ETTP Environmental Monitoring Program also conducts sediment monitoring at one location, just upstream of the K1700 weir on Mitchell Branch. Monitoring at this location in 2002 indicates that the sediment contains approximately 6 μg/g PCBs, 1 mg/kg mercury, 51 mg/kg chromium, 157 mg/kg zinc, and 140 mg/kg nickel. Results from the sediment monitoring conducted in association with CERCLA activity are described in the *2002 Remediation Effectiveness Report* (DOE 2003a).

4.11 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, Oak Ridge Operations, Office* (DOE 1999) 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 or multiple areas of concern 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 moni-

toring at the ETTP, including exit pathway monitoring wells. Groundwater discharges 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 *2003 Remediation Effectiveness Report for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2003a) 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.

4.12 ETTP DIRECT RADIATION

The UF_6 cylinder storage yards at ETTP may be sources of potential exposure to the public from gamma radiation from radionuclides in the cylinders. Measured exposure rates and a hypothetical model of a maximally exposed individual were used to calculate theoretical doses. The calculated EDEs were based on gamma 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 noted in the discussion that follows are less than the 100 mrem/year required by DOE Order 5400.5.

Gamma dose rates from each area were measured in January 2002 with a tissue-equivalent dose rate meter. Background readings were established at the ambient air monitoring stations north and northeast of ETTP off Blair Road and near the intersection of Power House Road and Bear Creek Road. The average gamma background was 0.003 mrem/h, and all neutron background measurements were 0 mrem/h. Neutron dose rates for a count time of 1 min were 0 mrem/h at each of the monitoring locations.

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 0.50 mrem along the bank of Poplar Creek near the K-1066-J Cylinder Yard, or 1.75 mrem along the bank of Poplar Creek near the K-1066-E Cylinder Yard during 2002. 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. The average gamma dose rate was equivalent to the background level of 0.003 mrem/h; therefore, a hypothetical Clinch River fisherman would not be expected to have received any EDE attributable to the K-770 Scrap Yard during 2002.

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. 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 1.13 mrem during 2002.