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OAK RIDGE NATIONAL LABORATORY

LOCKHEED MARTIN

ENVIRONMENTAL SCIENCES DIVISION

Report on the Biological Monitoring Program at Paducah Gaseous Diffusion Plant December 1993 to December 1994

L. Adams Kszos

Environmental Sciences Division
Publication No. 4390

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Report on the Biological Monitoring Program at Paducah Gaseous Diffusion Plant December 1993 to December 1994

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ACRONYMS

ANOVA	analysis of variance
BMAP	Biological Monitoring and Abatement Program
BMP	Biological Monitoring Program
BBK	Big Bayou Creek kilometer
DCBP	decachlorobiphenyl
DOE	U.S. Department of Energy
ESD	Environmental Sciences Division
EPA	U.S. Environmental Protection Agency
EPT	Ephemeroptera, Plecoptera, Trichoptera
FDA	U.S. Department of Agriculture Food and Drug Administration
GC/ECD	gas chromatography/electron capture detection
GLM	general linear model
HINDS CR	Hinds Creek
IC	inhibition concentration
KDOW	Kentucky Division of Water
KPDES	Kentucky Pollutant Discharge Elimination System
LUK	Little Bayou Creek kilometer
MAK	Massac Creek kilometer
MMES	Martin Marietta Energy Systems, Inc.
MMUS	Martin Marietta Utility Systems, Inc.
MS-222	tricaine methanesulfonate
NCBP	National Contaminant Biomonitoring Program
NOEC	no-observed-effect concentration
NPDES	National Pollutant Discharge Elimination System
ORNL	Oak Ridge National Laboratory
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
QA	quality assurance
RGA	regional gravel aquifer
RCW	recirculating cooling water
SAS	statistical analysis system
TRC	total residual chlorine
TU	toxicity unit(s)
TUc	chronic toxicity unit(s)
USEC	United States Enrichment Corporation
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Service
WKWMA	West Kentucky Wildlife Management Area

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EXECUTIVE SUMMARY

On September 24, 1987, the Commonwealth of Kentucky Natural Resources and Environmental Protection Cabinet issued an Agreed Order that required the development of a Biological Monitoring Program (BMP) for the Paducah Gaseous Diffusion Plant (PGDP). The PGDP BMP was implemented in 1987 by the University of Kentucky. Research staff of the Environmental Sciences Division (ESD) at Oak Ridge National Laboratory (ORNL) served as reviewers and advisers to the University of Kentucky. Beginning in fall 1991, ESD added data collection and report preparation to its responsibilities for the PGDP BMP. The goals of BMP are to (1) demonstrate that the effluent limitations established for PGDP protect and maintain the use of Little Bayou and Big Bayou creeks for growth and propagation of fish and other aquatic life, (2) characterize potential environmental impacts, (3) document the effects of pollution abatement facilities on stream biota, and (4) recommend any program improvements that would increase effluent treatability. In September 1992, a renewed Kentucky Pollutant Discharge Elimination System (KPDES) permit was issued to PGDP. As of this writing, a new Agreed Order is in draft form. The renewed permit requires toxicity monitoring of continuous and intermittent outfalls on a quarterly basis. A BMP is not required in either the draft Agreed Order or the renewed permit; however, biological monitoring of the U.S. Department of Energy (DOE) facilities at PGDP is required under draft DOE Order 5400.1. Data collected under BMP will also be used to support two studies proposed in the draft Agreed Order.

The BMP for PGDP consists of three major tasks: (1) effluent and ambient toxicity monitoring, (2) bioaccumulation studies, and (3) ecological surveys of stream communities (i.e., benthic macroinvertebrates and fish). This report includes ESD activities occurring from December 1993 to December 1994, although activities conducted outside this time period are included as appropriate.

Study Area

The PGDP is owned by the United States Department of Energy (DOE). Production facilities are leased to the United States Enrichment Corporation (USEC) and are managed by Martin Marietta Utility Systems, Inc. (MMUS). The environmental restoration and waste management activities are managed by Martin Marietta Energy Systems, Inc. (MMES). The plant was constructed in 1951 and is an active uranium enrichment facility consisting of a diffusion cascade and extensive support facilities. Enriched uranium is transferred to the Portsmouth (Ohio) Gaseous Diffusion Plant. Most of the uranium produced is used for national defense and commercial reactors in the United States and abroad.

PGDP is located in the western part of the Ohio River basin. Surface drainage from PGDP enters Big Bayou Creek and Little Bayou Creek which are two small tributaries to the Ohio River. Big Bayou Creek is a perennial stream with a drainage basin extending from ~4 km south of PGDP to the Ohio River. Part of its 14.5-km course flows along the western boundary of the plant. Little Bayou Creek originates in the Western Kentucky Wildlife Management Area and flows for 10.5 km north toward the Ohio River; its course includes part of the eastern boundary of PGDP. Four continuously flowing outfalls (001, 006, 008, and 009) discharge to Big Bayou Creek. Outfalls 002, 010, 011, and 012 are combined at the C617 pond and discharged via Outfall 011 (or 010) into Little Bayou Creek. Effluent from Outfalls 013, 015, 016, 017, and 018 regularly discharge into Big Bayou and Little Bayou creeks when it rains.

Three sites on Big Bayou Creek—Big Bayou Creek kilometer (BBK) 12.5, BBK 10.0, and BBK 9.1—one site on Little Bayou Creek, Little Bayou Creek kilometer (LUK) 7.2; and one off-site reference station on Massac Creek, Massac Creek kilometer (MAK) 13.8, were routinely sampled to assess the ecological health of the stream and to evaluate ambient toxicity. Three additional sites (BBK 2.8, LUK 9.0, and LUK 4.3) were sampled as part of the bioaccumulation monitoring task. Toxicity monitoring and benthic macroinvertebrate sampling were conducted quarterly, and fish community and bioaccumulation sampling were conducted twice annually: in the spring and fall. KPDES outfalls evaluated for effluent toxicity included 001, 006, 008, 009, 010 (or 011), 013, 015, 016, 017, and 018.

Toxicity Monitoring

Ceriodaphnia and fathead minnow toxicity tests of effluents from the continuously flowing outfalls (001, 006, 008, 009, and 011), the intermittently flowing outfalls (013, 015, 016, 017, and 018) were conducted quarterly as required by the KPDES permit. Fathead minnow toxicity tests of water from ambient sites (BBK 12.5, BBK 9.1, LUK 7.2, and MAK 13.8) were conducted concurrently with the continuously flowing outfalls. Tests with *Ceriodaphnia* and fathead minnows were typically conducted concurrently. The 25% inhibition concentrations (IC25; that concentration causing a 25% reduction in fathead minnow growth or *Ceriodaphnia* survival compared with the control) were determined for each test. The chronic toxicity unit rating (TUc=100/IC25) is required as a compliance endpoint in the renewed permit (September 1992 to present). The higher the TUc, the more toxic an effluent. Because Little Bayou and Big Bayou creeks have been determined to have a low flow of zero, a TUc > 1.0 would be considered a noncompliance (for the continuously flowing outfalls) and an indicator of potential instream toxicity.

During 1994, no toxicity was evident in effluent samples from 001. Effluent from Outfall 008 had TUcs > 1.0 two times; however, follow-up tests demonstrated that the toxicity was transient. Outfalls 006 and 011 had high TUcs for fathead minnows during two consecutive tests in March; however, no toxicity was observed in subsequent testing. Outfall 006 had a TUc > 1 for *Ceriodaphnia* during August; however a retest of the effluent did not demonstrate toxicity. Outfall 009 had the greatest number of exceedances during 1994. The effluent exceeded the a TUc > 1 four times with an average TUc of 4.32. Identification procedures conducted during December 1994 showed that minnow mortality in the effluent may be due to suspended solids or to a particle-bound contaminant. However, the results were inconclusive since other treatments also improved minnow survival. Although PGDP does not have a compliance limit for the intermittent outfalls, TUc > 1 was used as a benchmark. In 1994, Outfalls 015 and 017 exceeded the TUc > 1 three times; Outfalls 013, 016, and 018 exceeded this limit once. The ranking of outfalls for tests conducted to-date (1991–94) in terms of TUc and frequency of TUc > 1 showed Outfall 017 > Outfall 015 > Outfall 13 > Outfall 18 > Outfall 016.

For ambient tests conducted in 1994, there was no evidence of chronic toxicity to fathead minnows for any of the ambient sites. Thus, toxicity to minnows observed in effluent from the continuously flowing outfalls was not observed in instream samples. The influence of effluent from Outfall 001 on the water chemistry of Big Bayou Creek was evident in the increase in pH, conductivity and hardness between BBK 10.0 and BBK 9.1. In addition, alkalinity is lower at BBK 10.0 than at BBK 12.5.

Bioaccumulation

The objectives of the bioaccumulation monitoring were (1) to continue polychlorinated biphenyl (PCB) tracking studies in fish from Big Bayou Creek and Little Bayou Creek; (2) to track elevated mercury concentrations in fish in Big Bayou Creek; and (3) to conduct screening analyses to detect other contaminants that may be of concern to consumers of fish from these streams.

Longear sunfish and spotted bass were collected for PCB and mercury analysis from Big Bayou Creek, Little Bayou Creek, and Massac Creek during October 1993 and May/June 1994. Hinds Creek (Anderson County, Tennessee) served as a source of uncontaminated reference fish. PCB contamination was again evident in longear sunfish collected from both Big Bayou and Little Bayou creeks. Mean PCB concentrations in sunfish from sites downstream of PGDP discharges exceeded concentrations in fish from the reference sites. In spring 1994, the highest mean concentration occurred in fish from the site in Little Bayou Creek immediately downstream from Outfall 011 (LUK 9.0). In Big Bayou Creek, the highest mean PCB concentration was again found in fish from BBK 9.1, below Outfall 001, but fish from BBK 10.0 also contained PCB contamination. In fall 1993, spotted bass from Big Bayou Creek averaged 0.23 μg/g PCBs, about 50% higher than longear sunfish. PCB concentrations in spotted bass from Little Bayou Creek were higher, averaging 0.44 μg/g in fish from LUK 4.3–LUK 7.2. Results of the October 1993 and May 1994 sampling reaffirm the variable nature of PCB contamination in stream sunfish and suggest continuing inputs to both Big and Little Bayou creeks from PGDP discharges or contaminated sediments in the immediate vicinity of those discharges. The strong downstream gradient in PCB contamination in sunfish, along with the close association between degree of contamination and proximity to outfalls demonstrated to be PCB sources in the past, suggests that the pattern of contamination is sustained by continuing low-level contamination of waters discharged to the creeks, rather than a result of residual PCB contamination in sediments of the creeks themselves. PCB residues in upstream ditch or pond sediments could act as primary continuing sources, or various in-plant sources of fugitive PCBs may continue to contribute concentrations below levels detectable in aqueous phase monitoring.

The results of mercury monitoring in longear sunfish in April 1994 confirmed the findings of previous studies that concentrations in fish from Big Bayou Creek were somewhat higher downstream from PGDP than upstream. Mean mercury concentrations in sunfish were somewhat lower than those observed previously, ranging from a maximum of 0.24 μg/g at BBK 9.1 to 0.08 μg/g at BBK 12.5, upstream from PGDP. In 1993, mercury concentrations in longear sunfish at those sites were 0.37 and 0.10 μg/g respectively. Mean mercury concentrations in fish from the sites in Big Bayou Creek downstream from PGDP exceeded that in local reference site fish again in 1994. Results of mercury monitoring in sunfish from LUK 7.2 again indicated background mercury concentrations typical of reference site fish. Mercury concentrations in spotted bass from BBK 9.1 averaged 0.61 $\pm$ 0.06 μg/g. One fish in the collection approached the FDA action level (1 μg/g), but the rest were below 0.7 μg/g. The slightly elevated concentrations of mercury in fish from Big Bayou Creek below PGDP may be a result of mercury in PGDP effluents, but they may also be a consequence of differences in the biogeochemical processing of mercury downstream from the plant.

Concentrations of metals measured in filets of longear sunfish from Big Bayou Creek and Little Bayou Creek were typical of those observed in previous monitoring and generally differed little (with several exceptions) from concentrations observed in fish from the Hinds Creek, Tennessee, reference site. Concentrations of arsenic, cadmium, copper, lead, selenium, and zinc were lower than the national geometric mean concentrations observed for whole body analyses of fish in the USFWS National Contaminant Biomonitoring Program. Concentrations of antimony, cadmium, chromium, nickel, selenium, and silver were well below screening levels used in the EPA Integrated Risk Information System (IRIS). Those metals for which IRIS screening levels are not published (copper, lead, thallium, uranium, and zinc) were found at concentrations similar to or lower than typically occur in food such as marine fish or mammalian muscle. Measurement of detectable concentrations of uranium in fish from Little Bayou Creek is consistent with the observed elevated concentrations of uranium in this creek and the results of previous monitoring of fish. No chlorinated pesticides were detected in fish from Big Bayou Creek or Little Bayou Creek.

Ecological Monitoring

Quantitative sampling of the fish community was conducted at three sites in Big Bayou Creek, one site in Little Bayou Creek, and at one offsite reference station (Massac Creek) during March and September, 1994. Qualitative sampling at one site in Little Bayou Creek was conducted during March, 1994.

Data on the fish communities of Big Bayou Creek and Little Bayou Creek downstream of PGDP were compared to data from reference sites located on Big Bayou Creek above PGDP and on Massac Creek. These comparisons indicated a slight but noticeable degradation in the communities downstream of PGDP. Data indicated that the effects on the fish community were greatest just downstream from PGDP at BBK 10.0. The fish community at this site had a low mean and total species richness in comparison with MAK 13.8. There were no sensitive species, while tolerant species were more abundant here than at the reference site. Compared to sampling in 1991 and 1992, BBK 10.0 has experienced a slight decline in biomass. The fish community at BBK 9.1 showed signs of impact similar to the level seen at BBK 10.0. Mean and total species richness were lower than at MAK 13.8. Although there were fewer sensitive species and at lower densities at BBK 9.1 than at MAK 13.8, more sensitive species were found at BBK 9.1 than at BBK 10.0. The tolerant species were common and abundant. Density was less than or equal to that at MAK 13.8, and species richness were slightly increased from 1993.

The fish community at LUK 7.2 was similar to the BBK 12.5 reference, with perhaps some species deficiencies. The mean species richness values were similar to those of the reference site but with a noticeable decline in fall 1994. Since 1991, species richness and biomass have increased slightly. However, in the fall 1994 sample species richness declined to the lowest level seen in sampling at LUK 7.2. This precipitous decline was not seen in density or biomass values. During the fall sampling, a noticeable increase in sediment level was observed at LUK 7.2. The downstream qualitative site, LUK 4.3, did not appear to be affected by plant operations.

Analysis of benthic macroinvertebrate data for the Big Bayou Creek sites indicates that, although there are differences between the three sampling locations on this stream, there is no strong evidence for a significant impact at any site. Periodically high densities at BBK 9.1 and BBK 10.0 suggest the presence of an occasionally organically enriched environment. However, persistently similar values for total and EPT richness at all three Big Bayou Creek sites, suggests that if these sites are impacted, the extent is minor relative to reference conditions. The site located on Little Bayou Creek (LUK 7.2) may be moderately impacted by a toxicant, as evidenced by low density and richness values. The suspected source of this toxicant has been identified as Outfall 011. However, the presence of poor habitat at this site cannot be discounted. Although MAK 13.8 does not appear to support large numbers of benthic macroinvertebrates, the relatively diverse community present validates its usefulness as a reference site.

1. INTRODUCTION

L. A. Kszos

On September 24, 1987, the Commonwealth of Kentucky Natural Resources and Environmental Protection Cabinet issued an Agreed Order that required the development of a Biological Monitoring Program (BMP) for the Paducah Gaseous Diffusion Plant (PGDP). A plan for the biological monitoring of the receiving streams (Little Bayou Creek and Big Bayou Creek) was prepared by the University of Kentucky (Birge et al. 1987), reviewed by staff at PGDP and Oak Ridge National Laboratory (ORNL), and submitted by the U.S. Department of Energy (DOE) to the Kentucky Division of Water (KDOW) for approval. The PGDP BMP was implemented in 1987 and consisted of ecological surveys, toxicity monitoring of effluents and receiving streams, evaluation of bioaccumulation of trace contaminants in biota, and supplemental chemical characterization of effluents. The goals of the BMP are to (1) evaluate the acceptability of PGDP effluents under the Kentucky Pollutant Discharge Elimination System (KPDES) regulatory program, (2) characterize the potential environmental impacts of PGDP effluents, and (3) make recommendations on any changes necessary to improve effluent discharges. The PGDP BMP was patterned after plans that were implemented in 1985 for the Oak Ridge Y-12 Plant (Loar et al. 1989) and in 1986 for ORNL (Loar et al. 1991) and the Oak Ridge Gaseous Diffusion Plant (presently the Oak Ridge K-25 Site, Kszos et al. 1993). Because research staff from the Environmental Sciences Division (ESD) at ORNL were experienced in biological monitoring, they served as reviewers and advisers throughout the planning and implementation of the PGDP BMP. Data resulting from BMP conducted by the University of Kentucky were presented in a 3-year draft report issued in December 1990 (Birge et al. 1990) and an annual report issued in December 1991 (Birge et al. 1992).

Beginning in fall 1991, ESD added data collection and report preparation to its responsibilities for the PGDP BMP. The BMP has been continued because it has proven to be extremely valuable in (1) identifying those effluents with the potential for adversely affecting instream fauna, (2) assessing the ecological health of receiving streams,

(3) guiding plans for remediation, and (4) protecting human health. For example, BMP revealed the accumulation of polychlorinated biphenyls (PCBs) in fish from selected reaches of the Bayou watershed, a finding that prompted issuance of a fish consumption advisory for Little Bayou Creek by the Kentucky Department for Environmental Protection. Continuation of the program will also provide a data base that can be used to determine the adequacy and efficacy of remedial actions that are implemented and to detect any new or unsuspected toxicants that are released in effluents.

In September 1992, a renewed KPDES permit was issued to PGDP. As of this writing, a new Agreed Order is in draft form. The renewed permit requires toxicity monitoring of continuous and intermittent outfalls on a quarterly basis. A BMP is not required in either the draft Agreed Order or the renewed permit. However, biological monitoring of the DOE facilities at PGDP, at Oak Ridge, Tennessee, and at Portsmouth, Ohio, is required under DOE Order 5400.1. Data collected under BMP will also be used to support two studies proposed in the draft Agreed Order: (1) temperature variability and instream effects of elevated temperature from outfalls 001 and 011 and (2) development of site-specific metal limits for outfalls.

The BMP for PGDP consists of three major tasks: (1) effluent and ambient toxicity monitoring, (2) bioaccumulation studies, and (3) ecological surveys of stream communities (i.e., benthic macroinvertebrates and fish). This report includes ESD activities occurring from December 1993 to December 1994, although activities conducted outside this time period are included as appropriate.

2. DESCRIPTION OF STUDY AREA[1]

2.1 SITE DESCRIPTION *(R. L. Hinzman)*

The PGDP is owned by the United States Department of Energy (DOE). Production facilities are leased to the United States Enrichment Corporation (USEC) and are managed by Martin Marietta Utility Systems, Inc. (MMUS). The environmental restoration and waste management activities are managed by Martin Marietta Energy Systems, Inc. (MMES). The plant was constructed in 1951 and is an active uranium enrichment facility consisting of a diffusion cascade and extensive support facilities (Kornegay et al. 1992a). The uranium enrichment gaseous diffusion process involves more than 1800 stages with operations housed in 5 buildings covering ~300 ha. Including support facilities, the plant has ~30 permanent buildings located on a 1385-ha site (Oakes et al. 1987). Support facilities include a steam plant, four electrical switchyards, four sets of cooling towers, a chemical cleaning and decontamination facility, water and wastewater treatment plants, a chromium reduction facility, maintenance and laboratory facilities, and two active landfills. Several inactive facilities are also located on the site. Currently, the Paducah cascade processes are being used for the enrichment of uranium up to 2% ^{235}U. This product is then transferred to the Portsmouth (Ohio) Gaseous Diffusion Plant for further enrichment (Oakes et al. 1987). Most of the uranium produced is used for national defense and commercial reactors in the United States and abroad.

2.1.1 Land Use

The area surrounding PGDP is mostly rural, with residences and farms surrounding the plant. Immediately adjacent to PGDP is the West Kentucky Wildlife Management Area (WKWMA), 2821 ha comprising natural habitat, state-maintained forage crops, and ponds, for use by hunters and fishermen. About 20 of the 35 ponds support fishing, and ~200 deer are harvested annually.

[1]Sections 2.1 and 2.2 contain large excerpts from: T. G. Jett, Surface Water, Section 4. pp 4.3–4.13. *IN* Kornegay et al. 1993. Paducah Gaseous Diffusion Plant Environmental Report for 1992. ES/ESH-22/V3. Oak Ridge National Laboratory. Oak Ridge, Tenn.

The population within the 80-km radius of the plant is about 300,500 people. The unincorporated communities of Grahamville and Heath are within 2–3 km, east of the facility. The largest cities in the region are Paducah, Kentucky, and Cape Girardeau, Missouri, located about 16 and 64 air km away respectively (U.S. Department of Commerce 1991).

2.1.2 Geohydrology

PGDP is located in the Jackson Purchase region of western Kentucky. It lies in the northern margin of the Mississippi Embayment portion of the Gulf Coastal Plain Province. The Mississippi Embayment was a large sedimentary trough, oriented roughly north-south, which existed during the Cretaceous and Tertiary periods. The sedimentary sequence overlying the Mississippian age bedrock in the vicinity of PGDP consists mainly of fine- to medium-grained clastic materials, including (from youngest to oldest) a basal gravel (i.e., Tuscaloosa Formation) or rubble zone, the McNary Formation, the Porters Creek Clay, and undifferentiated Eocene sands.

Following deposition of the embayment sediments, the embayment was either uplifted and/or sea level lowered, resulting in the development of an erosional surface that truncated the sediments. Subsequently, during the late Tertiary and Quaternary periods, a unit designated as the Continental Deposits was laid down in the region. The Continental Deposits have been interpreted as originally being deposited in an alluvial fan that covered most of the Jackson Purchase region (Olive 1980). The Continental Deposits have been informally divided into a lower gravel region and an upper silt or clay unit; each unit varies in thickness from 0 to 32 m. The clay facies are believed to consist of discontinuous fine sand lenses enclosed by clay; however, this interpretation is based on limited data, and the degree of interconnectedness of the interbedded sand lenses cannot be verified at this time (Kornegay et al. 1992a). Immediately overlying the Continental Deposits, Pleistocene loess (originating as windblown material generated by glacial activity) was deposited in a layer of variable thickness (3–10 m). Recent Ohio River alluvial deposits occur at lower elevations along the river's floodplain.

Current understanding of local groundwater hydrology in the vicinity of PGDP is dominated by the recognized importance of the Continental Deposits. This hydrologic unit is termed the regional gravel aquifer (RGA) and is the uppermost aquifer underlying most of PGDP and the contiguous area north. This groundwater flow system is primarily developed in Pleistocene sands and gravels of the lower member of the Continental Deposits, ~13 to 33 m beneath PGDP. The Continental Deposits rest upon terraces cut by the ancestral Tennessee and Tennessee-Ohio rivers. Terrace escarpments occurring under the south end of PGDP form the southern limit of the RGA.

Groundwater flow in the loess and the upper member of the Continental Deposits is primarily oriented downward because of the interbedded sand and gravel lenses and the significantly lower potentiometric surface of the RGA. Within the RGA, flow is directed north, discharging into the Ohio River. The hydrology of the RGA was first investigated by the U.S. Geological Service (USGS) in the mid 1960s. Results of these studies indicated that the gravel is saturated over most of its areal extent in the region of the plant, and wells completed within it are reported to be capable of producing yields of up to 3790 L/min. For a more detailed description of the geohydrology of the area, see Kornegay et al. 1992a; CH2M Hill 1991; D'Appolonia 1983; TERRAN 1990; GeoTrans 1990.

2.1.3 Surface Water

The PGDP is located in the western part of the Ohio River basin. The confluence of the Ohio River with the Tennessee River is ~24 km upstream of the site, and the confluence of the Ohio River with the Mississippi River is ~90 km downstream of the site. Surface drainage from PGDP is two small tributaries of the Ohio River, Big Bayou Creek and Little Bayou Creek (Fig. 2.1). These streams meet ~4.8 km north of the site and discharge to the Ohio River at kilometer 1524 (Fig. 2.2), which is ~56 km upstream of the confluence of the Ohio and Mississippi Rivers. The PGDP is located on a local drainage divide; surface flow is east-northeast toward Little Bayou Creek and west-northwest toward Big Bayou Creek. Big Bayou Creek is a perennial stream with a drainage basin extending from ~4 km south of PGDP to the Ohio River; part of its 14.5-km course flows along the western boundary of the plant. Little Bayou Creek originates in the WKWMA and flows for 10.5 km north toward the Ohio River; its course includes part of the eastern boundary of the plant. The watershed areas for Big Bayou Creek and Little Bayou Creek are about 4819 and 2428 ha respectively. These streams exhibit widely fluctuating

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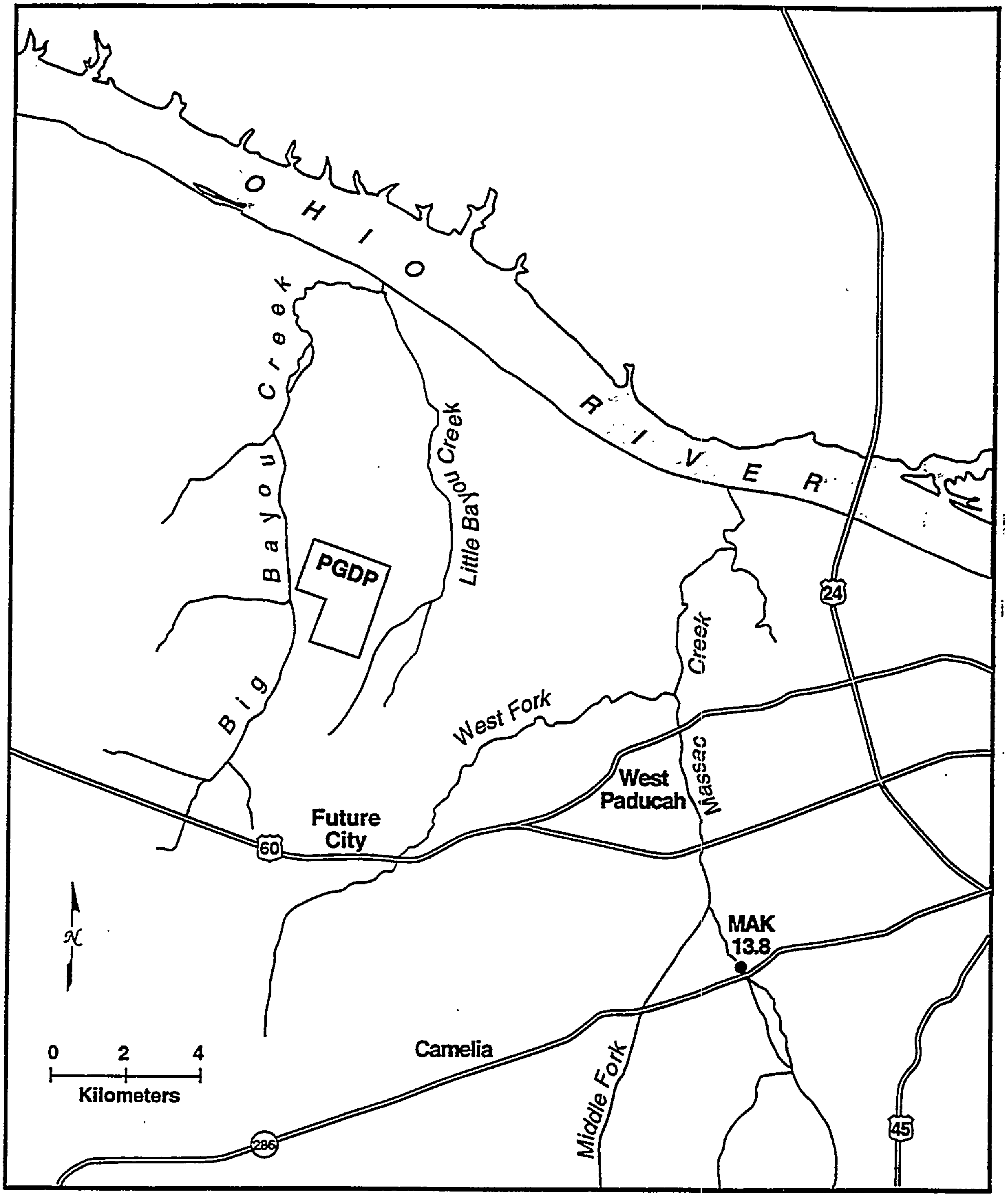
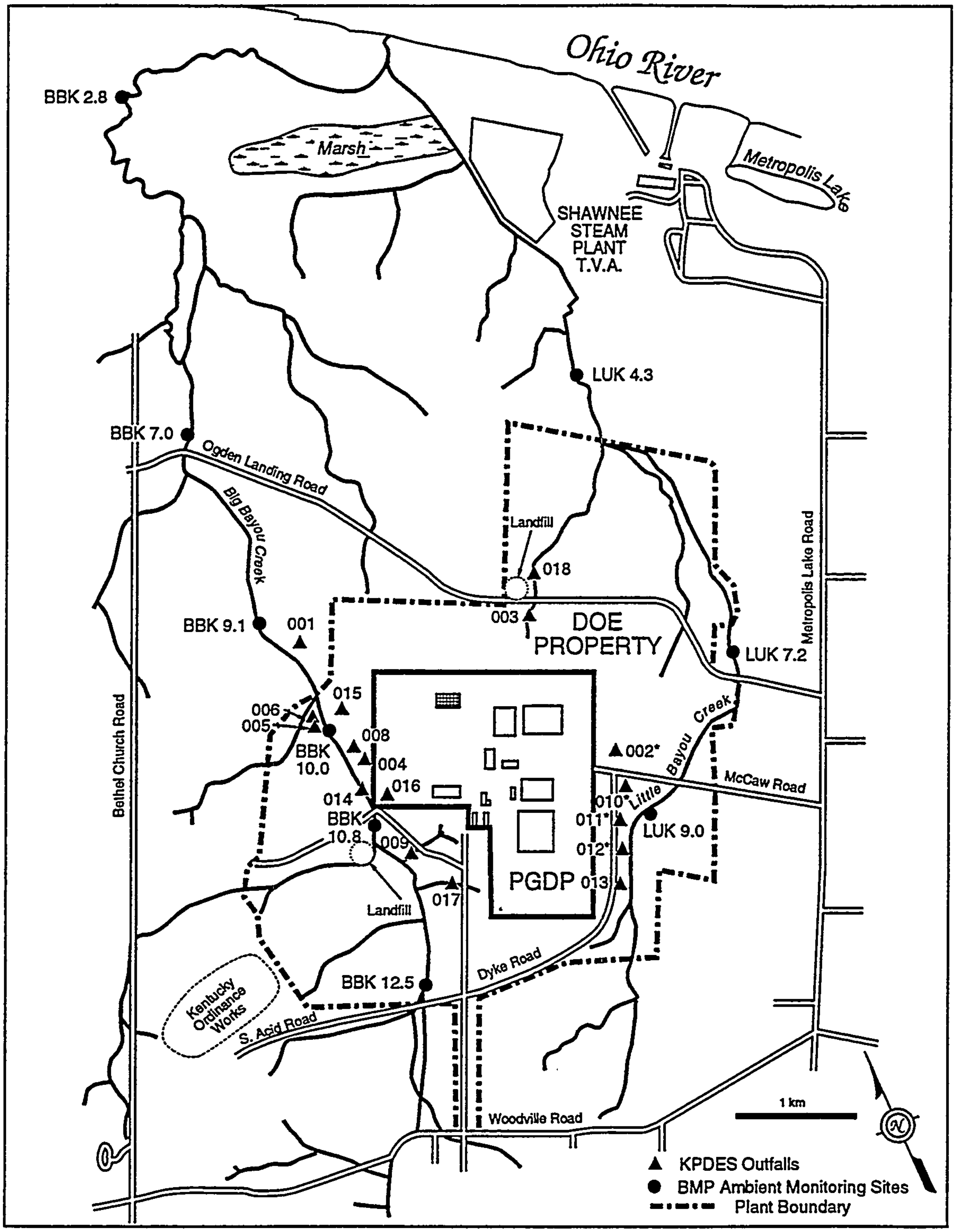


Fig. 2.1. Map of Paducah Gaseous Diffusion Plant (PGDP) in relation to the geographic region. The reference site for PGDP biological monitoring activities is located on Massac Creek at kilometer (MAK) 13.8.

ORNL-DWG 95M-7164R



*Combined at C617 pond and discharged through 011/010

Fig. 2.2. Location of Biological Monitoring Program (BMP) sites and Kentucky Pollutant Discharge Elimination System (KPDES) permitted outfalls for the Paducah Gaseous Diffusion Plant (PGDP). BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; T.V.A. = Tennessee Valley Authority; DOE = U.S. Department of Energy.

discharge characteristics that are closely tied to local precipitation and facility effluent discharge rates. Natural runoff makes up a small portion of the flow; and, during dry weather, effluents from PGDP operations can constitute about 85% of the normal flow in Big Bayou Creek and 100% in Little Bayou Creek. During the dry season which extends from summer to early fall, no-flow conditions may occur in the upper section of Little Bayou Creek (Birge et al. 1992). Precipitation in the region averages about 120 cm per year. Precipitation was 83 cm in 1991 (69% of normal), with one major storm (≥5 cm in 24–48 hours). Precipitation was 104 cm in 1992 (87% of normal) with three major storms. Precipitation in 1993 was greater than 150 cm (November data are missing; >125% of normal). There were five major storms in 1993. Two of the storms occurred in February; one storm had 20 cm of snow and 2 cm of rain, the other had 18 cm of snow and 3 cm of rain. Precipitation in 1994 was 138 cm (115% of normal) with two major storms. The lower Bayou drainage has low to moderate gradient, and the lower reaches are within the flood plain of the Ohio River. The drainage basin is included in ecoregion 72 (Interior River Lowland) of the contiguous United States (Omernik 1987). Vegetation is a mosaic of forest, woodland, pasture, and cropland.

The majority of effluents at PGDP consist of once-through cooling water, although a variety of effluents (uranium-contaminated as well as noncontaminated) result from activities associated with uranium precipitation and facility-cleaning operations. Conventional liquid discharges such as domestic sewage, steam-plant wastewaters, and coal-pile runoff also occur. Routine monitoring activities provide data to quantify total discharges to surface water in order to demonstrate compliance with federal, state, and DOE requirements. Monitoring also assists with evaluating the effectiveness of effluent treatment and control programs.

2.2 WATER QUALITY AND PGDP EFFLUENTS *(R. L. Hinzman)*

The Clean Water Act is currently administered for PGDP by the Kentucky Division of Water (KDOW) through the KPDES Wastewater Discharge Permitting Program. A National Pollutant Discharge Elimination System (NPDES) permit (KY0004049), issued by Region IV of the U.S. Environmental Protection Agency (EPA), became effective February 15, 1975. The NPDES permit was revised February 4, 1977, and expired in 1980. Although PGDP had applied for a new permit, no system was in place at KDOW to replace the NPDES permit and a new permit could not be issued. PGDP operated under the original 1975 NPDES permit until the state of Kentucky issued the KPDES permit (KY0004049). On November 5, 1986, the state permit was adjudicated because the permit limits were not achievable. As part of the negotiations associated with the adjudication process, an Agreed Order was proposed that included interim limits while a biological monitoring study was conducted at PGDP. The KPDES permit expired in October 1991; however, monitoring continued under the KPDES Agreed Order. By submitting permit renewal documents in May 1991, PGDP complied with regulations that allow the continued discharge of wastewater under the auspices of the expired permit. KDOW issued KPDES Permit No. KY0004049 to PGDP in September 1992. This permit became effective November 1, 1992, and is enforced by the KDOW. At the request of PGDP, the state of Kentucky granted a stay of permit limits for pH, metals, toxicity, and temperature in October 1992. PGDP is working with KDOW to approve an Agreed Order concerning the establishment of final limits for these parameters. All other conditions stated in the permit are in effect (Kornegay et al. 1993).

Monitoring of 17 individual outfalls is conducted in accordance with the KPDES Agreed Order. Table 2.1 lists all outfalls and their contributing processes; Fig. 2.2 shows the location of the outfalls. Eight of the 17 outfalls discharge continuously to the receiving streams. Outfalls 001, 006, 008, and 009 discharge continuously to Big Bayou Creek; Outfalls 002, 010, and 012 are combined at the C-617 pond and discharge through Outfall 010 continuously to Little Bayou Creek. After PCBs were detected in sediments from Outfall 011 in June 1994, the combined C-617 lagoon discharge was diverted on a full-time basis to Outfall 010. Outfall 011 has been a stormwater outfall since the change (C. C. Travis, Environmental Waste Management Division, Environmental Compliance Department, personal communication).

Detections of PCBs at Outfall 011 and 012 are believed to be the result of the mobilization of PCB contaminated sediment into the sewer and drainage system. A total of eleven PCB exceedances were recorded for Outfalls 011 and 012 during 1994 (Table 2.2). Concentrations of PCBs ranged from 0.1–0.6 μg/L (the maximum daily permit limit is 0.000079 μg/L). While the mobilization of PCBs in sediment may be attributable to the line ruptures described below, no definite connection can be made. Increased construction activity associated with Environmental Restoration and Waste

Table 2.1. Kentucky Pollutant Discharge Elimination System (KPDES) permitted outfalls at Paducah Gaseous Diffusion Plant

Location[a]	Discharge source	Flow[b]	Contributing processes
001	C-616, C-600, C-400, C-410, C-635, C-335, C-337, C-535, C-537, C-746-A, C-747-A, C-635-6	6.2±4.3	Recirculating cooling water blowdown treatment effluent, coal-pile runoff, once-through cooling water, surface runoff, roof and floor drains, treated uranium solutions, sink drains
002	C-360, C-637, C-337-A	0.4±0.6	Once through cooling water, roof and floor drains, sink drains, extended aeration sewage treatment system
003	North edge of plant	2.8	Storm overflow of north/south diversion ditch discharges
004	C-615 sewage treatment plant, C-710, C-728, C-750, C-100, C-620, C-400	1.5±0.2	Domestic sewage, laboratory sink drains, motor cleaning, garage drains, laundry, machine coolant treatment filtrate, condensate blowdown, once-through cooling water
005	C-611 primary sludge lagoon	NM[c]	Water treatment plant sludge, sand filter backwash, laboratory sink drains
006	C-611 secondary lagoon	2.7±1.1	Water treatment plant sludge, sand filter backwash, laboratory sink drains from outfall 005
007	Outfall eliminated	NM[c]	
008	C-743, C-742, C-741, C-723, C-721, C-728, C-729, C-400, C-420, C-410, C-727, C-411, C-331, C-310, C-724, C-744, C-600, C-405, C-409, C-631, C-720	4.5±3.2	Surface drainage, roof and floor drains, once-through cooling water, paint shop discharge, condensate, instrument shop cleaning area, metal-cleaning rinse water, sink drains
009	C-810, C-811, C-331, C-333, C-310, C-100, C-102, C-101, C-212, C-200, C-300, C-320, C-302, C-750, C-710, C-720	1.7±4.6	Surface drainage, roof and floor drains, condensate, once-through cooling water, sink drains
010	C-531, C-340, C-533, C-532, C-315, C-333, C-331	NA	Switchyard runoff, roof and floor drains, condensate, sink drains, once-through cooling water,
011		NA	Stormwater runoff
012	C-633, C-533, C-333-A	0.6±1.2	Roof, floor, and sink drains, condensate, surface runoff, extended aeration sewage treatment system
013	Southeast corner of the plant	5.3±8.1	Surface runoff
014	C-611 U-shaped sludge lagoon	NM[c]	Sand filter backwash, sanitary water
015	West central plant areas	1.5±3.7	Surface runoff
016	Southwest corner of the plant	4.7±6.3	Surface runoff
017	Extreme south area of the plant	0.8±1.8	Surface runoff
018	Landfill at north of plant	4.97[d]	Surface runoff

[a]Numeral indicates outfall designation. Locations also identified in Fig. 2.2 of this report.
[b]Mean discharge in millions of liters per day ± 1 standard deviation. NA = not available.
[c]NM = Not monitored
[d]Mean value based on 11 KPDES measurements for 1994, see Table A-15.

Note: This table was taken from Kornegay et al. 1993 (Paducah Gaseous Diffusion Plant Environmental Report for 1992. ES/ESH-36. Oak Ridge National Laboratory, Oak Ridge, Tennessee) and Birge et al. 1992 (Biological Monitoring Program for the Paducah Gaseous Diffusion Plant. Annual Report for Study Period October 1990 through March 31, 1992. University of Kentucky, Lexington, Kentucky).

Table 2.2. Exceedances in 1994 for parameters for which permit limits are still in effect

Parameter	Outfall	Date	Limit (daily maximum)	Result
Residual chlorine	002	3/14/94	0.019 mg/L	0.1 mg/L
PCB	011	4/18/94	0.000079 μg/L	0.2 μg/L
PCB	011	4/26/94	0.000079 μg/L	0.1 μg/L
PCB	011	5/23/94	0.000079 μg/L	0.1 μg/L
PCB	011	6/06/94	0.000079 μg/L	0.1 μg/L
PCB	011	6/24/94	0.000079 μg/L	0.6 μg/L
PCB	011	7/06/94	0.000079 μg/L	0.15 μg/L
PCB	011	8/29/94	0.000079 μg/L	0.1 μg/L
PCB	012	8/29/94	0.000079 μg/L	0.1 μg/L
PCB	011	9/24/94	0.000079 μg/L	0.13 μg/L
PCB	011	10/13/94	0.000079 μg/L	0.1 μg/L
PCB	012	10/13/94	0.000079 μg/L	0.26 μg/L
Residual chlorine	011	10/13/94	0.019 mg/L	0.06 mg/L

Note: PCB = polychlorinated biphenyl. Data provided by C. C. Travis, Environmental Waste Management Division, Environmental Compliance Department.

Management projects may be another possible explanation for the mobilization of PCBs. However, this activity does not appear to have increased suspended sediment levels in the plant effluents, so no direct correlation can be made (C. C. Travis, Environmental Waste Management Division, Environmental Compliance Department, personal communication).

Two exceedances of the chlorine permit limit were recorded in 1994 (Table 2.2). On March 14, 1994, a recirculating cooling water (RCW) line ruptured at Outfall 002. The RCW line is underground and contains water at approximately 60°C. The failure released approximately 310,000 L of water into the drainage system and lasted less than four hours. Measured total residual chlorine (TRC) values were 0.1 mg/L (the daily maximum limit is 0.019 mg/L). An underground potable water line ruptured in May, releasing about 946,000 L of potable water which overflowed the 012 lift station and discharged through Outfall 012; there was no exceedance associated with this discharge. A second chlorine exceedance occurred October 13, 1994, at Outfall 011. The concentration of TRC was 0.06 mg/L. No cause was determined for this exceedance.

Summary statistics (mean, maximum, minimum, and the number of observations) for KPDES chemical parameters for 1994 observed at each outfall are given in Appendix A (Tables A.1 to A.15). Water quality in 1994 differed little from water quality in 1993. In general, water quality in the outfalls was characterized by occasional increases in concentrations of some metals. Metals of concern included Cd, Cr, Cu, Pb, Ni, and Zn. Maximum values for one or more of these metals have exceeded EPA water quality criteria at most outfalls in 1994 (Tables A.1–A.15; EPA 1986). Currently, KDOW has issued a stay on limits for the aforementioned metals. The PGDP and KDOW have agreed that PGDP will conduct a study to determine whether alternative metal limits are justified based on concentrations of dissolved metals in the outfalls; current limits are based on concentrations of total metals. The KDOW will review the information developed to determine metal limits. Maximum pH levels exceeded water quality criteria at Outfalls 001, 006, 010, 011, and 014 in 1994. The PGDP has met the interim limit for pH (6.0–10.5) in all cases, however, the permit limit currently under negotiation is 6.0–9.0 and would have been exceeded at these outfalls. However, instream pH measurements have been within the limits set by the permit (see Sect. 3.2). The KDOW is reviewing the instream pH data collected by PGDP to determine whether in-stream monitoring of pH would be an acceptable option for PGDP to pursue. The PGDP is exploring engineering controls for temperature at outfalls 001 and 011; these controls may enable PGDP to meet permit limits for temperature at these sites. In addition, ESD staff are conducting a temperature study to evaluate the effects of elevated temperatures on the biota of Big Bayou and Little Bayou creeks. Mean hardness values at Outfall 001 were about twice as high in 1992 and 1993 than in previous years (Table 5.3 in Birge et al. 1992). Hardness was reduced substantially in 1994 (mean hardness was 99 mg/L in 1994 compared with 364 mg/L in 1993). A discussion of current instream water quality monitoring occurs in Sect. 3.2 of this report. Discussions of previous water quality monitoring efforts can be found in Birge et al. 1992.

Flow from the north/south diversion ditch is normally channeled through Outfall 001 by a lift station that pumps the effluent through the C-616 full-flow lagoon. However, during rainfalls with flows that have maximum daily averages greater than a 10-year occurrence interval, the lift station overflows to Outfall 003. This is the only time that Outfall 003 is monitored. Outfall 005 is not monitored regularly because its effluent flows into the C-611 secondary lagoon. Outfall 006, the C-611 secondary lagoon, is monitored for the same parameters as those required for Outfall 005. Outfall 007, a septic field for the C-611 water treatment plant, is not permitted for discharge. Monitoring of Outfall 014 occurs only when the C-611 sludge lagoon is dredged (i.e., every 2 or 3 years), and the filter backwash is discharged to the outfall.

Corrective measures have been taken to reduce the number of KPDES noncompliances at PGDP. Emphasis has been placed on erosion control at construction sites, effluent ditches, and landfills. A best management practices plan for the control of suspended solids, prepared in 1991, details measures taken to prevent erosion and investigates erosion-related problems and corrective measures. The plan was submitted to and approved by the KDOW. The Plant Effluent Chlorine and Temperature Control Project became operational in October 1991, providing common lagoon (C-617) for Outfalls 002, 010, 011, and 012. This lagoon, designed to contain effluent from the outfall except during heavy rainfall, provides sodium thiosulfate feed for chlorine removal and increased holding time for temperature reduction. In addition, sodium thiosulfate feed stations were installed permanently at Outfalls 009 and 004. Once-through cooling water that originally flowed through Outfall 001 is now routed through the C-616 full-flow lagoon to allow for chlorine dissipation. In response to temperature noncompliances, leaking steam traps in several buildings were repaired or replaced and temperature noncompliances ceased.

In 1993 the chromium based inhibitor was replaced with a phosphate based inhibitor at the chromium reduction facility. The only notable change in water quality in Outfall 001 was a reduction in hardness values from 1993 to 1994. Whether this change resulted from the modification is unknown.

Dredging of the sludge lagoon at the C-611 water treatment plant was initiated in September 1993. Currently the clarifier bottoms are being discharged directly into the full flow lagoon for settling. This change did not resulted in permit violations, and no changes in water quality were noted as a result of this action. The sludge lagoon was returned to service March 25, 1994.

2.3 DESCRIPTION OF STUDY SITES *(J. G. Smith, M. J. Peterson, and M. G. Ryon)*

Three sites on Big Bayou Creek (Fig. 2.2), Big Bayou Creek kilometer (BBK) 12.5, BBK 10.0, and BBK 9.1; one site on Little Bayou Creek (Fig. 2.2), Little Bayou Creek kilometer (LUK) 7.2; and one off-site reference station on Massac Creek (Fig. 2.1), Massac Creek kilometer (MAK) 13.8, were routinely sampled to assess the ecological health of the stream. Sites BBK 12.5, BBK 9.1, LUK 7.2, and MAK 13.8 were routinely sampled to evaluate ambient toxicity. A summary of the site locations is given in Table 2.3. Three additional sites (BBK 2.8, LUK 9.0, and LUK 4.3; Fig 2.2) were sampled as part of the bioaccumulation monitoring task. Hinds Creek in East Tennessee also served as a reference site for the bioaccumulation monitoring task. A description of the sampling locations for the bioaccumulation monitoring is provided in Sect. 4. Site selection and sampling locations for the ecological monitoring studies are described below. Ambient toxicity monitoring sites were chosen to correspond with those used for ecological monitoring. Biological monitoring activities conducted through December 1994 are outlined in Table 2.4. Toxicity monitoring and benthic macroinvertebrate sampling were conducted quarterly, and fish community and bioaccumulation sampling were conducted twice annually (in the spring and fall). KPDES outfalls at which effluents were evaluated for toxicity included 001, 004, 006, 008, 009, 011, 013, 015, 016, 017, and 018.

Prior to ORNL's initiation of the instream monitoring task for the PGDP BMP, a site selection study was conducted in early December 1990. This study included visits to 24 potential reference stream sites located in the vicinity of PGDP but outside its boundaries (see Table 2.4 in Kszos et al. 1994), and 5 stream sites adjacent to the boundary of PGDP: LUK 7.2, LUK 4.3, BBK 12.5, BBK 9.1, and the tributary draining Outfall 003. The site selection study also involved the collection of qualitative benthic macroinvertebrate and fish samples at some of the sites to aid in final site selection (Tables 2.5 and 2.6 in Kszos et al. 1994). Because these samples were qualitative, the results served primarily to document which taxa were present at these sites at the time of the survey. However, these qualitative data did provide some minimal information on the relative health of each stream sampled and, thus, helped in making final site selections.

Based on the site visits, biota surveys, and previous work conducted by the University of Kentucky (Birge et al. 1990), five stream sites were included in the instream monitoring task of the BMP. A list of the selected sites and a summary of their locations are given in

Table 2.3. Locations and names of sampling sites included in Paducah Gaseous Diffusion Plant Biological Monitoring Program for the Instream Monitoring Task

Current site name[a]	Location[b]	Former name/site[c]
Big Bayou Creek		
BBK 12.5	~200 m downstream of bridge on South Acid Road	BB1
BBK 10.0	~50 m upstream of Outfall 006	BB4
BBK 9.1	~25 m upstream of flume at gaging station at Bobo Road	BB7
Little Bayou Creek		
LUK 7.2	~110 m downstream of bridge on Route 358	LB3
Massac Creek		
MAK 13.8	~40 m upstream of bridge on Route 62, 10 km SE of PGDP	Not sampled

[a]Site names are based on stream name and distance of the site from the mouth of the stream. For example, BB7 is designated as Big Bayou Creek Kilometer (BBK) 9.1 and is located 9.1 km upstream of the mouth; LUK = Little Bayou Creek kilometer; and MAK = Massac Creek kilometer.

[b]Locations are based on approximate distances from a major landmark (e.g., bridge or outfall) to the bottom of the reach.

[c]Site designations formerly used by the University of Kentucky.

Table 2.4. Sampling schedule for the four components of the Biological Monitoring Program at Paducah Gaseous Diffusion Plant for January–December 1994

Month	Toxicity monitoring	Benthic macroinvertebrates	Fishes	Bioaccumulation
Jan.				
Feb.				
Mar.	X	X	X	
Apr.				X
May	X			X[b]
June		X	X[a]	
July				
Aug.	X			
Sept.		X	X	X
Oct.	X			
Nov.				
Dec.		X		

[a]Qualitative survey of Massac Creek watershed.

[b]Big Bayou Creek kilometer 2.8 only.

Table 2.3; their locations in relation to the PGDP are shown in Fig. 2.1 and Fig. 2.2. Final sampling locations within each selected site were made in June 1991 during a habitat characterization study. This study included measurements of vegetative cover, bank structure, channel morphology, substrate and cover variables, and flow conditions. Pertinent results of this study for each site are presented in sections 2.3.1–2.3.3 and Table 2.7 in Kszos et al. 1994.

3. TOXICITY MONITORING

L. A. Kszos and J. R. Sumner

The toxicity monitoring task for BMP consists of two subtasks. The first measures the toxicity of effluents as required by the KPDES permit. The second monitors ambient water toxicity of three sites in Big Bayou Creek, one site in Little Bayou Creek, and one reference site in Massac Creek. The effluent toxicity data are presented in Sect. 3.1; the ambient toxicity data are presented in Sect. 3.2.

3.1 EFFLUENT TOXICITY

3.1.1 Introduction

The EPA supports the use of aquatic test organisms to determine the chronic toxicity of a test water (Weber et al. 1989). Toxicity monitoring at PGDP uses the Cladoceran (*Ceriodaphnia dubia*) Survival and Reproduction Test (hereinafter referred to as the *Ceriodaphnia* test) and the Fathead Minnow (*Pimephales promelas*) Larval Survival and Growth Test (hereinafter referred to as the fathead minnow test; Weber et al. 1989) concurrently to characterize the toxicity of the continuous and intermittent effluents that discharge into Big Bayou and Little Bayou creeks. These two tests are EPA-approved for use to estimate (1) the chronic toxicity of effluents collected at the end of the discharge pipe and tested with a standard dilution water; (2) the toxicity of receiving water downstream from or within the influence of the outfall; and (3) the effects of multiple discharges on the quality of the receiving water (Weber et al. 1989). These tests are also part of the Biological Monitoring and Abatement Programs at ORNL, the Oak Ridge K-25 Site, and the Oak Ridge Y-12 Plant.

The ESD Toxicology Laboratory at ORNL began evaluating the toxicity of continuous and intermittent outfalls at PGDP in October 1991. As required by a draft Agreed Order, *Ceriodaphnia* and fathead minnow tests were conducted quarterly. In September 1992, a renewed KPDES permit was issued to PGDP. Under the requirements of this permit, *Ceriodaphnia* and fathead minnow tests were continued on a quarterly basis.

3.1.2 Materials and Methods

Toxicity tests of effluents from the continuously flowing outfalls (001, 006, 008, 009, and 011) and the intermittently flowing outfalls (013, 015, 016, 017, and 018) were conducted according to the schedule shown in Tables 3.1 and 3.2 respectively. After PCBs were detected at Outfall 011 in June 1994, effluent from the C-617 lagoon was diverted from Outfall 011 to Outfall 010. As a result, effluent from Outfall 010 was tested for toxicity in August and October 1994 instead of Outfall 011. This report includes all tests conducted from 1991 to 1994 by ESD. Most of the outfalls have been evaluated at least 13 times.

Prior to September 1992, tests of the continuously flowing outfalls were conducted using seven consecutive, daily grab samples collected at the KPDES discharge points. Subsequent tests used seven 24-h composite samples as required by the renewed KPDES permit. Samples from the continuously flowing outfalls were collected by personnel from ESD and transported to a nearby offsite laboratory at the Paducah Community College. During one test period, October 1994, samples from the continuously flowing outfalls were collected by personnel from PGDP, refrigerated, and shipped to ESD using 24-h delivery. The intermittently flowing outfalls are rainfall dependent; thus, tests were conducted using one grab sample. Samples from the intermittently flowing outfalls were collected by personnel from PGDP, refrigerated, and shipped to ESD using 24-h delivery. All samples were collected and delivered according to established chain-of-custody procedures (Kszos et al. 1989). Time of collection, water temperature, and arrival time in the laboratory were recorded.

Tests with *Ceriodaphnia* and fathead minnows were typically conducted concurrently following procedures outlined in Weber et al. (1989) and Kszos et al. (1989). These tests are static-renewal tests, meaning that test water is replaced daily for 6 or 7 consecutive days. The fathead minnow test consists of four replicates per test concentration with ten animals per replicate. Each day before the water was replaced, the number of surviving larvae was recorded. At the end of 7 d, the larvae were dried and weighed to obtain an estimate of growth. The *Ceriodaphnia* test consists of ten replicates per test concentration with one animal per replicate. Each day the animals were transferred from a beaker containing old test solution and placed in a beaker containing fresh test solution. At this

Table 3.1. Summary of toxicity test dates for continuous outfalls

Outfall	Test date	Species
001, 006, 008, 009, 011	October 24–31, 1991	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	February 13–20, 1992	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	May 21–28, 1992	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	August 13–20, 1992	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	October 22–29, 1992	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	February 11–18, 1993	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	May 20–27, 1993	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	August 19–16, 1993	*Ceriodaphnia* and Fathead minnow
001, 006, 008, 009, 011	October 14–21, 1993	*Ceriodaphnia* and Fathead minnow
008	December 2–9, 1993	Fathead minnow
001, 006, 008, 009, 011	March 10–17, 1994	*Ceriodaphnia* and Fathead minnow
006, 011	March 25–April 1, 1994	Fathead minnow
006, 011	April 28–May 5, 1994	*Ceriodaphnia* and Fathead minnow
001, 008, 009	May 25–June 2, 1994	*Ceriodaphnia* and Fathead minnow
008, 009	June 16–23, 1994	Fathead minnow
001, 006, 008, 009, 010	August 11–18, 1994	*Ceriodaphnia* and Fathead minnow
006	September 8–16, 1994	*Ceriodaphnia*
008, 009	September 8–16, 1994	Fathead minnow
001, 006, 008, 009, 010	October 27–November 4, 1994	*Ceriodaphnia* and Fathead minnow
001	November 16–23, 1994	*Ceriodaphnia*
009	November 16–23, 1994	Fathead minnow

Table 3.2. Summary of toxicity test dates for intermittent outfalls

Outfall	Test Date	Species
013, 015, 016, 017, 018	December 27, 1991- January 3, 1992	*Ceriodaphnia* and Fathead minnow
	March 20-27, 1992	*Ceriodaphnia* and Fathead minnow
	June 26 - July 3, 1992[a]	*Ceriodaphnia* and Fathead minnow
	September 22-29, 1992	Fathead minnow
	September 29 - October 6, 1992	*Ceriodaphnia*
	November 13-20, 1992	*Ceriodaphnia* and Fathead minnow
	January 6-13, 1993	*Ceriodaphnia* and Fathead minnow
	May 4-11, 1993	*Ceriodaphnia* and Fathead minnow
	September 16-23, 1993	*Ceriodaphnia* and Fathead minnow
	November 16-23, 1993	*Ceriodaphnia* and Fathead minnow
	February 15-22, 1994	*Ceriodaphnia* and Fathead minnow
	April 7-14, 1994	*Ceriodaphnia* and Fathead minnow
	September 24 - October 1, 1994	*Ceriodaphnia* and Fathead minnow
	November 17-24, 1994	*Ceriodaphnia* and Fathead minnow

[a]Outfall 016 was not tested due to lack of flow.

time, survival and the number of offspring produced were recorded. A control consisting of dilute mineral water augmented with trace metals was included with each test. On each day of a test, subsamples of each effluent were routinely analyzed for pH, conductivity, alkalinity, water hardness, and total residual and free chlorine (Kszos et al. 1989).

During December 1994, various treatments were used to investigate the type(s) of compounds causing toxicity in effluent from Outfall 009. Subsamples of the effluent were treated as follows: (1) ultraviolet radiation (UV) for 20 minutes to kill naturally occurring pathogens and viruses; (2) aerated for 1-h to remove volatiles; (3) filtered through 0.2 μm nuclepore filters to remove suspended particles; (4) C_{18} solid phase extracted to remove suspended particles and organics; (5) adjusted from ambient pH and maintained at pH 6 or 8 throughout the test period to determine if the toxicity was pH sensitive; (6) treated with a chelating agent (1.0 mg/L EDTA) to bind divalent metals; or (7) treated with sodium thiosulfate to remove oxidants. The nontreated and treated samples were then tested for toxicity with fathead minnow larvae.

During tests conducted in May 1993, February 1994, April 1994, and September 1994, subsamples of effluent from 018 were filtered through glass microfiber filters (1.2 μm) to remove suspended solids. Fathead minnow tests were then conducted using nontreated and filtered effluent samples. The amount of suspended solids in the effluent was measured by filtering a known volume of effluent through a pre-dried, pre-weighed filter.

A linear interpolation method (Weber et al. 1989) was used to determine the 25% inhibition concentration (IC25, that concentration causing a 25% reduction in fathead minnow growth or *Ceriodaphnia* survival compared to a control). A computer program (A Linear Interpolation Method for Sublethal Toxicity: Inhibition Concentration (ICp) Approach, version 2.0) distributed by the EPA (Environmental Research Laboratory, Duluth, Minnesota) was used for the calculation. The chronic toxicity unit (TUc=100/IC25) is required as a compliance endpoint in the renewed permit (September 1992 to present). The higher the TUc, the more toxic an effluent. Because Little Bayou and Big Bayou creeks have been determined to have a low flow of zero, a TUc > 1.0 would be considered a noncompliance and an indicator of potential instream toxicity. Summary statistics (e.g. mean, standard deviation) were calculated using SAS (SAS 1985a, 1985b).

3.1.3 Results

3.1.3.1 Continuously flowing Outfalls 001, 006, 008, 009, and 011

Mean survival and growth of fathead minnows and survival and mean reproduction of *Ceriodaphnia* for each outfall and test are provided in Appendixes B.1 and B.2. A summary of the TUcs for all toxicity tests conducted during 1991–94 are provided in Table 3.3. For tests conducted to date, effluent from Outfall 001 exceeded the permit limit of TUc > 1.0 for two tests (*Ceriodaphnia* in May 1992 and October 1993). Effluent from Outfall 006 exceeded the permit limit five times, twice in 1992 and three times in 1994. Two of the 1994 exceedances occurred during March for fathead minnows. The resulting TUcs were high (5.97 and 18.32). However, when the effluent was tested again during April, August, and October 1994 the TUcs for Outfall 006 were < 1.0. The third exceedance in 1994 was for *Ceriodaphnia*, where the TUc was 1.36 during August. Outfall 008 exceeded the permit limit during four fathead minnow tests. The effluent has not demonstrated toxicity to *Ceriodaphnia*. During the two exceedances for Outfall 008 in 1994, the TUcs for fathead minnows were just above the permit limit (1.30 and 1.56), and follow-up tests resulted in a TUcs < 1.0. Outfall 009 exceeded the permit limit seven times with six occurring for fathead minnow tests. Outfall 011 exceeded the permit limit three times, once in February 1992 and twice in March 1994. For the two exceedances during March 1994 the TUcs for fathead minnows were high (23.53 and 32.57); however, for tests conducted during April, August, and October 1994, the TUc < 1.

Water quality measurements (pH, conductivity, alkalinity, and hardness) for each outfall and test are provided in Appendix B.3. A summary of water quality parameters for the continuously flowing outfalls is provided in Table 3.4. The pH of the effluent samples ranged from a minimum of 6.8 (Outfall 006) to a maximum of 9.7 (Outfall 006). Effluent from Outfall 006 had the highest mean pH (8.75 S.U.). Mean alkalinity ranged from 34 (Outfall 008) to 51 mg/L $CaCO_3$ (Outfall 009). Mean hardness and conductivity were highest in effluent from Outfall 001 (402 mg/L $CaCO_3$ and 1256 μS/cm respectively). Mean hardness at the remaining outfalls ranged from 75 to 85 mg/L $CaCO_3$ and mean conductivity ranged from 224 to 262 μS/cm.

Due to four exceedances occurring for Outfall 009 in 1994 alone, steps were taken to identify the possible toxicant(s) in the effluent. During December 1994, subsamples of effluent from Outfall 009 were treated by various methods and tested for toxicity with

Table 3.3. Results of effluent toxicity tests for outfalls 001, 006, 008, 009, and 011

Outfall	Test Date	Chronic Toxicity Units (TUc)[a]	
		Fathead Minnow	*Ceriodaphnia*
001	October 1991	ND[b]	<1
	February 1992	<1	<1
	May 1992	ND[b]	4.5
	August 1992	<1	<1
	October 1992	<1	<1
	February 1993	<1	<1
	May 1993	<1	<1
	August 1993	<1	<1
	October 1993	<1	1.09
	March 1994	<1	<1
	May 1994	<1	<1
	August 1994	<1	<1
	October 1994	<1	I[d]
	November 1994	NT[c]	<1
006	October 1991	ND[b]	<1
	February 1992	1.39	1.56
	May 1992	ND[b]	<1
	August 1992	<1	<1
	October 1992	<1	<1
	February 1993	<1	<1
	May 1993	<1	I[d]
	June 1993	NT[c]	<1
	August 1993	<1	<1
	October 1993	<1	<1
	March 1994	5.97	<1
	March 1994	18.32	NT[c]
	April 1994	<1	<1
	August 1994	<1	1.36
	September 1994	NT[c]	<1
	October 1994	<1	<1

Table 3.3 (continued)

Outfall	Test Date	Chronic Toxicity Units (TUc)[a]	
		Fathead Minnow	*Ceriodaphnia*
008	October 1991	ND[b]	<1
	February 1992	9.77	<1
	May 1992	ND[b]	<1
	August 1992	<1	<1
	October 1992	<1	<1
	February 1993	<1	<1
	May 1993	<1	I[d]
	June 1993	NT[c]	<1
	August 1993	<1	<1
	October 1993	4.08	<1
	December 1993	<1	NT[c]
	March 1994	<1	<1
	May 1994	1.30	<1
	June 1994	<1	NT[c]
	August 1994	1.56	<1
	September 1994	<1	NT[c]
	October 1994	<1	<1
009	October 1991	ND[b]	<1
	February 1992	7.87	<1
	May 1992	<1	<1
	August 1992	<1	<1
	October 1992	2.16	1.05
	February 1993	<1	<1
	May 1993	<1	I[d]
	June 1993	NT[c]	<1
	August 1993	<1	<1
	October 1993	<1	<1
	March 1994	<1	<1
	May 1994	1.09	<1
	June 1994	<1	NT[c]
	August 1994	2.09	<1
	September 1994	<1	NT[c]
	October 1994	10.73	<1
	November 1994	3.38	NT[c]

Table 3.3 (continued)

Outfall	Test Date	Chronic Toxicity Units (TUc)[a]	
		Fathead Minnow	*Ceriodaphnia*
011	October 1991	ND[b]	<1
	February 1992	7.69	<1
	May 1992	ND[b]	<1
	August 1992	<1	<1
	October 1992	<1	<1
	February 1993	<1	<1
	May 1993	<1	<1
	August 1993	<1	<1
	October 1993	<1	<1
	March 1994	23.53	<1
	March 1994	32.57	NT[c]
	April 1994	<1	<1
	August 1994[e]	<1	<1
	October 1994[e]	<1	<1

[a]Chronic toxicity unit = 100/IC25; IC25 = the concentration causing a 25% reduction in fathead minnow growth or *Ceriodaphnia* reproduction. IC = inhibition concentration.
[b]ND = not determined.
[c]NT = not tested.
[d]I = Invalid test due to low reproduction in the control water.
[e]Outfall 010 tested for toxicity instead of Outfall 011.

fathead minnow larvae. Minnow survival in the nontreated effluent was 43.8% (Table 3.5). Removing suspended particles through filtration or C_{18} solid phase extraction of Outfall 009 effluent increased minnow survival to 93.8%. Minnow survival was also improved in effluent adjusted from ambient pH 7.66 to pH 8. Minnow growth was high in both the treated and nontreated effluent.

3.1.3.2 Intermittently flowing Outfalls 013, 015, 016, 017, and 018

Mean survival and growth of fathead minnows and survival and mean reproduction of *Ceriodaphnia* for each outfall and test are provided in Appendixes B.4 and B.5. A summary of the TUcs for all toxicity tests conducted during 1991–94 is provided in Table 3.6. Although PGDP does not have a compliance limit for the intermittent outfalls, TUc > 1.0 was used as a benchmark. Out of the thirty exceedances of TUc > 1.0 for the

Table 3.4. Summary of water chemistry analyses of full-strength samples from continuously flowing outfalls from 1991–94

Sample	pH (Standard units)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (μS/cm)
Outfall 001				
Mean (± SD)	8.34 (0.63)	34.5 (9.8)	402.4 (109.5)	1256.2 (317.2)
Range	7.12–9.54	23–85	134–680	489–1867
n	98	98	98	98
Outfall 006				
Mean (± SD)	8.75 (0.54)	50.3 (14.4)	85.2 (22.8)	223.5 (41.7)
Range	6.80–9.72	30–88	50–204	163–329
n	111	111	111	111
Outfall 008				
Mean (± SD)	7.39 (0.22)	34.4 (11.4)	75.4 (15.4)	261.7 (43.6)
Range	6.86–8.20	18–65	44–112	177–461
n	118	118	118	118
Outfall 009				
Mean (± SD)	7.70 (0.31)	51.2 (25.5)	84.6 (24.1)	257.2 (118.1)
Range	7.10–8.83	30–233	44–210	116–1020
n	119	119	119	119
Outfall 011 or 010				
Mean (± SD)	7.77 (0.27)	39.3 (13.7)	83.8 (21.7)	253.6 (54.7)
Range	7.27–9.15	21–77	52–158	168–491
n	98	98	98	98

effluents, toxicity to *Ceriodaphnia* was only observed in three tests (January 1993 and February 1994 for Outfall 013 and September 1994 for Outfall 018). In 1994, fathead minnows continued to be more sensitive than *Ceriodaphnia* to the effluents (Kszos et al. 1994). For tests conducted to date, effluent from Outfall 013 most frequently exceeded a TUc > 1.0 (eight times) in comparison to the other outfalls. Outfall 013 was followed by Outfalls 015, 017, and 018, each having six exceedances. Outfall 016 had the fewest exceedances, with four for fathead minnows. The average TUcs using all tests where the limit was exceeded for Outfalls 013, 015, 016, 017, and 018 were 3.9, 7.3, 7.1, 17.4, and 7.0.

Table 3.5. Summary of a toxicity identification test using fathead minnow larvae of full-strength effluent from Outfall 009, December 1994

Treatment[a]	Mean survival (%)	Mean growth (mg)	Growth SD (mg)
Control	100	0.40	0.00
Nontreated	43.8	0.50	0.12
UV-treated	18.8	0.35	0.16
Aerated	37.5	0.35	0.00
Filtered	93.8	0.49	0.03
C_{18}-Solid Phase Extraction	93.8	0.50	0.01
Adjusted to pH6	56.3	0.59	0.14
Adjusted to pH8	87.5	0.45	0.01
EDTA	50.0	0.54	0.00
Sodium thiosulfate	37.5	0.50	0.07

[a]UV-treated with ultraviolet radiation for 20 minutes; Aerated for 1-h; Filtered through a 0.2 μm nuclepore filter; 1.0 mg/L EDTA (chelating agent) added to bind divalent metals; Sodium thiosulfate added to remove oxidants.

Ranking the outfalls provided a means to compare the frequency of toxicity and mean TUcs of the outfalls. Each outfall was ranked in terms of frequency of TUc > 1.0 (5 = highest frequency and 1 = lowest frequency) and by mean TUc (5 = highest mean and 1 = lowest mean). The ranks were then summed to obtain an overall ranking (Table 3.7). Outfall 017 had the highest overall rank sum (8) and was followed by Outfalls 015 (7) and 013 (6). Outfall 013 had the greatest frequency of TUc > 1.0 (31%); however, had the lowest mean TUc (3.9) in comparison to the other outfalls. Outfall 017 had the highest mean TUc (17.4).

Water quality measurements (pH, conductivity, alkalinity, and hardness) for each outfall and test are provided in Appendix B.6. A summary of water quality parameters for each outfall is provided in Table 3.8. In general, water from the intermittent outfalls had higher alkalinity and hardness than the continuous outfalls. Mean alkalinity ranged from

Table 3.6. Results of effluent toxicity tests for Outfalls 013, 015, 016, 017, and 018

Outfall	Test Date	Chronic toxicity unit (TUc)[a]	
		Fathead minnow	*Ceriodaphnia*
013	December 1991	<1	<1
	March 1992	5.82	<1
	June 1992	1.02	<1
	September 1992	<1	<1
	November 1992	1.96	<1
	January 1993	<1	6.99
	May 1993	1.3	<1
	September 1993	1.39	<1
	November 1993	<1	<1
	February 1994	11.31	1.04
	April 1994	<1	<1
	September 1994	<1	<1
	November 1994	<1	<1
015	December 1991	<1	<1
	March 1992	7.91	<1
	June 1992	<1	<1
	September 1992	<1	ND[b]
	November 1992	<1	<1
	January 1993	1.52	<1
	May 1993	3.62	<1
	September 1993	<1	<1
	November 1993	<1	<1
	February 1994	2.04	<1
	April 1994	11.15	<1
	September 1994	<1	<1
	November 1994	17.54	<1
016	December 1991	<1	<1
	March 1992	1.74	<1
	September 1992	<1	<1
	November 1992	1.32	<1
	January 1993	2.04	<1
	May 1993	<1	<1
	September 1993	<1	<1
	November 1993	<1	<1
	February 1994	<1	<1
	April 1994	<1	<1
	September 1994	<1	<1
	November 1994	23.47	<1

Table 3.6 (continued)

Outfall	Test Date	Chronic toxicity unit (TUc)[a]	
		Fathead minnow	*Ceriodaphnia*
017	December 1991	ND[b]	<1
	March 1992	4.54	<1
	June 1992	<1	<1
	September 1992	5.01	<1
	November 1992	<1	<1
	January 1993	<1	<1
	May 1993	23.8	<1
	September 1993	<1	<1
	November 1993	<1	<1
	February 1994	2.83	<1
	April 1994	1.79	<1
	September 1994	<1	<1
	November 1994	66.23	<1
018	December 1991	<1	<1
	March 1992	5.27	<1
	June 1992	<1	<1
	September 1992	<1	<1
	November 1992	1.43	<1
	January 1993	8.47	<1
	May 1993	21.7	<1
	September 1993	<1	<1
	November 1993	<1	<1
	February 1994	<1	<1
	April 1994	1.39	<1
	September 1994	<1	3.47
	November 1994	<1	<1

[a]Chronic toxicity unit = 100/IC25; IC25 = the concentration causing a 25% reduction in fathead minnow growth or *Ceriodaphnia* reproduction. IC = inhibition concentration.
[b]ND = not determined.

57 to 120 mg/L $CaCO_3$ and mean hardness ranged from 110 to 175 mg/L $CaCO_3$. Minimum pH ranged from 6.91 to 7.75 S.U. and maximum pH ranged from 7.96 to 8.27 S.U. Mean conductivity ranged from 200 to 380μS/cm.

Filtering effluent samples from Outfall 018 significantly (ANOVA; $p = 0.0007$) improved fathead minnow survival by 5-52.5% when compared with the nonfiltered samples (Table 3.9). The difference was largest during April 1994, which was also the period with the highest concentration of suspended solids (0.13 g/L). Mean growth in the filtered effluent was not significantly different from nonfiltered effluent (Table 3.9).

Table 3.7. Ranking of intermittent outfalls based upon frequency of chronic toxicity unit (TUc) > 1.0 and mean TUc for 26 tests

Outfall	Frequency (%) of TUc > 1.0	Rank[a] of Frequency (TUc > 1)	Mean TUc	Rank[a] of Mean TUc	Sum of Ranks
013	31	5	3.9	1	6
015	23	3	7.3	4	7
016	17	1	7.1	3	4
017	23	3	17.4	5	8
018	23	3	7.0	2	5

[a]Highest rank = 5; lowest rank = 1.

Table 3.8. Summary of water chemistry analyses of full-strength samples from intermittently flowing effluents from 1991–94

Sample	pH (Standard units)	Alkalinity (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Conductivity (μS/cm)
Outfall 013				
Mean (± SD)	7.49 (0.27)	57.1 (14.7)	153.4 (99.0)	307.1 (192.9)
Range	6.91–7.96	28–81	42–360	84–704
n	14	14	14	14
Outfall 015				
Mean (± SD)	7.76 (0.26)	86.2 (25.5)	146.0 (39.6)	317.0 (118.8)
Range	7.20–8.18	42–119	76–244	153–656
n	13	13	13	13
Outfall 016				
Mean (± SD)	7.81 (0.24)	97.6 (20.6)	175.4 (90.6)	379.5 (222.0)
Range	7.35–8.20	60–122	72–446	138–856
n	13	13	13	13
Outfall 017				
Mean (± SD)	7.95 (0.16)	120.1 (22.9)	174.7 (36.3)	353.4 (80.8)
Range	7.75–8.27	70–146	92–230	175–466
n	14	14	14	14
Outfall 018				
Mean (± SD)	7.72 (0.26)	74.6 (65.1)	110.1 (40.9)	200.1 (90.2)
Range	7.23–8.13	36–295	52–162	55–342
n	14	14	14	14

Table 3.9. Comparison of fathead minnow survival and growth in filtered (1.2 μm) and nonfiltered water from outfall 018

Test Date	Treatment[a]	Mean Survival (%)	Mean Growth (± SD) (mg)	Total Suspended Solids (g/L)
May 1993	N	70.0	0.35 (0.07)	0.04
	F	92.5	0.39 (0.07)	
February 1994	N	95.0	0.45 (0.04)	0.05
	F	100	0.43 (0.06)	
April 1994	N	42.5	0.41 (0.24)	0.13
	F	95.0	0.41 (0.03)	
September 1994	N	85.0	0.40 (0.08)	Not measured
	F	92.5	0.43 (0.07)	

[a]N = none; F = filtered.

3.1.4 Summary

3.1.4.1 Continuously flowing outfalls

During 1994, no toxicity was evident in effluent samples from 001. Effluent from Outfall 008 had TUcs > 1.0 two times; however, follow-up tests demonstrated that the toxicity was transient. Outfalls 006 and 011 had high TUcs for fathead minnows during two consecutive tests in March; however, no toxicity was observed in subsequent testing during April, August, and October 1994. Outfall 006 had a TUc > 1 for *Ceriodaphnia* during August; however a retest of the effluent did not demonstrate toxicity. Outfall 009 had the greatest number of exceedances during 1994. The effluent exceeded a TUc > 1 four times with an average TUc of 4.32. Identification procedures conducted during December 1994 showed that minnow mortality in the effluent may be due to suspended solids or to a particle-bound contaminant. However, the results were inconclusive since other treatments (pH adjustment to 8) also improved minnow survival.

3.1.4.2 Intermittently flowing outfalls

After ranking the outfalls, Outfall 013 was identified as having the greatest frequency of toxicity in comparison to the other outfalls. Outfall 017 ranked highest for mean TUc and for the overall sum of ranks. For 1991-93 data, Outfall 018 had the highest overall rank sum; however, when 1994 data was included, the outfall had a low overall rank sum (5) in comparison to the other outfalls. Survival of minnows in filtered effluent from Outfall 018 was higher than in non-filtered effluent but growth was not different. These results indicate that suspended solids may directly (e.g. deposition on gill surfaces) or indirectly (e.g., contaminant desorption from particles) reduce the survival of the minnows. Additional tests will be conducted in 1995 to further evaluate minnow survival and growth in filtered effluent from Outfall 018 and other outfalls.

3.2 AMBIENT TOXICITY

3.2.1 Introduction

Ambient toxicity monitoring at PGDP employed the *Ceriodaphnia* test described in Sect. 3.1. Toxicity monitoring was incorporated into BMP in order to (1) evaluate area source contributions to stream toxicity, (2) characterize patterns of toxicity in Big Bayou and Little Bayou creeks, (3) document changes in water quality attributable to changes in operations at PGDP, and (4) provide data to evaluate whether the effluent limitations established for PGDP protect and maintain the use of Big Bayou and Little Bayou creeks for growth and propagation of fish and other aquatic life. The sites chosen for testing on Big Bayou Creek were changed during the past year. Because there was no evidence of *consistent* chronic toxicity to fathead minnows or *Ceriodaphnia* at ambient sites, testing with *Ceriodaphnia* was discontinued at all sites and testing with fathead minnows was discontinued at BBK 10.0. Unless otherwise noted, the discussion below is limited to 1994 data.

3.2.2 Materials and Methods

Ambient toxicity was evaluated using the fathead minnow test and the *Ceriodaphnia* test (prior to 1994) as described in Sect. 3.1 for continuously flowing outfalls with the following exceptions: (1) no dilutions were tested, and (2) each test used seven consecutive, daily grab samples of stream water. Tests which included evaluating a water sample that had been exposed to ultraviolet light were discontinued in 1994. Two ambient sites on Big Bayou Creek (BBK 12.5 and BBK 9.1; Fig. 2.2), one site on Little Bayou Creek (LUK 7.2, Fig. 2.2), and one site on Massac Creek (MAK 13.8, Fig. 2.1) were evaluated for toxicity. Prior to 1994, an additional site on Big Bayou Creek (BBK 10.0) was also evaluated for toxicity (Kszos et al. 1994). Water chemistry analyses continued on samples from BBK 10.0. These sites are similar to those selected for the ecological monitoring component of BMP (Sect. 5). Toxicity tests with minnows were conducted on a quarterly basis in 1994. See Kszos et al. (1994) for discussion of previous toxicity test results. Water sampling and water chemistry analyses were conducted as described for continuously flowing outfalls in Sect. 3.1.2.

Significant differences in *Ceriodaphnia* reproduction and fathead minnow survival and growth among sites for all tests were evaluated using the General Linear Models (GLM) procedure in SAS (SAS 1985a, 1985b). Because significant differences existed from test to test in *Ceriodaphnia* reproduction and fathead minnow survival and growth, the GLM procedure was inappropriate for separating differences among all sites. Thus, separate GLM analyses (followed by a separation of means using Tukey's Studentized Range Test) were conducted for each test period. Unless otherwise noted, statements of significance (probability) are based on $p = 0.05$.

3.2.3 Results

Mean survival and growth of fathead minnows for each site and test in 1994 are provided in Table 3.10. During 1994, survival at the reference sites (BBK 12.5 and MAK 13.8) ranged from 67.5% to 92.5% and 45% to 75%. Survival in water from sites below discharges from PGDP (BBK 9.1 and LUK 7.2) was not significantly different from the reference sites. In fact, during the August 1994 test period, survival at MAK 13.8 (57.5%) was significantly lower than survival at BBK 12.5 (67.5%) and BBK 9.1 (85.0%).

Minnow growth was quite variable from tests to test; growth in the reference sites (BBK 12.5 and MAK 13.8) ranged from 0.31 to 0.63 mg/larvae and 0.39 to 0.68 mg/larvae. Minnow growth in water from BBK 9.1 ranged from 0.38 to 0.80 mg/larvae and in water from LUK 7.2 ranged from 0.33 to 0.72 mg/larvae. The analysis of minnow growth in water from Big Bayou and Little Bayou creek sites showed that growth in sites downstream of PGDP discharges (BBK 9.1 and LUK 7.2) was never lower than the reference sites (BBK 12.5 and MAK 13.8).

A summary of water quality measurements (pH, conductivity, alkalinity, hardness, and temperature) for each site and test in 1994 is provided in Appendix B.7. The change in

Table 3.10. Summary of fathead minnow survival and growth measured for toxicity tests of ambient sites in 1994

Test Date	Site[a]	Mean survival (%)	Survival SD (%)	Mean growth (mg)	Growth SD (mg)
Mar. 1994	BBK 12.5	77.5	9.6	0.45	0.07
	BBK 9.1	67.5	33.0	0.59	0.24
	LUK 7.2	77.5	22.2	0.49	0.10
	MAK 13.8	75.0	19.2	0.47	0.11
May 1994	BBK 12.5	82.5	9.6	0.52	0.07
	BBK 9.1	90.0	14.1	0.51	0.02
	LUK 7.2	82.5	17.1	0.48	0.06
	MAK 13.8	45.0	17.3	0.46	0.04
Aug. 1994	BBK 12.5	67.5	26.3	0.31	0.03
	BBK 9.1	85.0	17.3	0.38	0.04
	LUK 7.2	62.5	17.1	0.33	0.04
	MAK 13.8	57.5	9.63	0.39	0.03
Oct. 1994	BBK 12.5	92.5	9.6	0.63	0.07
	BBK 9.1	65.0	23.8	0.80	0.11
	LUK 7.2	82.5	15.0	0.72	0.04
	MAK 13.8	62.5	22.2	0.68	0.11

[a]BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; MAK = Massac Creek kilometer; SD = Standard deviation.

water chemistry (hardness, conductivity, pH, and alkalinity) with distance downstream in Big Bayou Creek for tests conducted in 1992-94 is illustrated in Figs. 3.1–3.4. A summary of water chemistry for MAK 13.8 and LUK 7.2 for each year is also provided in Figs. 3.1–3.4. Figure 3.1 shows that each year (1992–94), mean conductivity has increased twofold from BBK 10.0 downstream to BBK 9.1 and there is little change in conductivity from BBK 12.5 downstream to BBK 10.0. Mean conductivity at the reference site (MAK 13.8) has been approximately 135 μS/cm each year (Fig. 3.1). The statistical comparison of mean conductivity in 1994 (Table 3.11), showed that BBK 9.1 was

ORNL-DWG 96-4966

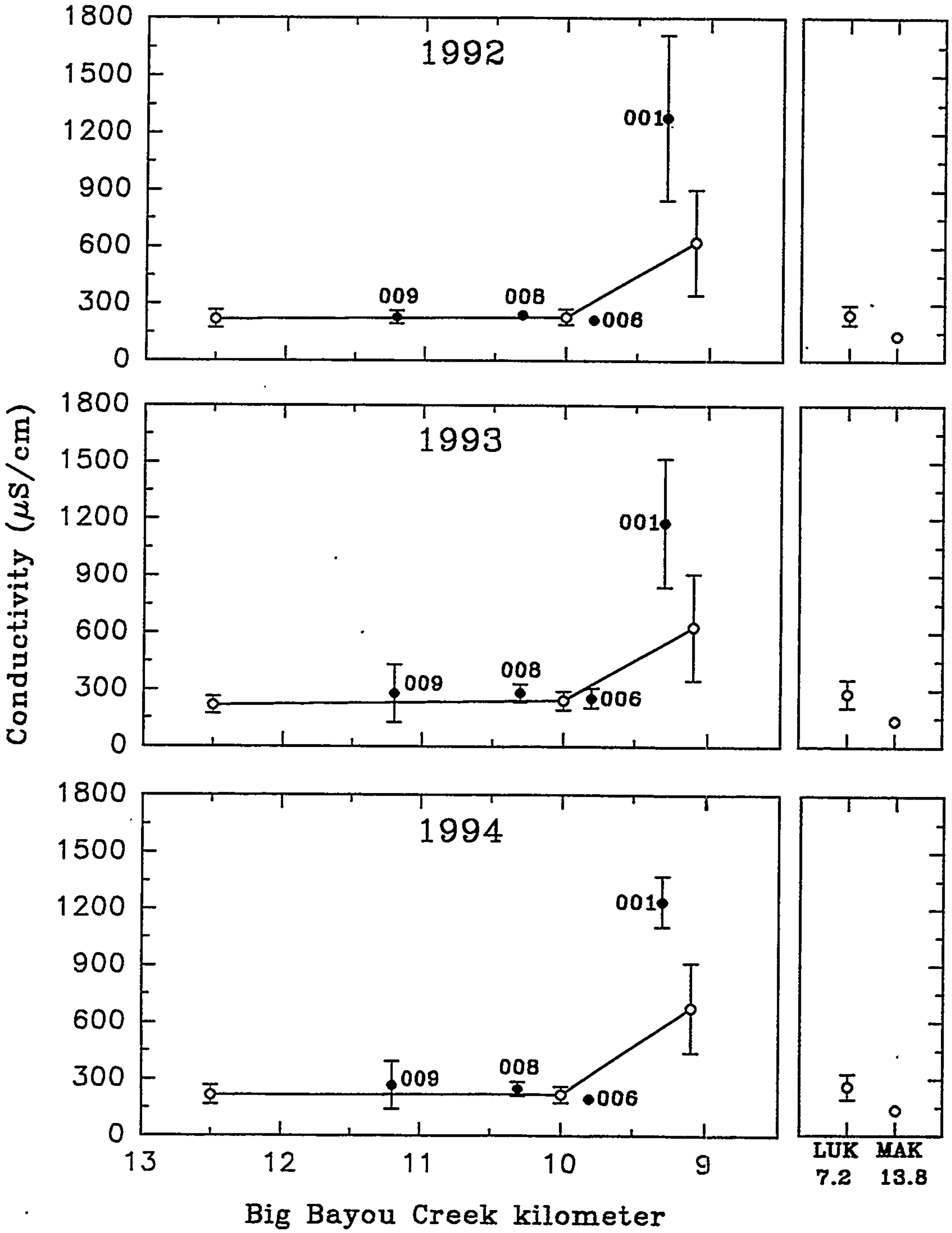


Fig. 3.1. Summary of conductivity (mean ± SD) at Big Bayou Creek, Little Bayou Creek (LUK), and Massac Creek (MAK) sites. Mean (±SD) value of continuously flowing outfalls is also shown.

ORNL-DWG 96-4967

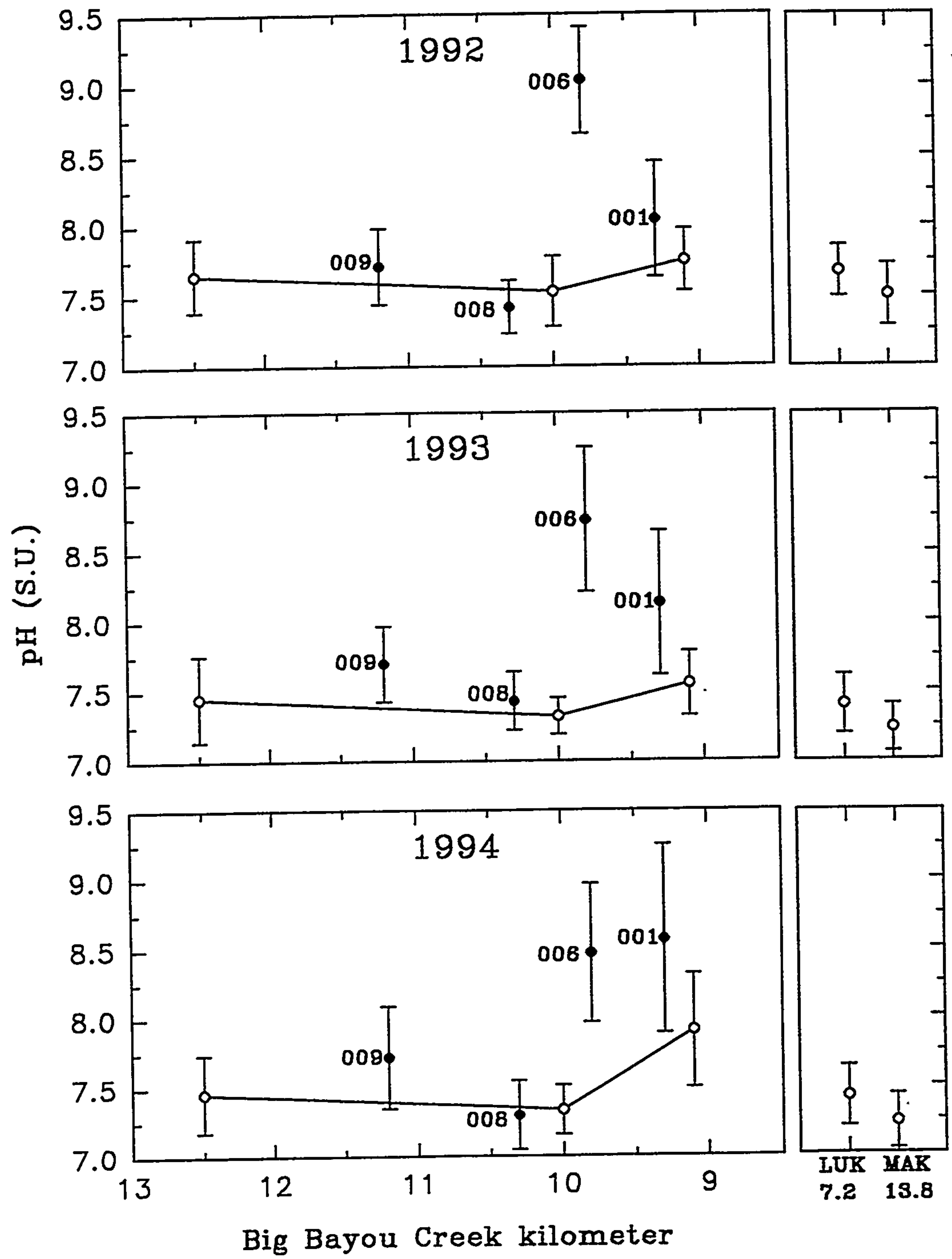


Fig. 3.2. Summary of pH (mean ± SD) at Big Bayou Creek, Little Bayou Creek (LUK), and Massac Creek (MAK) sites. Mean (±SD) value of continuously flowing outfalls is also shown.

ORNL-DWG 96-4968

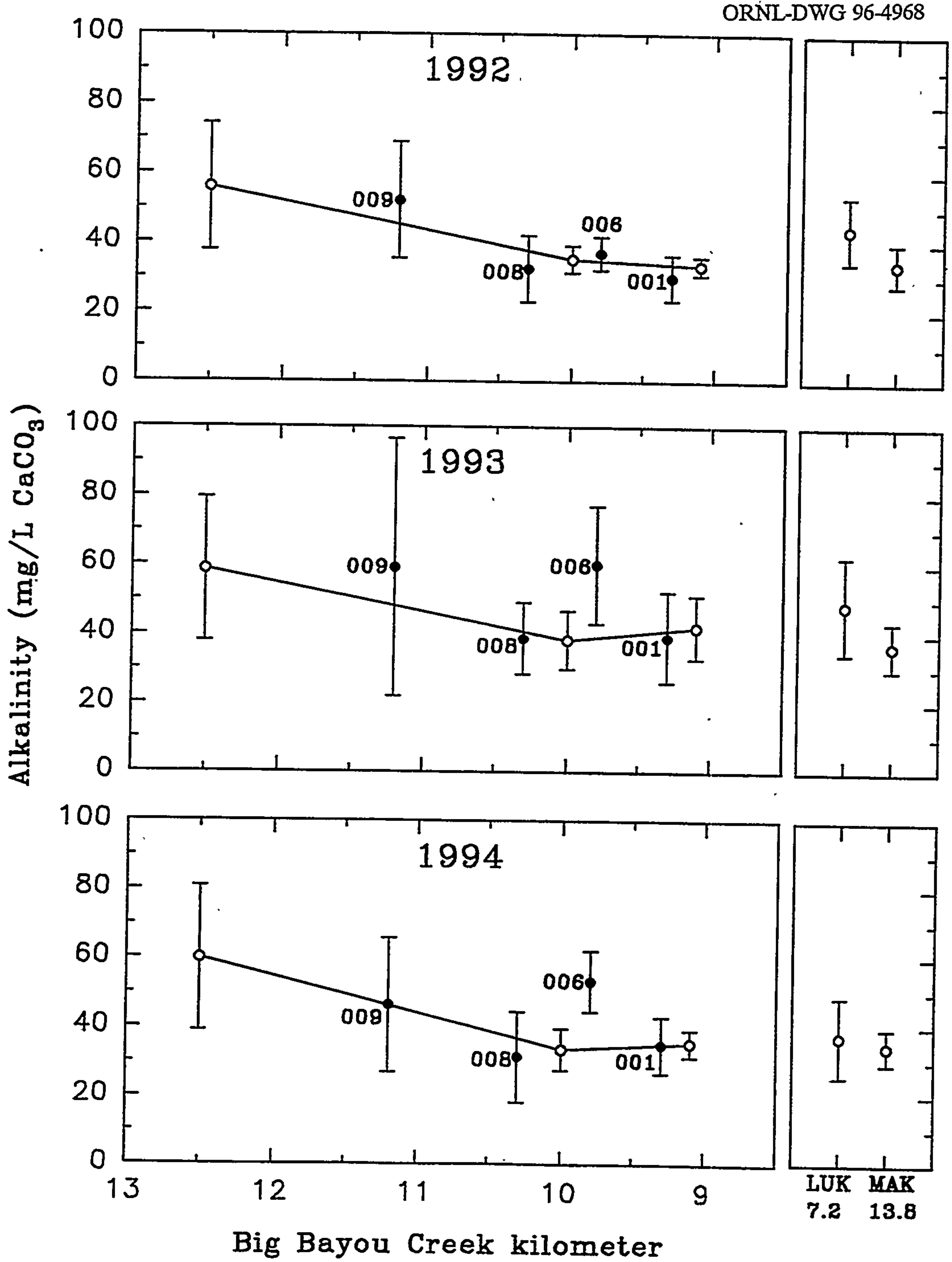


Fig. 3.3. Summary of alkalinity (mean ± SD) at Big Bayou Creek, Little Bayou Creek (LUK), and Massac Creek (MAK) sites. Mean (±SD) value of continuously flowing outfalls is also shown.

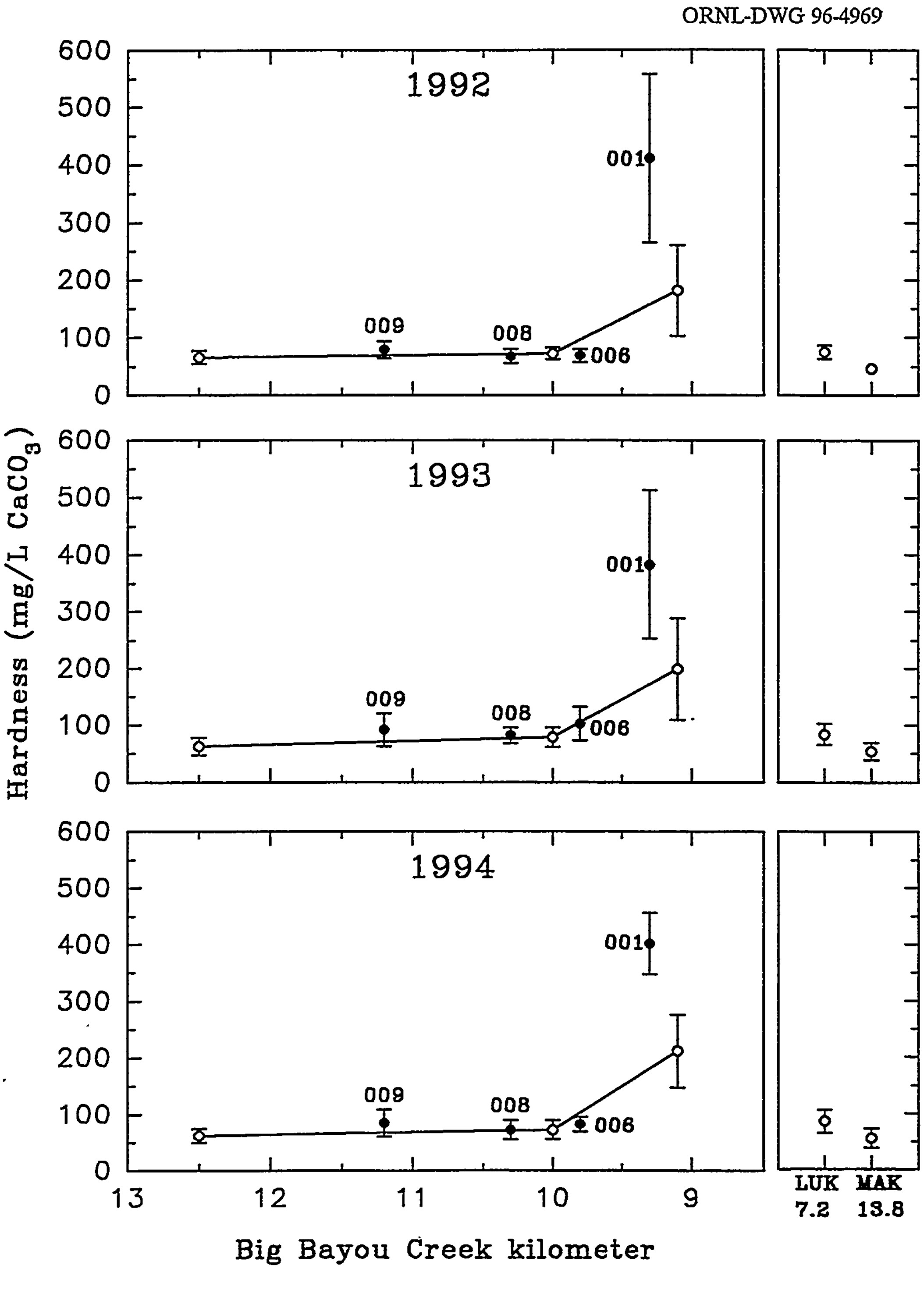


Figure 3.4. Summary of hardness (mean ± SD) at Big Bayou Creek, Little Bayou Creek (LUK), and Massac Creek (MAK) sites. Mean (±SD) value of continuously flowing outfalls is also shown.

Table 3.11. Mean conductivity (μS/cm; n = 7) measured at each site and comparison of means (Tukey's Studentized Range test)

Test	Site[a]				
	BBK 12.5	BBK 10.0	BBK 9.1	LUK 7.2	MAK 13.8
March 10–16, 1994					
Mean	135	158	299	175	137
Comparison	B	B	A	B	B
May 26–June 1, 1994					
Mean	253	262	796	327	136
Comparison	B	B	A	B	C
August 11–17, 1994					
Mean	240	209	848	246	129
Comparison	B	B	A	B	C
October 27–November 2, 1994					
Mean	240	244	766	278	140
Comparison	C	C	A	B	D

Note: Sites with the same letter are not significantly different.
[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

consistently distinguishable from all other sites. In August 1994, conductivity was fourfold higher at BBK 12.5 (209 μS/cm) than at BBK 10.0 (848 μS/cm).

The mean pH at BBK 9.1 was also higher than at BBK 10.0 for each year (Fig. 3.2). For three of the in 1994, mean pH at BBK 9.1 was significantly higher (range = 8.07–8.13 S.U.) than pH at all other sites (range = 7.13–7.71 S.U.). In most of the 1994 tests, pH at BBK 10.0, BBK 12.5, and LUK 7.2 was not significantly different from pH at the reference site (MAK 13.8; Table 3.12).

Unlike conductivity and pH which increased with distance downstream, alkalinity decreased with distance downstream each year (Fig. 3.3). For three of the tests conducted in 1994, alkalinity at BBK 10.0 was significantly lower (range = 27–39 mg/L) than alkalinity at BBK 12.5 (range = 69–72 mg/L; Table 3.13). During the March 1994 test, there was little difference in alkalinity among sites (range = 25–35 mg/L). Alkalinity at LUK 7.2 was similar to that at BBK 9.1 during two tests (Table 3.13). For three tests,

Table 3.12. Mean pH (S. U.; n = 7) measured at each site and comparison of means (Tukey's Studentized Range test)

Test	Site[a]				
	BBK 12.5	BBK 10.0	BBK 9.1	LUK 7.2	MAK 13.8
March 10–16, 1994					
Mean	7.09	7.21	7.34	7.19	7.16
Comparison	B	A,B	A	A,B	A,B
May 26–June 1, 1994					
Mean	7.48	7.31	8.11	7.53	7.13
Comparison	B	B,C	A	B	C
August 11–17, 1994					
Mean	7.55	7.26	8.13	7.33	7.18
Comparison	B	C	A	C	C
October 27–November 2, 1994					
Mean	7.71	7.59	8.07	7.61	7.44
Comparison	B	B	A	B	B

Note: Sites with the same letter are not significantly different.
[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

mean alkalinity at the reference site (MAK 13.8) was not significantly different from mean alkalinity at BBK 9.1 (Table 3.13).

The trends in hardness were similar to those for conductivity, in that there was little difference in hardness from BBK 12.5 downstream to BBK 10.0 and hardness increased three to four fold from BBK 10.0 downstream to BBK 9.1 (Fig. 3.4). In August, 1994, for example, mean hardness was 67 mg/L at BBK 12.5, 66 mg/L at BBK 10.0, and 270 mg/L at BBK 9.1. For all tests conducted in 1994, mean hardness at BBK 9.1 was significantly higher than hardness at all other sites and ranged from 118–270 mg/L (Table 3.14). Hardness at LUK 7.2 was similar to that at BBK 10.0 and BBK 9.1 (Table 3.14). In three tests, mean hardness at the reference site (53–66 mg/L) was not different than at BBK 10.0 (66-75 mg/L; Table 3.14).

Table 3.13. Mean alkalinity (mg/L as $CaCO_3$; $n = 7$) measured at each site and comparison of means (Tukey's Studentized Range test)

Test	Site[a]				
	BBK 12.5	BBK 10.0	BBK 9.1	LUK 7.2	MAK 13.8
March 10–16, 1994					
Mean	25	31	32	35	27
Comparison	B	A,B	A,B	A	A,B
May 26–June 1, 1994					
Mean	69	39	40	54	37
Comparison	A	C	C	B	C
August 11–17, 1994					
Mean	74	27	33	31	38
Comparison	A	D	C	C	B
October 27–November 2, 1994					
Mean	72	36	36	29	36
Comparison	A	B	B	C	B

Note: Sites with the same letter are not significantly different.
[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

During the 1994 tests, mean temperature at the reference site (MAK 13.8) was never significantly different from mean temperature at BBK 12.5 (Table 3.15). During the March and August tests, temperature was not different among any sites (Table 3.15). In March, mean temperatures ranged from 4.9 to 6.5°C; in August, mean temperatures ranged from 21.9 to 25.8°C. During the May and October tests, mean temperature at BBK 9.1 (21.5°C and 14.3°C) was significantly higher than temperature at BBK 12.5 (17.7°C and 9.9°C). Mean temperature at LUK 7.2 was higher than the reference site during the October test (Table 3.15).

3.2.4 Discussion

During 1994, there was no evidence of toxicity to fathead minnows in laboratory tests of water from any site in Big Bayou Creek or Little Bayou Creek. This is based on a comparison of survival in the water from the site with survival in water from the reference

Table 3.14. Mean hardness (mg/L as $CaCO_3$; $n = 7$) measured at each site and comparison of means (Tukey's Studentized Range test)

	Site[a]				
Test	BBK 12.5	BBK 10.0	BBK 9.1	LUK 7.2	MAK 13.8
March 10–16, 1994					
Mean	59	75	115	87	66
Comparison	B	B	A	A,B	B
May 26–June 1, 1994					
Mean	63	79	240	92	46
Comparison	C,D	B,C	A	B	D
August 11–17, 1994					
Mean	67	66	270	79	53
Comparison	B	B	A	B	B
October 27–November 2, 1994					
Mean	62	73	221	85	57
Comparison	C	B,C	A	B	C

Note: Sites with the same letter are not significantly different.
[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

site (MAK 13.8). Similar results were found during 1991–93: fathead minnow survival and growth in the water from the sites near PGDP were typically equal to or greater than survival or growth in water from the reference site (Kszos 1994).

The influence of discharges from PGDP on water chemistry of Big Bayou and Little Bayou creeks is shown by the increase or decrease in conductivity, hardness, alkalinity, pH and temperature at sites downstream of those discharges. Conductivity and hardness were significantly greater at BBK 9.1 than at BBK 10.0; effluent from Outfalls 001 and 006 enter Big Bayou Creek between these two sites (Fig. 2.2). Chemistry data collected during toxicity tests of these two effluents and ambient sites shows that Outfall 001 has much higher conductivity and hardness values than 006 (Table 3.5) or BBK 10.0 (Tables 3.11 and 3.14). Thus, effluent from Outfall 001 has the most influence on the increased conductivity and hardness at BBK 9.1. The pH at BBK 9.1 is often distinguishable from pH at BBK 10.0. In this case, pH measured during toxicity tests (Table 3.5.) show that

Table 3.15. Mean temperature (°C; n = 7) measured at each site and comparison of means (Tukey's Studentized Range test)

Test	Site[a]				
	BBK 12.5	BBK 10.0	BBK 9.1	LUK 7.2	MAK 13.8
March 10–16, 1994					
Mean	4.9	5.5	6.4	6.5	5.9
Comparison	A	A	A	A	A
May 26–June 1, 1994					
Mean	17.7	20.5	21.5	20.7	18.7
Comparison	B	A,B	A	A,B	A,B
August 11–17, 1994					
Mean	21.9	25.6	25.8	24.0	24.8
Comparison	A	A	A	A	A
October 27–November 2, 1994					
Mean	9.9	14.8	14.3	13.2	10.1
Comparison	B	A	A	A	B

Note: Sites with the same letter are not significantly different.
[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

Outfall 006 has the highest pH and therefore had greater influence on instream pH. Alkalinity was significantly higher at BBK 10.0 than at BBK 12.5, but was not different from alkalinity at BBK 9.1. Effluent from Outfalls 008 and 009 enter Big Bayou Creek between these two sites (Fig. 2.2). Both outfalls have alkalinity approximately equal to BBK 10.0 and less than BBK 12.5. In 1994, temperature differences among sites were found during the spring and fall.

3.3 SUMMARY

During 1994, there was no evidence of toxicity in effluent samples from Outfall 001. Effluent from Outfalls 008, 006, and 011 exceeded the permit limit for one or two tests, but no toxicity was observed in tests conducted after the exceedances. Effluent from Outfall 009 exceeded the permit limit four times in 1994. Toxicity identification procedures identified that minnow mortality may be due to suspended solids or to a particle-bound contaminant but results were not conclusive. For all tests conducted since 1991, Outfall 001 had the highest mean conductivity and hardness. Outfall 006 had the highest mean pH and outfall 008 had the lowest alkalinity of any of the continuously flowing outfalls. Effluent samples from the intermittent outfalls were toxic to *Ceriodaphnia* during only one test (Outfall 018 in September, 1994); however the TUc for minnows was frequently >1.0 for several of the intermittent outfalls. Ranking the intermittently flowing outfalls in terms of mean TUc and frequency of TUc > 1.0 identified that Outfall 017 ranked the highest for mean TUc and for the overall sum of ranks.

During 1994, there was no evidence of chronic toxicity to fathead minnows for any of the ambient sites. This is consistent with findings from 1991–93 (Kszos et al. 1994). Thus, toxicity to minnows observed in effluent from the continuously flowing outfalls is not observed in instream samples. The influence of effluent from Outfall 001 on the water chemistry of Big Bayou Creek was evident in the increase in pH, conductivity and hardness between BBK 10.0 and BBK 9.1. In addition, alkalinity is lower at BBK 10.0 than at BBK 12.5.

Because of the high frequency of TUc >1.0 at Outfall 009 during 1994, an additional ambient site will be included for fathead minnow toxicity tests during 1995. The site will be located at BBK 10.8 which is below Outfall 009 and above Outfall 008. The site at BBK 10.0 which was eliminated during 1994 was located below both of these outfalls. Water chemistry will continue to be measured at BBK 10.0.

4. BIOACCUMULATION

G. R. Southworth and M. J. Peterson

4.1 INTRODUCTION

Bioaccumulation monitoring conducted to date as part of the Biological Monitoring Plan at PGDP identified PCB contamination in fish in Big Bayou Creek and Little Bayou Creek as major concerns (Birge et al. 1990, 1992; Kszos 1993, 1994). Mercury concentrations in fish from Big Bayou Creek were found to be higher in fish collected downstream from PGDP discharges than in fish from an upstream site (Birge et al. 1990, 1992; Kszos 1993, 1994), but the difference was not large and mercury concentrations in fish were well below both the FDA limit (FDA 1984a) and the EPA risk assessment guidelines (EPA 1990). Concentrations of various metals in fish from Big Bayou Creek and Little Bayou Creek were well below levels of concern for human consumption.

The objectives of the 1993–94 bioaccumulation monitoring were (1) to continue PCB tracking studies in fish from Big Bayou Creek and Little Bayou Creek, (2) to track elevated mercury concentrations in fish in Big Bayou Creek, and (3) conduct screening analyses to detect other contaminants that may be of concern to consumers of fish from these streams.

4.2 STUDY SITES

Longear sunfish (*Lepomis megalotis*) were collected for PCB analysis at BBK 12.5 (the upstream reference site on Big Bayou Creek), BBK 10.0, BBK 9.1, and BBK 2.8 on Big Bayou Creek below PGDP, and LUK 9.0 and LUK 4.3 on Little Bayou Creek (Fig. 2.2). Longear sunfish were also taken for mercury analysis at BBK 12.5, BBK 10.0, BBK 9.1, BBK 2.8, MAK 13.8 (local reference site, Fig. 2.1). Hinds Creek in Anderson County, Tennessee, served as a source of uncontaminated reference fish. This stream has been used as a reference site for monitoring conducted at DOE facilities in Oak Ridge since 1985, and concentrations of various metals and organic contaminants in fish from this site are well characterized (Ashwood 1994). Longear sunfish were also sampled from LUK 7.2 and BBK 9.1 for contaminant screening analyses. Spotted bass, *Micropterus* *punctulatus*, were collected, when present, from BBK 9.1 and LUK 4.3. The length of stream sampled at each site varied with the degree of difficulty in obtaining fish but was held to less than or equal to 1000 m. The site at BBK 10.0 was constrained to the reach between PGDP outfalls 008 and 006 (Fig. 2.2). The BBK 9.1 site encompassed the reach from BBK 9.1 up to outfall 001 (Fig. 2.2). Bass require large pools and deeper water. Because such habitat is scarce at sites in Big Bayou Creek close to PGDP, a 1000-m reach below BBK 9.1 that contains such habitat was used for collection.

In Little Bayou Creek, the very sharp decrease in PCB contamination in fish between LUK 9.0 and LUK 7.2 (LB2 and LB3 in Birge et al. 1990, 1992) required that collections be confined to a relatively short reach near LUK 9.0 at the expense of expanding the reach downstream in order to obtain larger fish of a single species. This site was restricted to approximately 250 m from outfall 011 downstream to LUK 9.0. The downstream site included 1000 m centered at LUK 4.3.

4.3 MATERIALS AND METHODS

Concentrations of contaminants in sunfish provide an effective monitor of temporal and spatial changes in contamination within stream fishes but do not provide a direct estimate of the maximum concentrations that may be present in stream biota. Larger, older, fattier fish, such as carp (*Cyprinus carpio*), black bass (*Micropterus* spp.), and catfish (*Ictalurus* spp.) accumulate several times higher contaminant concentrations under the same exposure conditions (Southworth 1990). Although concentrations in these larger species can be inferred from concentrations in sunfish, direct measurement provides a more reliable estimate.

Fish were collected by backpack electrofishing. Eight fish were taken from each site for PCB and mercury analysis and four fish taken for screening analyses. Collections of spotted bass (*Micropterus punctulatus*) for PCB and mercury monitoring were made on October 13–14, 1993, in Big Bayou Creek (BBK 9.1) and Little Bayou Creek (LUK 4.3). Eight longear sunfish were obtained at all sites for PCB monitoring at the same time. Collections of sunfish were restricted whenever possible to fish of a size large enough to be taken by sport fisherman in order to minimize effects of covariance between size and contaminant concentrations and to provide data directly applicable to assessing risks to people who might eat fish from these sources. High fish densities at most sites enabled the collection of eight specimens of sunfish ≥35 g at all sites except LUK 9.0 (the site closest to PGDP where habitat is extremely limited). No carp were found in either Big Bayou Creek or Little Bayou Creek; therefore eight spotted bass were taken at BBK 9.1 as a substitute. Neither species was found in Little Bayou Creek. Spotted bass are abundant in Big Bayou Creek downstream from PGDP, and the fish attain large enough size to make the creek an attractive sport fishing resource. This species is probably the most likely species in the creek to be eaten in significant numbers by anglers.

Longear sunfish were collected in Big Bayou Creek and Little Bayou Creek on May 2–3, 1994, as part of routine twice yearly monitoring of PCB concentrations in this species. Fish were also taken for mercury analysis at BBK 12.5, BBK 10.0, BBK 9.1, LUK 7.2, and MAK 13.8 (local reference site) on May 2–3, 1994. Floodwaters of the Ohio River again inundated the lower site on Big Bayou Creek (BBK2.8) in May 1994 (as they had in spring 1993), and turbid water prevented successful collection of sunfish at that site on a return visit in June 1994. Each fish was individually tagged with a unique four-digit tag wired to the lower jaw and placed on ice in a labeled ice chest. Fish were held on ice overnight and processed within 48 hours. Each fish was weighed and measured, then fileted, scaled, and rinsed in process tap water. Samples of sunfish for specific analyses were excised, wrapped in heavy duty aluminum foil, labeled, and frozen on dry ice (if processed on site) or in a standard freezer at −15°C. For larger fish (bass), filets were wrapped and labeled as were sunfish samples, but at a later date the frozen filets were partially thawed, cut into 2- to 4-cm pieces, and homogenized by passing each sample three times through a hand meat grinder. A 25-g sample of the ground tissue was wrapped in heavy duty aluminum foil, labeled, frozen, and submitted to ORNL Analytical Chemistry Division for PCB analyses. Any remaining tissue from filets of sunfish or larger fish was wrapped in foil, labeled, and placed in the freezer for short-term archival storage.

PCB/pesticide determinations in fish were conducted by capillary column gas chromatography/electron capture (GC/ECD) detection using a method based on EPA procedure PPB 12/83 (EPA 1984), which involves homogenizing the sample in anhydrous sodium sulfate, extraction with methylene chloride, cleanup using column chromatography, and GC/ECD. When pesticide screening was not needed (PCBs only), analyses were conducted using a modification to this method in which sulfuric acid partitioning is used as a cleanup step to destroy lipids (Mid-America Group, 1989). Fish were analyzed for total mercury by cold vapor atomic absorption spectrophotometry following digestion in HNO3/H2SO4 (EPA 1991, procedure 245.6), for arsenic, cadmium, chromium, copper, lead, nickel, selenium, silver, vanadium, and uranium by inductively coupled plasma/mass spectrometry (EPA 1991, procedures 200.3, 200.8) and for zinc by inductively coupled plasma/optical emission spectrometry (EPA 1991, procedure 200.11). Radionuclides were detected by gamma scintillation spectrometry.

Quality assurance was maintained by a combination of blind duplicate analyses, analysis of biological reference standards and uncontaminated fish, and determination of recoveries of analyte spikes to uncontaminated fish. Results are summarized in Appendix C.

Statistical evaluations of mercury data were made using SAS and SPSS procedures and software (SAS 1985a,b; Norusis 1993) for ANOVA, Tukey's Multiple Comparison Test, and the calculation of mean, standard error, and standard deviation. Statistical comparisons were not used for PCB data because of the huge number of samples in which PCB concentrations were below the limit of detection. Tests for homogeneity of variance among various data groups were conducted using Levene's test on untransformed and $\log_e$-transformed variables (Sokal and Rohlf 1981). Dunnett's Test was used to compare means of various groups with reference sites (Zar 1984). The level of significance used for all statistical tests was 5% ($p < 0.05$).

4.4 RESULTS

4.4.1 PCBs

Fall 1993. Results of PCB analyses of sunfish collected from Big Bayou Creek and Little Bayou Creek in October 1993 are presented in Tables 4.1 and C.1. Detectable concentrations of PCBs were found in sunfish at BBK 9.1 and BBK 10.0. PCB concentrations in sunfish from Little Bayou Creek (LUK 9.0) near PGDP were much higher than in Big Bayou Creek, averaging 0.75 μg/g. The mean concentration dropped sharply with distance downstream, averaging only 0.14 μg/g at BBK 4.3. Composition of the PCB mixtures found in sunfish resembled Aroclor 1254 and 1260 at most sites, with less chlorinated constituents (Aroclor 1248) occurring in samples from LUK 9.0 and BBK 9.1.

Table 4.1. Mean concentrations of PCBs ($\mu g/g$ wet weight) in longear sunfish from streams near PGDP, October 1993

Site	Species[a]	Mean	SE	Range	n
BBK 12.5	LNGEAR	BLD	...	<0.07–<0.09	8
BBK 10.0	LNGEAR	0.06	0.01	<0.06–0.12	8
BBK 9.1	LNGEAR	0.16	0.04	0.04–0.34	8
	SPOBASS	0.23	0.04	0.10–0.44	8
BBK 2.8	LNGEAR	BLD	...	<0.06–<0.10	8
LUK 9.0	LNGEAR	0.75	0.17	0.24–1.67	8
LUK 4.3	LNGEAR	0.14	0.04	<0.08–0.29	8
	SPOBASS	0.44	0.13	0.03–0.95	6[b]
HindsCr	REDBRE	BLD	...	<0.09–<0.13	6

[a]LNGEAR = Longear sunfish (*Lepomis megalotis*); SPOBASS = Spotted bass (*Micropterus punctulatus*); REDBRE = Redbreast sunfish (*Lepomis auritus*).
[b]One of six fish was from LUK 7.2.

Spotted bass from Big Bayou Creek (BBK 9.1) averaged (± SE) 0.23 ± 0.04 $\mu g/g$ PCBs, about 50% higher than longear sunfish. Concentrations in the eight fish ranged from 0.10 to 0.44 $\mu g/g$, primarily as highly chlorinated materials similar to Aroclor 1254/1260 (Table C.1). Although it was expected that bass would contain higher concentrations than sunfish because of its trophic position, the similarity in lipid content of the two species in Big Bayou Creek may partially explain why PCB concentrations in bass were not higher. PCB concentrations in spotted bass from Little Bayou Creek were higher, averaging 0.44 ± 0.13 $\mu g/g$ in fish from LUK 4.3–LUK 7.2 (5 of 6 from LUK 4.3). The difference between PCB levels in bass and sunfish was closer to that expected at this site. PCB concentrations in individual fish ranged from 0.03 to 0.95 $\mu g/g$, with mixture compositions spanning the range from Aroclor 1248/1260.

Spring 1994. In spring 1994, PCB contamination was again evident in longear sunfish collected from both Big Bayou Creek and Little Bayou Creek (Tables 4.2 and C.1). The

Table 4.2. Mean concentrations of PCBs (μg/g wet weight) in longear sunfish from streams near PGDP, March 1994

Site	Mean	SE	Range	n
BBK 12.5	BLD	. . .	<0.05–<0.17	8
BBK 10.0	0.14	0.035	0.04–0.33	8
BBK 9.1	0.19	0.054	0.03–0.50	8
LUK 9.0	1.41	0.42	0.08–3.42	8
LUK 7.2	0.37	0.12	<0.13–0.62	4
LUK 4.3	0.21	0.06	0.03–0.61	8
HindsCr[a]	BLD	. . .	<0.07–<0.12	5

[a]Redbreast sunfish, *Lepomis auritus*.

constituents of the PCB mixtures extracted from fish most closely resembled Aroclor 1254 and 1260. Lower chlorinated PCBs were found in abundance only in fish from LUK 9.0.

As was the case in all previous sampling (Birge et al. 1990, 1992; Kszos 1993), the highest mean concentration occurred in fish from the site in Little Bayou Creek immediately downstream from outfall 011 (LUK 9.0). The level of contamination in sunfish from Little Bayou Creek declined substantially farther downstream at LUK 4.3, a pattern also observed consistently in previous monitoring (Birge et al. 1990, 1992; Kszos 1993, 1994), and in fall 1993. In Big Bayou Creek, the highest mean PCB concentration was again found in fish from BBK 9.1, below outfall 001, but fish from BBK 10.0 also contained PCB contamination (Table 4.2). In spring 1993, contamination was not obvious in sunfish from LUK 4.3 (Kszos 1994), but PCBs were clearly evident in fall 1993 and spring 1994. This gives credence to the hypothesis that the absence of PCB contamination in spring 1993 may have been related to the extended period of flooding in spring 1993 at this site, during which Big Bayou Creek fish populations may have exchanged with Ohio River populations.

Mean concentrations of PCBs in sunfish varied considerably among sampling periods in previous monitoring in Big Bayou and Little Bayou creeks, with no apparent temporal trend or pattern (Birge et al. 1990, 1992; Kszos 1993)). Generally, when higher PCB concentrations were observed in sunfish, lower chlorinated constituents (Aroclor 1248) were present in substantial proportions, and PCBs were detected in aqueous effluent samples. Results of the October 1993 and April 1994 sampling reaffirm the variable nature of PCB contamination in stream sunfish and suggest continuing inputs to both Big and Little Bayou creeks from PGDP discharges or contaminated sediments in the immediate vicinity of those discharges. The strong downstream gradient in PCB contamination in sunfish, along with the close association between degree of contamination and proximity to outfalls demonstrated to be PCB sources in the past, suggests that the pattern of contamination is sustained by continuing low-level contamination of waters discharged to the creeks, rather than a result of residual PCB contamination in sediments of the creeks themselves. PCB residues in upstream ditch or pond sediments could act as primary continuing sources, or various in-plant sources of fugitive PCBs may continue to contribute concentrations below levels detectable in aqueous phase monitoring. PCB concentrations of about 0.3 μg/g in fish having 1% lipids would imply aqueous phase PCB concentrations of roughly 0.03 μg/L (using concentration factor = 10,000 from EPA 1990).

4.4.2 Mercury

Mercury concentrations in fish from Big Bayou Creek were found to be somewhat higher downstream from PGDP than upstream in previous monitoring (Birge et al. 1990, 1992; Kszos 1993, 1994). Fish from all sites contained concentrations of mercury that appeared to be elevated relative to reference sites in East Tennessee.

The results of mercury monitoring in longear sunfish in April 1994 confirmed the findings of previous studies (Birge et al. 1992, Kszos 1993, 1994) that concentrations in fish from Big Bayou Creek were somewhat higher downstream from PGDP than upstream (Tables 4.3 and C.1). Mean mercury concentrations in sunfish were somewhat lower than those observed previously, ranging from a maximum of 0.24 μg/g at BBK 9.1 to 0.08 μg/g at BBK 12.5, upstream from PGDP. In 1993, mercury concentrations in longear sunfish at those sites were 0.37 and 0.10 μg/g respectively. Previous sampling (Birge et al. 1992, Kszos 1993, 1994) suggested that background or reference site concentrations of mercury

Table 4.3. Mean concentrations of total mercury (μg/g wet wt) in longear sunfish and spotted bass from streams near PGDP, May 1994

Site	Species[a]	Mean	SE	Range	n	Tukey group[b]	Dunnett's test[c]
BBK 12.5	LNGEAR	0.08	0.004	0.07–0.10	8	B	ref
BBK 10.0	LNGEAR	0.24	0.05	0.11–0.53	8	A	S
BBK 9.1	LNGEAR	0.21	0.02	0.15–0.29	8	A	S
	SPOBASS	0.61	0.06	0.44–0.95	8	—	—
LUK 7.2	LNGEAR	0.09	0.004	0.08–0.10	4	B	NS
Massac Cr	LNGEAR	0.13	0.01	0.07–0.18	8	A,B	ref
HindsCr	REDBRE	0.10	0.03	0.05–0.18	4	B	excluded

[a]LNGEAR = Longear sunfish (*Lepomis megalotis*); SPOBASS = Spotted bass (*Micropterus punctulatus*); REDBRE = Redbreast sunfish (*Lepomis auritus*).

[b]Groups separated by results of Tukey's Multiple Comparison Test on $\log_e$-transformed data. Mean concentrations are similar at sites having the same letter grouping, $p < 0.05$.

[c]Results of one-tailed Dunnett's Test for comparing group means with a local reference site mean (ref) using $\log_e$-transformed data. Data from Massac Cr and BBK 12.5 were pooled to compute the reference site mean. S indicates statistically significant difference, $p < 0.05$.

in streams near PGDP were elevated relative to concentrations of mercury typical of fish from uncontaminated streams in East Tennessee; therefore, a second local reference site, Massac Creek, was sampled to help determine the appropriate reference concentration. The mean concentration of mercury in redbreast sunfish from Hinds Creek, Tennessee was again lower than that observed in Massac Creek (Table 4.3), but was not less than that at BBK 12.5 Statistical comparison of mean mercury concentrations in fish from Big Bayou Creek, Massac Creek, and Hinds Creek (Tukey's Test) indicated that the Hinds Creek sunfish did not differ significantly from the Kentucky reference sites (Table 4.3). Mercury concentrations in fish from all sites in Big Bayou Creek below PGDP were similar. Because previously mercury concentrations in both Kentucky reference sites were similar, and much different from the Tennessee reference site, data from the two Kentucky sites (BBK 12.5, Massac Cr) were combined as a local reference collection for comparison with Big Bayou Creek sites below PGDP. Dunnett's test indicated that mean mercury concentrations in fish from the sites in Big Bayou Creek downstream from PGDP exceeded that in local reference site fish again in 1994. Results of mercury monitoring in sunfish from LUK 7.2 again indicated background mercury concentrations (Tables 4.3 and C.1) typical of reference site fish.

Because the bioaccumulation of methylmercury by fish is predominantly a food chain mediated process, predatory species that occupy trophic positions at or near the top of the aquatic food web would be expected to contain higher concentrations of mercury than species lower in the food chain. Spotted bass in Big Bayou Creek occupy that role of terminal predator. Mercury concentrations in spotted bass from BBK 9.1 averaged 0.61 ± 0.06 μg/g (range, 0.44–0.95 μg/g). One fish in the collection approached the FDA action level (1 μg/g), but the rest were below 0.7 μg/g. Such concentrations are not unexpected given concentrations of about 0.2–0.5 μg/g in sunfish, which probably provide a reasonable estimate of mercury concentrations in bass food organisms. Thus, mercury concentrations in bass that are double those of sunfish are a reasonable consequence of the higher trophic position of bass. Mercury concentrations in bass collected from ponds on the West Kentucky Wildlife Management Area in 1993 were very similar to mercury concentrations in bass from Big Bayou Creek, averaging about 0.7 μg/g (Kornegay et al. 1994), giving further credence to the hypothesis that the geochemistry of surface waters in this region favors the production and accumulation of mercury from natural sources.

As noted previously (Kszos 1994), the slightly elevated concentrations of mercury in fish from Big Bayou Creek below PGDP may be a result of mercury in PGDP effluents, but they may also be a consequence of differences in the biogeochemical processing of mercury downstream from the plant. The bioaccumulation of mercury is a complex process, in which inorganic mercury is converted to methylmercury by microorganisms, and the methylmercury is then accumulated via food chain processes. Mercury concentrations in fish would be affected by factors that alter the rate at which naturally occurring mercury is converted to methyl mercury, or by changes in food chain structure that induce fish at some locations to feed on more highly contaminated prey. Naturally occurring mercury appears to be more bioavailable in streams near PGDP than in some other parts of the country (Lowe et al. 1985). Thus, it is possible that elevated mercury concentrations in fish in Big Bayou Creek are a consequence of changes in water chemistry or invertebrate community structure downstream from PGDP.

4.4.3 Screening studies

4.4.3.1 Metals

Concentrations of metals measured in filets of longear sunfish from Big Bayou Creek and Little Bayou Creek are listed in Tables 4.4 and C.2. Levels are typical of those observed in previous monitoring (Birge et al. 1990, Kszos 1993, 1994), and generally differ little (with several exceptions) from concentrations observed in fish from the Hinds Creek, Tennessee, reference site. Concentrations of arsenic, cadmium, copper, lead, selenium, and zinc were lower than the national geometric mean concentrations (Table 4.4) observed for whole body analyses of fish in the USFWS National Contaminant Biomonitoring Program (Lowe et al. 1985). Concentrations of antimony, cadmium, chromium, nickel, selenium, and silver were well below screening levels used in the EPA Integrated Risk Information System (IRIS) (EPA 1990). Beryllium was not detected in PGDP fish (beryllium detection limit was at the IRIS screening level; arsenic, for which the detection limit was 10X screening level, was found at concentrations near the limit of detection in one sample). Those metals for which IRIS screening levels are not published (copper, lead, thallium, uranium, and zinc were found at concentrations similar to or lower than typically occur in food such as marine fish or mammalian muscle (Bowen 1979).

Measurement of detectable concentrations of uranium (Table 4.4) in fish from Little Bayou Creek is consistent with the observed elevated concentrations of uranium in this creek (Kornegay et al. 1994) and the results of previous monitoring of fish (Kszos 1993; 1994). Uranium has a low bioconcentration factor, consequently concentrations in fish would be expected to fluctuate rapidly in response to changing aqueous phase concentrations. Uranium measurements in fish thus provide little time averaging of exposure, and variation in yearly measurements cannot be used to infer long-term trends in exposure.

4.4.3.2 Chlorinated pesticides

No chlorinated pesticides were detected in fish from Big Bayou Creek or Little Bayou Creek. These results are consistent with previous monitoring (Kszos 1992, 1993).

Table 4.4. Mean metal concentrations ($\mu g/g$ wet weight) ± SE in longear sunfish from streams at PGDP, April 1994. N = 4 except where noted. If ≥ 50% of results are below detection limit, range is given. NS = not sampled, ND = not determined

	Site				
Metal	BBK 9.1	LUK 7.2	HindsCr[a]	NCBP[b]	EPA[c]
Antimony	<0.5	<0.5	<0.5	NS	43.1
Arsenic	<0.05–0.06[d]	<0.05	<0.05	0.16	0.006
Beryllium	<0.003	<0.003	<0.003	NS	0.0025
Cadmium	<0.2	<0.2	<0.2	0.04	10.8
Chromium	<0.5–3.0[d]	<0.5	<0.5	NS	10,800
Copper	<0.5	<0.5	<0.5	0.86	ND
Lead	<0.5	<0.5	<0.5	0.19	ND
Nickel	<0.5	<0.5	<0.5	NS	2.15
Selenium	<0.5–0.61[d]	0.60 ± 0.05	<0.5	0.46	5.4
Silver	<0.2–0.48[d]	<0.2	<0.2	NS	2.48
Thallium	<0.02	<0.02	<0.02	NS	ND
Uranium	0.004 ± 0.0001	0.025 ± 0.0017	<0.003	NS	ND
Zinc	10.1 ± 0.58	9.6 ± 0.38	8.4 ± 1.6	25.6	ND

[a]Reference stream, Anderson Co., Tn; N = 2.
[b]Mean concentration of metals collected for the National Contaminant Biomonitoring Program (NCBP) (Lowe et al. 1985).
[c]EPA Integrated Risk Information System screening levels (EPA 1990).
[d]Single value exceeded detection limit.
[e]Two values exceeded detection limit.

4.4.3.3 Radionuclides

Gamma spectroscopy of freeze-dried fish samples found detectable concentrations of only naturally occurring K-40 in fish, with a single exception. That fish, from LUK 7.2, contained 0.07 pCi/g wet wt cesium- 134. This isotope would not be expected at PGDP, and the result is presumed to be anomalous.

4.5 Future studies

Annual screening for chlorinated pesticides will be dropped. An adequate body of data currently exists to indicate that these substances are not present at concentrations of concern in fish from sites at PGDP. Twice annual PCB tracking studies will continue. The monitoring site at BBK 2.8 will be dropped. High water commonly makes this site inaccessible, and it is not necessary to continue to demonstrate that concentrations of PCBs decrease strikingly between BBK 9.1 and LUK 2.8. Annual mercury monitoring in bass and sunfish will continue at BBK 9.1 and LUK 7.2 but be discontinued at other sites except Massac Creek and BBK 12.5 reference sites. Screening analyses for metals and radionuclides have demonstrated that these substances do not accumulate appreciably in muscle of fish from streams at PGDP. However, because discharge of metals in effluents is an NPDES concern at PGDP, annual monitoring is of value in demonstrating that fish are uncontaminated.

Beaver activity on both Big Bayou Creek and Little Bayou Creek has expanded considerably in recent years, and dams have modified habitat in several sites. Such dams may have a significant effect on the retention of sediment associated contaminants in both creeks, and may make it more difficult to observe rapid improvement in PCB contamination in fish following successful reduction of PCB inputs. Fish populations appear to be considerably lower in ponds behind these dams than in free flowing stretches of stream. It may be necessary to revise sampling strategies and site selection in the future if such habitat modifications continue to expand.

5. ECOLOGICAL MONITORING STUDIES

M. G. Ryon and M. R. Smith

5.1 FISHES *(M. G. Ryon)*

5.1.1 Introduction

Fish population and community studies can be used to assess the ecological effects of changes in water quality and habitat. These studies offer several advantages over other indicators of environmental quality (see Karr et al. 1986, Karr 1987) and are especially relevant to assessment of the biotic integrity of Little Bayou and Big Bayou creeks because both creeks receive point and nonpoint impacts. Monitoring of fish communities has been used by the Biological Monitoring and Abatement Program (BMAP) in ESD for receiving streams at ORNL (Loar et al. 1991); K-25 Site (Loar et al. 1992, Ryon 1993a); the Portsmouth, Ohio, facility (Ryon, 1994); and the Y-12 Plant (Loar et al. 1989, Ryon 1992a, Southworth et al. 1992), with some programs operational since 1984. Changes in the fish communities in these systems have indicated recovery (Ryon 1994d) as well as documented impacts (Ryon 1994c, 1993b).

The objectives of the instream fish monitoring task were (1) to characterize spatial and temporal patterns in the distribution and abundance of fishes in Little Bayou and Big Bayou creeks and (2) to document the effects of PGDP operations on fish community structure and function.

5.1.2 Study Sites

Quantitative sampling of the fish community was conducted at five sites. Three sites are located on Big Bayou Creek (BBK 12.5, BBK 10.0, and BBK 9.1; Fig. 2.2), one on Little Bayou Creek (LUK 7.2, Fig. 2.2), and one offsite reference station on Massac Creek (MAK 13.8, Fig. 2.1). MAK 13.8 was chosen as a reference site for BBK 9.1 and BBK 10.0. The upper site on Big Bayou Creek (BBK 12.5) was selected as a smaller reference site to be comparable to LUK 7.2. A qualitative sampling site (LUK 4.3) was established to evaluate the fish community in this area in response to earlier concerns of possible PGDP impacts (see Ryon 1994a).

5.1.3 Materials and Methods

Quantitative sampling of the fish populations at four sites in the Bayou Creek watershed (BBK 12.5, BBK 10.0, BBK 9.1, and LUK 7.2) and at one site in a reference stream, Massac Creek (MAK 13.8), was conducted by electrofishing on March 7, 22–23 and September 11–13, 1994. Data from these samples were used to estimate species richness, population size (numbers and biomass per unit area), and calculate annual production. Fish sampling sites either overlapped or were within 100 m of the sites included in the benthic macroinvertebrate monitoring task. Qualitative fish sampling was conducted by electrofishing on March 22, 1994. Data from this sample were used to determine the species richness and number of specimens (relative abundance) based on sampling a known length of stream. All field sampling was conducted according to standard operating procedures (Ryon 1992b).

5.1.3.1 Quantitative field sampling procedures

All stream sampling was conducted using two or three Smith-Root Model 15A backpack electrofishers, depending on stream size. Each unit can deliver up to 1200 V of pulsed direct current in order to stun fish.

After 0.64-cm-mesh seines were placed across the upper and lower boundaries of the fish sampling site to restrict fish movement, a five- to nine-person sampling team electrofished the site in an upstream direction on three consecutive passes. Stunned fish were collected and stored, by pass, in seine-net holding pens (0.64-cm-diam mesh) or in buckets during further sampling.

Following the electrofishing, fish were anesthetized with MS-222 (tricaine methanesulfonate), identified, measured (total length), and weighed using Pesola spring scales. Individuals were recorded by 1-cm size classes and species. After ten individuals of a species-size class were measured and weighed, additional members of that size class were only measured. Length-weight regressions based on the weighed individuals were used to estimate missing weight data. Representative specimens of each species were also kept in a voucher collection to verify species identifications.

After processing fish from all passes, the fish were allowed to fully recover from the anesthesia and returned to the stream. Any additional mortality that occurred as a result of processing was noted at that time. Following completion of fish sampling, the length, mean width, mean depth, and pool:riffle ratio of the sampling reach were measured at each site.

5.1.3.2 Qualitative field sampling procedures

Qualitative sampling involved electrofishing a limited length of stream for one pass and collecting all stunned fish. A five-person sampling team electrofished upstream for approximately 1 h using two Smith-Root backpack electrofishers. Sampling always started at the same stream location and proceeded through a known length of stream. Stunned fish were netted, placed in buckets, and given to a two- to three-person shore crew for processing. The shore crew counted and identified all specimens; easily identifiable species were immediately released downstream from the sampling crew. Species that were more difficult to identify were preserved in 10% formaldehyde and taken to the ESD laboratory for positive identification. Representative specimens of each species were also kept in a voucher collection to verify species identifications. The duration of the electrofishing effort (in minutes) and the length of stream (in meters) sampled were recorded.

5.1.3.3 Data analysis

Population Size. Quantitative species population estimates were calculated using the method of Carle and Strub (1978). Biomass was estimated by multiplying the population estimate by the mean weight per size class. To calculate density and biomass per unit area, total numbers and biomass were divided by the surface area (in square meters) of the study reach. These data were compiled and analyzed by a comprehensive Fortran 77 program developed by ESD staff (Railsback et al. 1989). Qualitative samples were compared using total number of species and specimens and the relative abundance of the specimens. Relative abundance of species was rated as follows: 1 specimen = rare, 2 to 20 specimens = uncommon, 21 to 100 specimens = common, and >100 specimens = abundant.

Annual Production. Annual production was estimated at each site using a size-frequency method (Garman and Waters 1983) as modified by Railsback et al. (1989). Production was calculated for the period between the spring 1993 and spring 1994 sampling dates.

5.1.4 Results

The physical parameters of the sample sites showed only minor differences between the March (spring) and September (fall) samples (Table 5.1). Most sites were deeper and wider in spring than in fall samples, similar to the pattern seen in previous years (Ryon 1994a,e).

5.1.4.1 Quantitative sampling

Species richness and composition. A total of 30 fish species were found at the 5 sites on Big Bayou Creek, Little Bayou Creek, and Massac Creek (Table 5.2) for the March and September 1994 samples. BBK 9.1 and BBK 10.0 had 18 and 15 species for the two sampling seasons, compared to 25 species at the reference stream, MAK 13.8. The LUK 7.2 site had 20 species during the year, while the comparable reference site, BBK 12.5 had 16 species. Mean species richness for MAK 13.8, BBK 9.1, and BBK 10.0 was 21.0, 14.5, and 11.0 respectively (Table 5.3). At LUK 7.2 and BBK 12.5, the mean richness was 14.0 and 13.5 respectively. At most sites, species richness was higher in the September samples than in March. However, at LUK 7.2, species richness declined during the year with a drop of 12 species (Table 5.3). The core species assemblage at all sites included central stoneroller (*Campostoma anomalum*), creek chub (*Semotilus atromaculatus*), yellow bullhead (*Ameiurus natalis*), blackspotted topminnow (*Fundulus olivaceus*), creek chubsucker (*Erimyzon oblongus*), green sunfish (*Lepomis cyanellus*), and longear sunfish (*L. megalotis*). Seven species were judged to be sensitive to water quality and/or habitat degradation (see Karr et al. 1986; Ohio EPA 1987, 1988) and seven were rated as tolerant to such conditions (Appendix D, Table D.1).

The lowest site on Big Bayou Creek, BBK 9.1, had several species which are more common in larger streams such as bigmouth buffalo (*Ictiobus cyprinellus*) and black bullhead (*Ameiurus melas*). These species were not taken at upstream Big Bayou Creek sites. BBK 9.1 had low numbers of cyprinid (four) and percid (0) species but higher levels of catostomid (four), and centrarchid (six) species. The number of sensitive species (three) was less than the number of species tolerant (four) of habitat degradation and/or pollution. The fish community composition at BBK 9.1 included representatives of all trophic levels. Piscivores or top carnivores included two species, largemouth bass (*Micropterus salmoides*), and spotted bass (*M. punctulatus*). Benthic insectivores, a feeding

Table 5.1. Lengths, mean width, mean depth, surface area, and pool-riffle ratio of fish sampling sites in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, for March and September 1994

Site[a]	Length (m)	Mean width (m)	Mean depth (cm)	Surface area (m^2)	Pool-riffle ratio
March 1994					
BBK 9.1	99	6.9	25.3	683	1.0
BBK 10.0	101	4.1	10.3	414	0.7
BBK 12.5	111	6.1	10.0	677	1.9
LUK 7.2	115	3.5	7.3	403	0.3
MAK 13.8	96	5.6	15.6	538	0.7
September 1994					
BBK 9.1	105	6.1	19.2	641	1.1
BBK 10.0	110	4.4	10.8	484	0.9
BBK 12.5	85	5.5	9.3	468	3.0
LUK 7.2	109	3.1	7.1	338	0.9
MAK 13.8	89	5.0	11.2	445	1.4

[a]Site designations are Big Bayou Creek kilometer (BBK), Little Bayou Creek kilometer (LUK), and Massac Creek kilometer (MAK).

guild that can reflect impacts on the benthic macroinvertebrate community (Miller et al. 1988), were represented by two species. There were seven species classified as generalist feeders, which are species that are capable of switching easily between food items and therefore can be more successful in streams exposed to a variety of stresses (Leonard and Orth 1986).

BBK 10.0 had low numbers of catostomid (one) and percid species (0), but moderate numbers of cyprinid (six) and centrarchid species (five). However, there were no sensitive species and four tolerant species. The trophic composition of the community at BBK 10.0 included two piscivores (the bass species), two benthic insectivores, and four generalist feeders.

Compared to the MAK 13.8 reference, the two lower Big Bayou Creek sites showed some degradation. The reference site had higher numbers of cyprinid (nine), catostomid (four), and percid (three) species, with the same level of centrarchid species (five). MAK 13.8 also had more sensitive species (seven) and similar numbers of tolerant species (five). Trophically, MAK 13.8 had fewer piscivore species (one), similar numbers of generalist feeders (seven), and three times as many benthic insectivores (six) as the Big Bayou Creek sites.

Table 5.2. Species composition of quantitative samples in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, March and September 1994

Species[b]	Sites[a]				
	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Cyprinidae					
Stoneroller (*Campostoma anomalum*)	2[c]	2	2	2	2
Red shiner (*Cyprinella lutrensis*)	0	1	1	2	1
Steelcolor shiner (*Cyprinella whipplei*)[d]	1	0	0	0	2
Mississippi silvery minnow (*Hybognathus nuchalis*)	0	0	0	0	1
Ribbon shiner (*Lythrurus fumeus*)[d]	1	0	0	1	2
Redfin shiner (*Lythrurus umbratilis*)[d]	1	1	1	1	2
Golden shiner (*Notemigonus crysoleucas*)	0	0	0	1	1
Suckermouth minnow (*Phenacobius mirabilis*)	0	1	1	2	0
Bluntnose minnow (*Pimephales notatus*)	0	2	2	2	2
Creek chub (*Semotilus atromaculatus*)	0	2	2	2	2
Catostomidae					
White sucker (*Catostomus commersoni*)	2	0	2	0	2
Creek chubsucker (*Erimyzon oblongus*)	2	2	2	1	2
Bigmouth buffalo (*Ictiobus cyprinellus*)[d]	1	0	0	0	0
Spotted sucker (*Minytrema melanops*)	2	0	0	0	1
Golden redhorse (*Moxostoma erythrurum*)[d]	0	0	0	0	1
Ictaluridae					
Black bullhead (*Ameiurus melas*)[c]	1	0	0	0	0
Yellow bullhead (*Ameiurus natalis*)	2	1	2	2	2
Aphredoderidae					
Pirate perch (*Aphredoderus sayanus*)	0	0	0	1	2
Cyprinodontidae					
Blackspotted topminnow (*Fundulus olivaceus*)	2	2	2	2	2
Poeciliidae					
Western mosquitofish (*Gambusia affinis*)	1	1	0	2	1
Centrarchidae					
Green sunfish (*Lepomis cyanellus*)	2	2	2	1	2
Warmouth (*Lepomis gulosus*)	1	0	1	1	1
Bluegill (*Lepomis macrochirus*)	2	1	2	1	2
Longear sunfish (*Lepomis megalotis*)	2	2	2	1	2
Hybrid sunfish[d]	1	1	1	0	1
Spotted bass (*Micropterus punctulatus*)	2	1	2	1	2
Largemouth bass (*Micropterus salmoides*)	2	1	1	0	0
Percidae					
Bluntnose darter (*Etheostoma chlorosomum*)	0	0	0	1	0
Slough darter (*Etheostoma gracile*)	0	0	0	1	1
Logperch (*Percina caprodes*)	0	0	0	0	2
Blackside darter (*Percina maculata*)	0	0	0	0	2
TOTAL SPECIES	18	15	16	20	25

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.
[b]Common and scientific names according to the American Fisheries Society (Robbins et al. 1991).
[c]Numbers represent the number of sampling periods ($N = 2$) that a given species was collected at the site and a zero indicates that the species was not collected.
[d]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Table 5.3. Total fish density (individuals/m^2), biomass (g/m^2), and species richness for March and September 1994 at sampling sites[a] in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek

Sampling periods	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
March 1994					
Density	0.97	1.36	3.09	3.82	1.49
Biomass	16.93	7.81	16.57	6.98	6.83
Species richness	13	10	12	20	17
September 1994					
Density	1.19	5.57	4.26	3.76	5.74
Biomass	14.45	15.10	10.22	5.86	17.75
Species richness	16	12	15	8	25
Means 1994					
Density	1.08	3.47	3.68	3.79	3.62
Biomass	15.69	11.46	13.40	6.42	12.29
Species richness	14.5	11.0	13.5	14.0	21.0

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

The LUK 7.2 site maintained high levels of cyprinid (eight) and centrarchid (five) species with one catostomid. LUK 7.2 had four tolerant and two sensitive species. The trophic composition of the fish community at LUK 7.2 included one piscivore, four benthic insectivores, and five generalist feeders. By comparison, the BBK 12.5 reference site had similar numbers of cyprinid (six), centrarchid (six), and catostomid (two) species. There were no sensitive species and a higher number of tolerant species (five). Trophically, the fish community at BBK 12.5 reflected the headwater influence, with six generalist feeders, two piscivores, and only two benthic insectivores. In headwater habitats, generalist feeders have a decided advantage because they can utilize terrestrial sources of food much easier than can benthic insectivores.

Density. Quantitative estimates of density were higher at most sites during the September samples than during the March samples (Table 5.3). This was the pattern in previous PGDP samples (Ryon 1994a,e) and has been the dominant pattern for the BMAP sampling conducted at the approximately 50 sites in the Oak Ridge, Tennessee, area since 1985 (Loar 1992, Ryon 1992c, Southworth et al. 1992). The higher fall density reflects recruitment of fish into the community and normally occurs at all sites, unless a substantial impact has occurred. The only exception was a slight decline in density at LUK 7.2.

The highest total density values were at MAK 13.8 and at BBK 12.5 during September sampling. The densities at BBK 9.1 were about one-half to two-thirds of the levels at BBK 10.0 and showed less variation between sampling seasons. The MAK 13.8 reference had levels similar to BBK 10.0 in March and September samples (Table 5.3).

Densities of individual species varied slightly between sites, with less variation among the two species with the highest values (Appendix D, Tables D.2 and D.4). During all sampling seasons at BBK 9.1, BBK 10.0, and MAK 13.8, the species present in highest or next highest numbers were the central stoneroller or longear sunfish. The high densities of central stoneroller (a scraping herbivore) in Big Bayou Creek probably reflected greater algal growth resulting from nutrient enrichment by PGDP discharges. The longear sunfish is a generalist feeder and the primary centrarchid in the PGDP area streams. At LUK 7.2, the species with the highest densities were bluntnose minnow (*Pimephales notatus*), blackspotted topminnow, and green sunfish (Tables D.2 and D.4). The BBK 12.5 reference site was similar to downstream Big Bayou Creek sites with highest densities for longear sunfish and central stoneroller.

Biomass. Unlike the density estimates, quantitative estimates of total fish biomass were not consistently higher in September samples than in March samples (Table 5.3). The highest biomass levels were at BBK 9.1 and MAK 13.8. Mean fish biomass at MAK 13.8 was similar to the biomass at the lower Big Bayou Creek sites, because of a decline from previous years in the Big Bayou Creek values. Mean fish biomass at LUK 7.2 was half the mean fish biomass at the BBK 12.5 reference site.

Each site was evaluated for the species that constituted the two highest biomass values during each sample period. The longear sunfish species contributed the highest or next highest biomass at every site except LUK 7.2 (Tables D.3 and D.5). Other fish species that were among the two highest biomass contributors included bluegill (*Lepomis macrochirus*) or spotted bass at BBK 9.1, and central stoneroller at BBK 10.0, MAK 13.8, and BBK 12.5. At LUK 7.2, the two highest biomass contributors varied among the creek chub, green sunfish, bluntnose minnow, or central stoneroller.

Production. Production values were calculated for the spring 1993 to spring 1994 period at all sites. Total production ($g \cdot m^{-2} \cdot year^{-1}$) was highest in Big Bayou Creek, increasing upstream (Table 5.4). The production at BBK 9.1 and BBK 10.0 was more than twice that at the reference site, MAK 13.8. The principal difference between production at BBK 9.1 and MAK 13.8 was the tremendously high levels for sunfish species, especially longear sunfish at BBK 9.1. At BBK 10.0, the higher production was dominated by the contribution of the central stoneroller. Production at LUK 7.2 was only a third of that found at BBK 12.5 (Table 5.4). A ten-fold difference in production of central stoneroller, longear sunfish, and yellow bullhead accounted for the majority of the disparity. The higher level of production at BBK 9.1 and BBK 10.0 might be expected given the other signs of enrichment; however, the overall high production throughout the Big Bayou Creek system was unexpected.

The production found in these streams was within the range of production values found in warmwater streams of the southeastern United States, including production estimates generated by similar methods at Oak Ridge monitoring sites (Table 5.5 in Ryon 1994e). Estimates of production in southeastern reference streams varied from 2.02 to 27.12 $g{\cdot}m^{-2}{\cdot}year^{-1}$ compared to 4.22 to 15.30 $g{\cdot}m^{-2}{\cdot}year^{-1}$ at PGDP area reference streams. Similarly, production at sites downstream of plant discharges ranged from 3.06 to 27.38 $g{\cdot}m^{-2}{\cdot}year^{-1}$ in the southeast v 6.80 to 10.59 $g{\cdot}m^{-2}{\cdot}year^{-1}$ in Big Bayou Creek watershed.

5.1.4.2 Qualitative sampling

During qualitative sampling conducted on lower Little Bayou Creek (LUK 4.3) in March, totals of 35 species and 1225 specimens were taken (Table 5-5). These levels far exceeded the previous patterns in past samples from this site (Fig. 5-1). The numbers of species and specimens were about 1.5 times greater than any previous sample. Also, the catch per unit effort was the highest measured since sampling was initiated at this site. The survey found six new species not taken in previous qualitative surveys of LUK 4.3, including the river shiner (*Notropis blennius*), two suckers (golden redhorse *Moxostoma erythrurum* and black buffalo *Ictiobus niger*), two darters (logperch *Percina caprodes* and mud darter *Etheostoma asprigene*) and one sunfish (orangespotted *Lepomis humilis*). The

Table 5.4. Fish annual production ($g/m^2/yr$) in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, March 1993 to March 1994

	Sites[a]				
Species[b]	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Stoneroller	1.20	10.41	7.81	0.38	1.11
Red shiner	0	-0.01	0.01	0.12	-
Steelcolor shiner[c]	-<0.01	-	-	-	<0.01
Ribbon shiner	-	-	-<0.01	-0.01	0.04
Redfin shiner[c]	0	0	-<0.01	0.02	-0.04
Golden shiner	-	-	-	-<0.01	-
Suckermouth minnow	-	<0.01	0.02	0.22	-0.01
Bluntnose minnow	-	0	0.23	3.96	0.32
Creek chub	-<0.01	-<0.01	0.54	0.57	0.01
White sucker	-0.68	-	-0.02	-	0.02
Creek chubsucker	0.02	0	0.08	-0.02	<0.01
Black redhorse	-	-	-	-	-0.18
Golden redhorse	-	-	-	-	-0.13
Yellow bullhead	0.01	-	0.66	-0.03	0.12
Pirate perch	-	-	-	-0.10	-0.02
Blackspotted topminnow	0.01	0.01	0.21	0.46	0.14
Western mosquitofish	-	-	-	-<0.01	-
Green sunfish	0.29	-0.08	1.02	0.73	0.05
Warmouth	-0.01	-	0	-0.04	-<0.01
Bluegill	0.06	-<0.01	-0.01	0	<0.01
Longear sunfish	8.27	0.28	4.73	0.49	2.85
Spotted bass	0.63	-0.02	0.02	-<0.01	-0.03
Largemouth bass	-0.03	-	-	-	-0.02
Bluntnose darter	-	-	-	0.02	0
Slough darter	-	-	-	0.03	-
Blackside darter	-	-	-	-	-0.01
Total production	9.77	10.59	15.30	6.80	4.22

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

[b]Common and scientific names according to the American Fisheries Society (Robbins et al.1991).

[c]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Table 5.5. Species composition of the qualitative fish sampling[a] conducted on Little Bayou Creek, March 22, 1994

Species identifications were performed in the field and/or confirmed in the laboratory on preserved specimens collected during the surveys

Species[b]	Number of specimens	Relative abundance[c]
Clupeidae		
Gizzard shad (*Dorosoma cepedianum*)	154	A
Cyprinidae		
Red shiner (*Cyprinella lutrensis*)	8	UC
Spotfin shiner (*Cyprinella spiloptera*)[d]	29	C
Steelcolor shiner (*Cyprinella whipplei*)[d]	1	R
Common carp (*Cyprinus carpio*)	4	UC
Mississippi silvery minnow (*Hybognathus nuchalis*)	458	A
Ribbon shiner (*Lythrurus fumeus*)[d]	29	C
Redfin shiner (*Lythrurus umbratilis*)	8	UC
Golden shiner (*Notemigonus crysoleucas*)	2	UC
Emerald shiner (*Notropis atherinoides*)[d]	34	C
River shiner (*Notropis blennius*)[d]	9	UC
Suckermouth minnow (*Phenacobius mirabilis*)	2	UC
Bluntnose minnow (*Pimephales notatus*)	124	A
Creek chub (*Semotilus atromaculatus*)	5	UC
Catostomidae		
Creek chubsucker (*Erimyzon oblongus*)	3	UC
Black buffalo (*Ictiobus niger*)[d]	2	UC
Spotted sucker (*Minytrema melanops*)	7	UC
Golden redhorse (*Moxostoma erythrurum*)	1	R
Ictaluridae		
Yellow bullhead (*Ameiurus natalis*)	4	UC
Aphredoderidae		
Pirate perch (*Aphredoderus sayanus*)	11	UC
Cyprinodontidae		
Blackspotted topminnow (*Fundulus olivaceus*)	57	C
Poeciliidae		
Western mosquitofish (*Gambusia affinis*)	3	UC
Centrarchidae		
Flier (*Centrarchus macropterus*)	23	C
Green sunfish (*Lepomis cyanellus*)	39	C
Warmouth (*Lepomis gulosus*)	5	UC
Bluegill (*Lepomis macrochirus*)	32	C
Longear sunfish (*Lepomis megalotis*)	135	A
Orangespotted sunfish (*Lepomis humilis*)[d]	4	UC
Spotted bass (*Micropterus punctulatus*)	11	UC
Largemouth bass (*Micropterus salmoides*)	1	R
White crappie (*Pomoxis annularis*)	3	UC
Percidae		
Mud darter (*Etheostoma asprigene*)[d]	3	UC
Bluntnose darter (*Etheostoma chlorosomum*)	10	UC
Slough darter (*Etheostoma gracile*)	3	UC
Logperch (*Percina caprodes*)	1	R

Table 5.5 (continued)

Species[b]	Number of specimens	Relative abundance[c]
TOTAL SPECIES	35	
TOTAL SPECIMENS	1225	
CATCH PER EFFORT (FISH/MIN)	7.5	

[a]Two electroshockers used for 150 m and 82 min.
[b]Common and scientific names according to the American Fisheries Society (Robins et al. 1991).
[c]Relative abundance is defined as: rare (R) 1 specimen; uncommon (UC) 2-20 specimens; common (C) 21-99 specimens; and abundant (A) >99 specimens.
[d]Species identification were confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

community represented by this sample included 13 minnow species, four sucker species, seven sunfish species, and four darter species. When the sample was analyzed for the sensitivity of species to pollution and/or environmental degradation, there were five species intolerant of such stressors and seven tolerant species.

This latest survey at LUK 4.3 underscored the general lack of a visible impact in this section of Little Bayou Creek. Although previous surveys suggested some impacts from PGDP operations (Birge et al. 1990), sampling conducted by ORNL has not substantiated this conclusion (Ryon 1994a,e). During the six surveys conducted by ORNL, a total of 40 species have been taken in this section of Little Bayou Creek, with no fewer than 20 species in any one sample. These surveys have always revealed a diverse fish community, with good representation of intolerant species and a range of trophic levels and feeding guilds. The high species richness and number of intolerant species in this latest sample supported the initial ORNL assessment of a healthy fish community at LUK 4.3. The qualitative sampling has demonstrated that the fish community in this section of Little Bayou Creek appears to be beyond the range of influence of the PGDP. Therefore, qualitative sampling was discontinued at this site in 1994, based on the 2-year sampling history at this site and the diversity represented by the latest sample.

5.1.5 Discussion

Data on the fish communities of Big Bayou Creek and Little Bayou Creek downstream of PGDP were compared to data from reference sites located on Big Bayou

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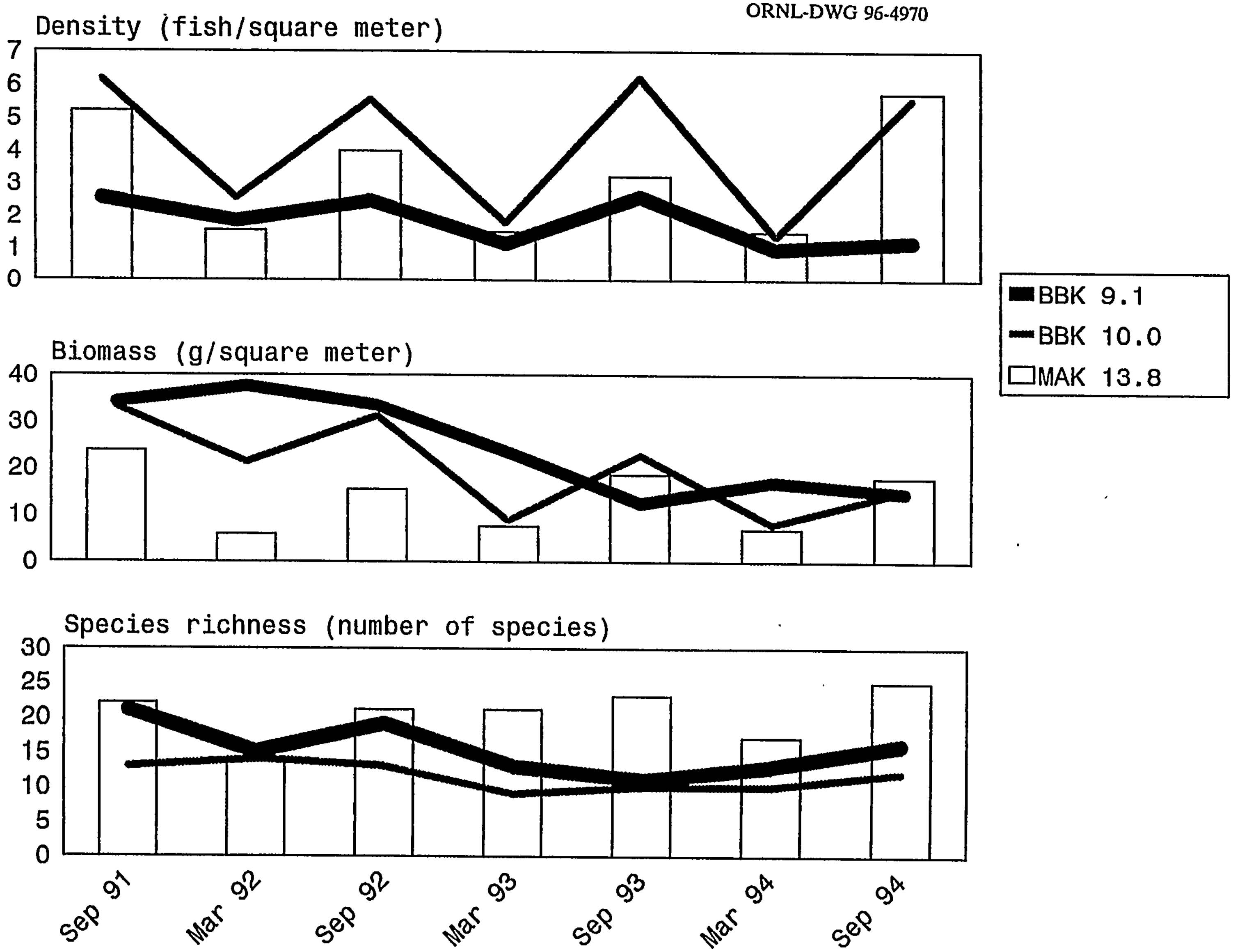

Fig. 5.1. Species richness, biomass, and density at Big Bayou Creek sites and reference.

Creek above PGDP and on Massac Creek. These comparisons indicated a slight but noticeable degradation in the communities downstream of PGDP.

Data indicated that the effects on the fish community were greatest just downstream from PGDP at BBK 10.0. The fish community at this site had a low mean and total species richness in comparison with MAK 13.8. There were no sensitive species, while tolerant species were more abundant here than at the reference site. The number of benthic insectivores was low, although the number of species in other feeding guilds was similar to levels seen at MAK 13.8. Density at BBK 10.0 was similar to or higher than that at the reference site, with a correspondingly high biomass. Compared to sampling in 1991 and 1992 (Ryon 1994a), BBK 10.0 has experienced a slight decline in biomass (Fig. 5.1). Overall the fish community at BBK 10.0 has demonstrated shortcomings.

The fish community at BBK 9.1 showed signs of impact similar to the level seen at BBK 10.0. Mean and total species richness were lower than at MAK 13.8. Although there were fewer sensitive species and at lower densities at BBK 9.1 than at MAK 13.8, more sensitive species were found at BBK 9.1 than at BBK 10.0. The tolerant species were common and abundant. Density was less than or equal to that at MAK 13.8, and species richness were slightly increased (Fig. 5.1) from 1993.

The fish community at LUK 7.2 was similar to the BBK 12.5 reference, with perhaps some species deficiencies. The mean species richness values were similar to those of the reference site but with a noticeable decline in fall 1994. Biomass were lower than at BBK 12.5. Since 1991, species richness and biomass have increased slightly (Fig. 5.2). However, in the fall 1994 sample species richness declined to the lowest level seen in sampling at LUK 7.2 (Fig. 5.2). This precipitous decline was not seen in density or biomass values. During the fall sampling, a noticeable increase in sediment level was observed at LUK 7.2.

The downstream qualitative site, LUK 4.3, did not appear to be affected by plant operations. Species richness was higher (Fig. 5.3) than that found in earlier sampling (Ryon 1994a,e), particularly in terms of sensitive species. The community was well represented in all families and significant absences in feeding guilds were not demonstrated. The relative abundance and catch-per-effort data were the highest seen at this site (Fig. 5.3). Thus, the community at LUK 4.3 appeared to be minimally affected by PGDP operations. The increases seen at this site followed a period of high water in the

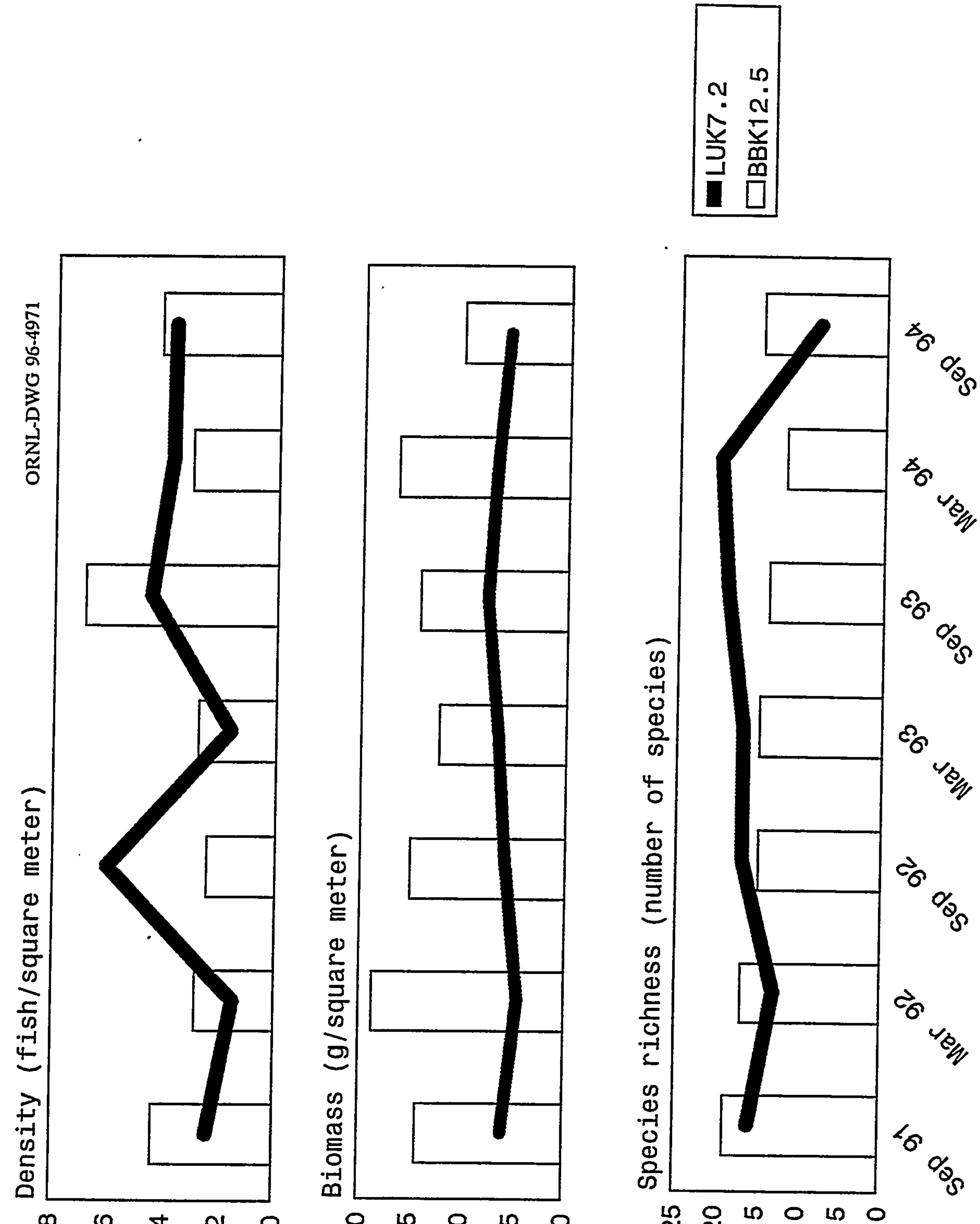

Fig. 5.2. Species richness, biomass, density at Little Bayou Creek site and reference.

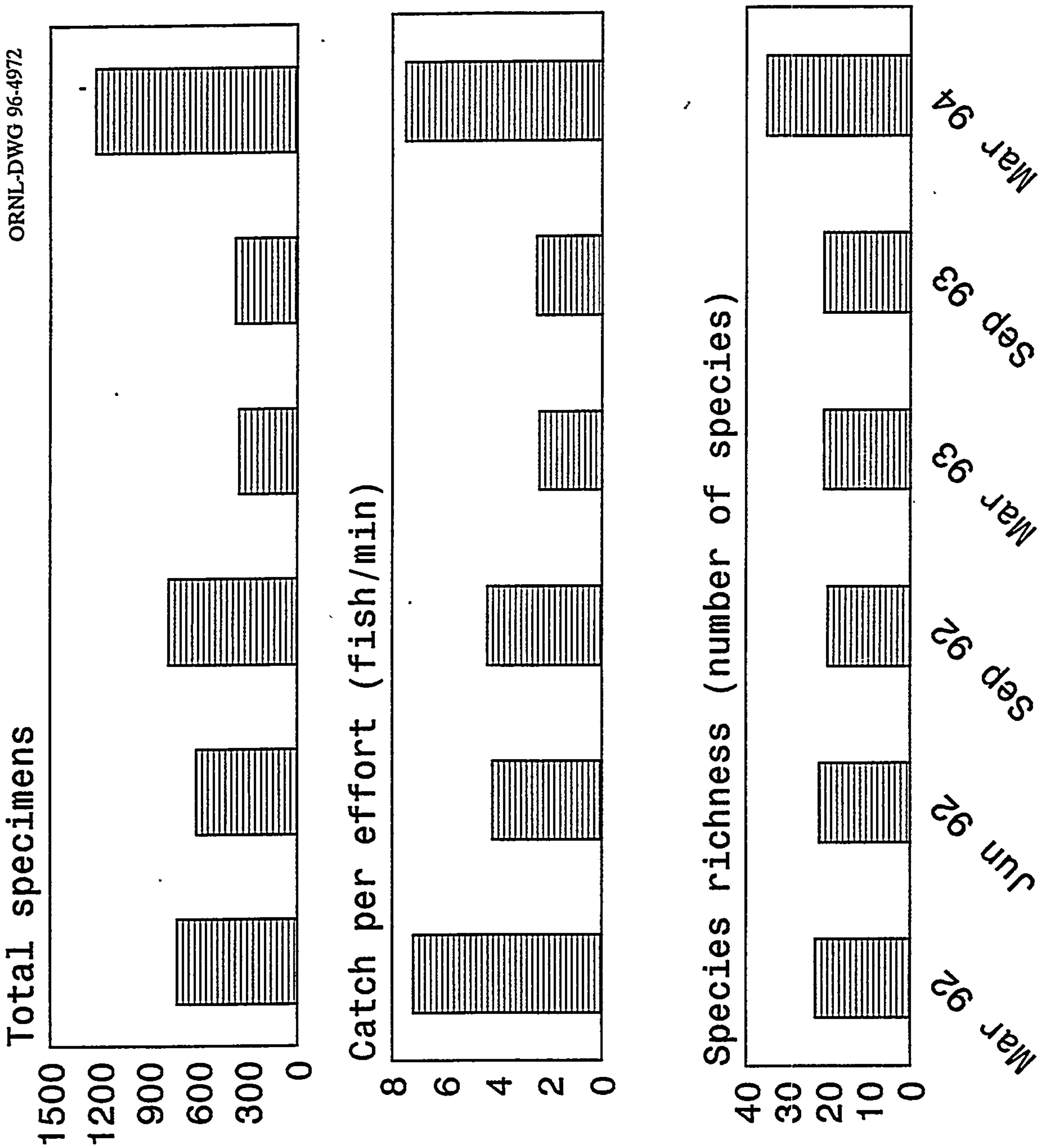

Fig. 5.3. Species richness, catch per effort, and total specimens at Little Bayou Creek qualitative site.

Ohio River. The increases reflect the site's proximity to this species source area and suggest that the river has a greater influence than PGDP at this point in Little Bayou Creek.

Monitoring of the fish communities associated with PGDP streams indicated some depressed conditions but did not specifically identify causative agents. The impacts were limited to sites closest to the plant, which suggests that PGDP activities may be the cause. The low species richness and lack of sensitive species may be caused by poor water quality or may reflect degraded habitat conditions. Biomass and density respond quickly to improvements in degraded conditions and it will be important to follow changes in these parameters, particularly at the most stressed sites. Later, the return of sensitive species or changes in proportions of feeding guilds (e.g., an increase in benthic insectivores) would be another signal of improvement in water quality.

5.2 BENTHIC MACROINVERTEBRATES (*M. R. Smith*)

5.2.1 Introduction

Benthic macroinvertebrates are organisms which inhabit the bottom substrates of freshwater systems for at least part of their life cycle and include aquatic insects, mollusks, annelids, and crustaceans. Because these organisms exhibit a diversity of physiological and morphological attributes, the analysis of benthic macroinvertebrate community composition can be used to assess the impacts of anthropogenic stressors on aquatic systems (Pontasch and Cairns 1989).

The objectives of the benthic macroinvertebrate monitoring task were to (1) aid in evaluating the ecological health of two streams (Big Bayou Creek and Little Bayou Creek) that receive effluents from the PGDP and (2) to document any changes in macroinvertebrate community composition resulting from pollution abatement programs and/or changes in operations at PGDP.

Presented in this report are the results of analyses on samples taken from September 1991 to March 1994.

5.2.2 Materials and Methods

Benthic macroinvertebrate samples have been collected quarterly (March, June, September, and December) since September 1991 from three sites on Big Bayou Creek

(BBK 9.1, BBK 10.0, and BBK 12.5) and one site each on Little Bayou Creek (LUK 7.2) and Massac Creek (MAK 13.8) (Figs. 2.1 and 2.2). Two sites, BBK 12.5 and MAK 13.8, served as reference sites; BBK 12.5 is located upstream of all PGDP discharges, while MAK 13.8 is located outside the PGDP boundary. Because riffle areas of streams generally possess the greatest variety of benthic organisms, including those considered to be sensitive to stress, samples were collected from riffles only. The locations of sampling sites were based not only on their proximity to major effluent discharges but also on the presence, similarity, and quality of riffle habitat.

At each site, three random samples were taken with a Surber sampler (0.09 m^2) equipped with a 363-μm mesh net. Samples were placed in pre-labeled, polyurethane-coated, glass jars and preserved with ~80% ethyl alcohol (ETOH). To prevent sample decomposition, the ETOH in each jar was replaced within 7 days of collection. Coincident with sample collection, water quality aspects (dissolved oxygen, conductivity, temperature, and pH) were measured with a Horiba U-7 Water Quality Checker. Selected physical attributes (distance from a permanent headstake at the base of the riffle, substrate size and embeddedness, flow rate, and water depth) were obtained for each sample prior to collection. A detailed description of procedures employed for site evaluation and sample collection, storage, and maintenance can be found in Smith (1992).

Laboratory processing consisted of washing the samples in a U. S. Standard No. 60-mesh (250-μm openings) sieve and placing small portions of the sample in a white, water-filled tray for removal of organisms from the debris. This process was repeated until all organisms were removed from the sample. Organisms were then identified to the lowest practical taxon and enumerated. Details of laboratory sample processing are available in Wojtowicz and Smith (1992). Samples from the four sampling periods of the first sampling year (September 1991 to August 1992) were processed to provide baseline information. Samples obtained during March and September of the following sampling years were processed, with samples from June and December being archived according to proscribed procedures (Smith 1992). These samples will not be processed unless further resolution of results are needed.

Data analysis was performed with the aid of Statistical Analysis System software and procedures (SAS 1985a, 1985b). Statistical analyses consisted of both descriptive and parametric techniques. A two-way ANOVA with site and sampling date as the main effects was performed on density, total richness, and EPT richness (the total number of Ephemeroptera, Plecoptera, and Trichoptera taxa), with $p \leq 0.05$ being considered statistically significant. Prior to performing the ANOVAs, values for each response were transformed [i.e. $\log_{10}(X+1)$ for density values, and square root of X for both total and EPT richness values, where X = the individual observed values for density, taxonomic richness, and EPT richness; Elliot 1977]. Due to the considerable temporal variation that was obvious from the mean values and the outcome of the ANOVAs (i.e., significant interaction between site and sampling date), results of the ANOVAs provided little useful information on significant spatial or temporal trends, and thus will not be discussed further. Descriptive techniques included the determination of mean values for density, total richness, and EPT richness for each site and date.

5.2.3 Results

5.2.3.1 Taxonomic composition

A checklist of benthic macroinvertebrate taxa collected at each site from September 1991 through March 1994 is presented in Appendix E, Table E.1. Taxonomic composition at all sites was generally similar, with most of the major taxonomic groups having one or more representatives at each site. Big Bayou Creek sites generally had a similar number of Ephemeroptera (mayfly) taxa present throughout each year, while Little Bayou Creek and Massac Creek had fewer Ephemeroptera taxa. Taxa such as *Baetis* sp. (Baetidae) and *Caenis* sp. (Caenidae) were fairly ubiquitous, being present at all sites throughout this period. Oligochaetes (aquatic worms) were present at all sites, as were the four major groups representing the midge family, Chironomidae (Chironomini, Orthocladiinae, Tanypodinae, and Tanytarsini).

The order Trichoptera (caddisflies) also had a fairly similar number of taxa both spatially and temporally at all sites. The caddisfly family Hydropsychidae was represented by two genera, *Cheumatopsyche* and *Hydropsyche*, and while *Cheumatopsyche* were collected at all sites during the three years included in this report, *Hydropsyche* were not collected at BBK 10.0.

More taxa of the order Plecoptera (stone flies) were present at the two reference sites (BBK 12.5 and MAK 13.8) than at the remaining sites, however, their occurrence varied temporally at BBK 12.5 and MAK 13.8, with no taxon being collected consistently at these sites.

Two genera in the order Coleoptera (beetles) were generally present at all sites. *Berosus* (Hydrophilidae), were present at all sites, while *Stenelmis* (Elmidae) were collected at all sites during sampling years one (September 1991–August 1992) and three (September 1993–March 1994), but were absent from samples collected at BBK 10.0, BBK 12.5, and MAK 13.8 during sampling year two (September 1992–August 1993).

5.2.3.2 Abundance

Total density. Mean densities (number of organisms/0.1 m^2) for each site during each sampling period from September 1991 to March 1994 are presented in Fig. 5.4. Densities tended to be highest at BBK 9.1 and BBK 10.0, with these sites exhibiting the two highest densities on five of the eight sampling dates (September 1991, December 1991, March 1992, September 1992, and September 1993). Except for MAK 13.8, all sites exhibited increases in density in March 1992, particularly BBK 9.1 and BBK 10.0, where average densities were 7306.5 and 6866.6 organisms/0.1 m^2, respectively. In contrast to March 1992, densities at BBK 9.1 and BBK 10.0 were at their lowest in March 1993, and were only slightly higher in March 1994 (Fig. 5.4).

The reference site on Big Bayou Creek (BBK 12.5) also exhibited a substantial increase in density in March 1992, but unlike the sites downstream (BBK 10.0 and BBK 9.1) the trend of increasing density at BBK 12.5 continued into the following sampling period (June 1992) (Fig. 5.4). Density values decreased substantially at BBK 12.5 in September 1992, and then exhibited slight increases in each of the following sampling periods.

LUK 7.2 exhibited fairly low densities throughout the study period, with the highest values occurring in March 1992 (1205 organisms/0.1 m^2). Densities declined in the following sampling period (June 1992), but remained higher than in 1991 throughout the remainder of the study, and were comparable to those observed at BBK 12.5 for the balance of the study period.

Densities at the reference site, MAK 13.8, were below 200 organisms/0.1 m^2 on four sampling dates (December 1992, March 1992, March 1993, and March 1994). The lowest density (5.0 organisms/0.1 m^2) was observed in March 1993 when densities at the other

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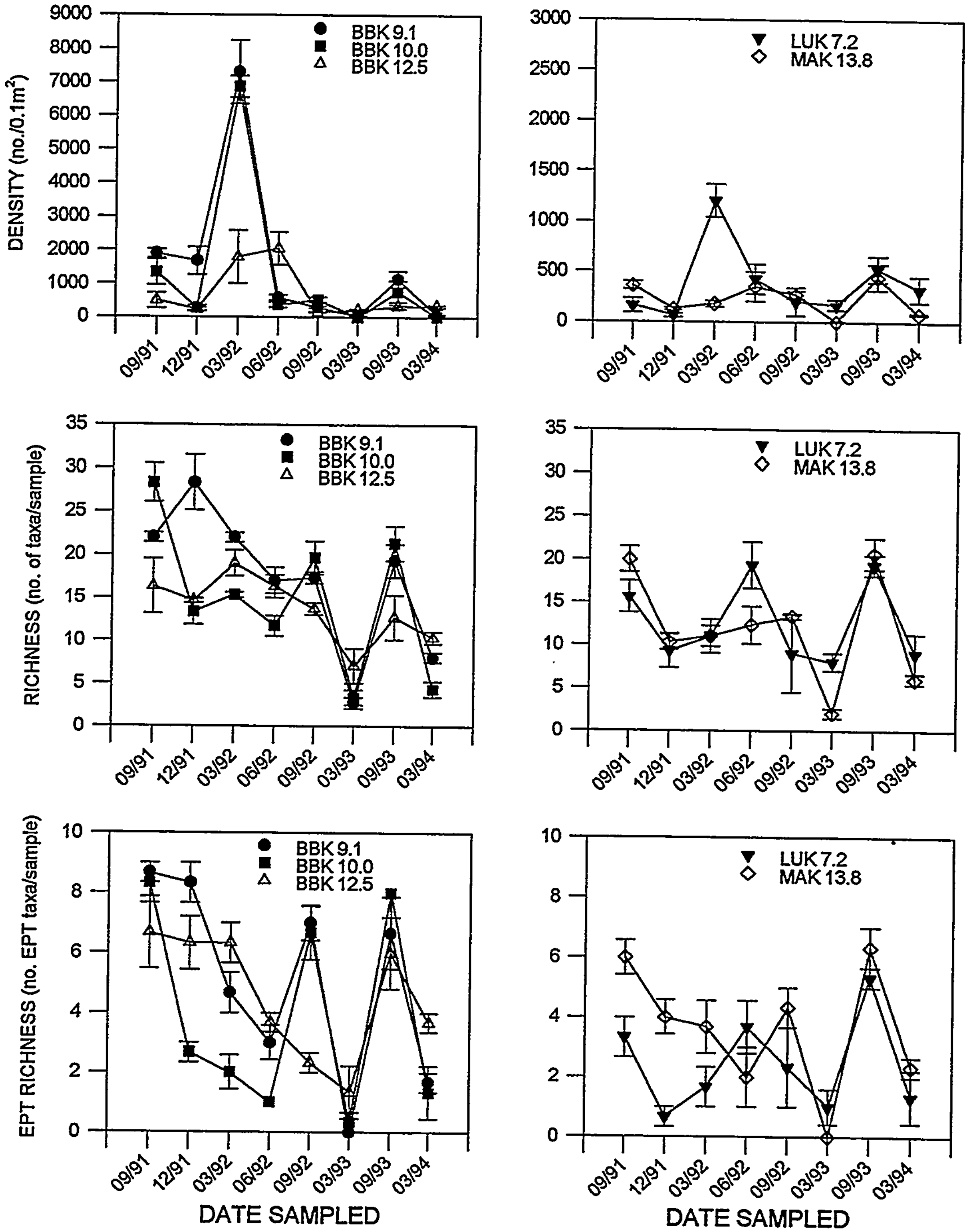

Fig. 5.4. Mean total density, mean total richness, and mean richness of the Ephemeroptera, Plecoptera, and Trichoptera (EPT richness) of the benthic macroinvertebrate communities in Big Bayou Creek, Little Bayou Creek, and Massac Creek, September 1991 to March 1994. BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; MAK = Massac Creek kilometer.

four sites were also at their lowest, while the highest density occurred during the sampling period that followed (448.2 organisms/0.1 m^2 in September 1993). Densities at this site remained low and fairly stable throughout the entire study period.

Relative abundance. The percent composition of five major categories of macroinvertebrates at each study site is presented in Fig. 5.5. As would be expected, the composition of the benthic macroinvertebrate community at each of the five sites exhibited considerable temporal variability.

The EPT category is comprised of aquatic insects in the orders Ephemeroptera (mayflies), Plecoptera (stone flies), and Trichoptera (caddisflies), which are generally considered to be pollution intolerant (e.g., Lenat 1988). Comparing the relative abundance of pollution sensitive organisms to those taxa considered to be relatively tolerant (e.g., Chironomidae, Planariidae, and Oligochaeta) can be helpful in assessing the relative health of a site. Planariidae were numerically prominent at all Big Bayou Creek sites on several sampling dates, frequently exceeding 20% of the mean density. In contrast, planariians were not collected at the other two sites (LUK 7.3 and MAK 13.8) during any sampling period (Fig. 5.5).

At BBK 9.1, the downstream most site on Big Bayou Creek, Chironomidae were the numerically dominant taxa in four sampling periods (December 1991, September 1992, March 1993, and March 1994), and while other organisms comprised at least 30% of the total present on three of these dates (December 1991, September 1992, and March 1994), in March 1993, chironomids composed over 94% of all organisms present. EPT taxa were numerically dominant in two sampling periods (September 1991 and September 1993), while Oligochaetes and Planariidae were the numerically dominant taxa in one sampling period each (~20% in March 1992 and ~35% in June 1992 respectively). Of the taxa categorized in the "other taxa" no individual taxon or major taxonomic group exceeded 12% of the total.

Although the relative amounts differed, the patterns of numerical dominance at BBK 10.0 and BBK 9.1 were very similar. The taxa numerically dominating differed on only one date (December 1991), when the Planariidae were the most abundant taxa at BBK 10.0 (39.7%), and the Chironomidae were the most abundant at BBK 9.1 (34.1%). Coleoptera were present in higher numbers at this site, when compared to BBK 9.1, with densities between 5% and 10% on three sampling periods (December 1991, September

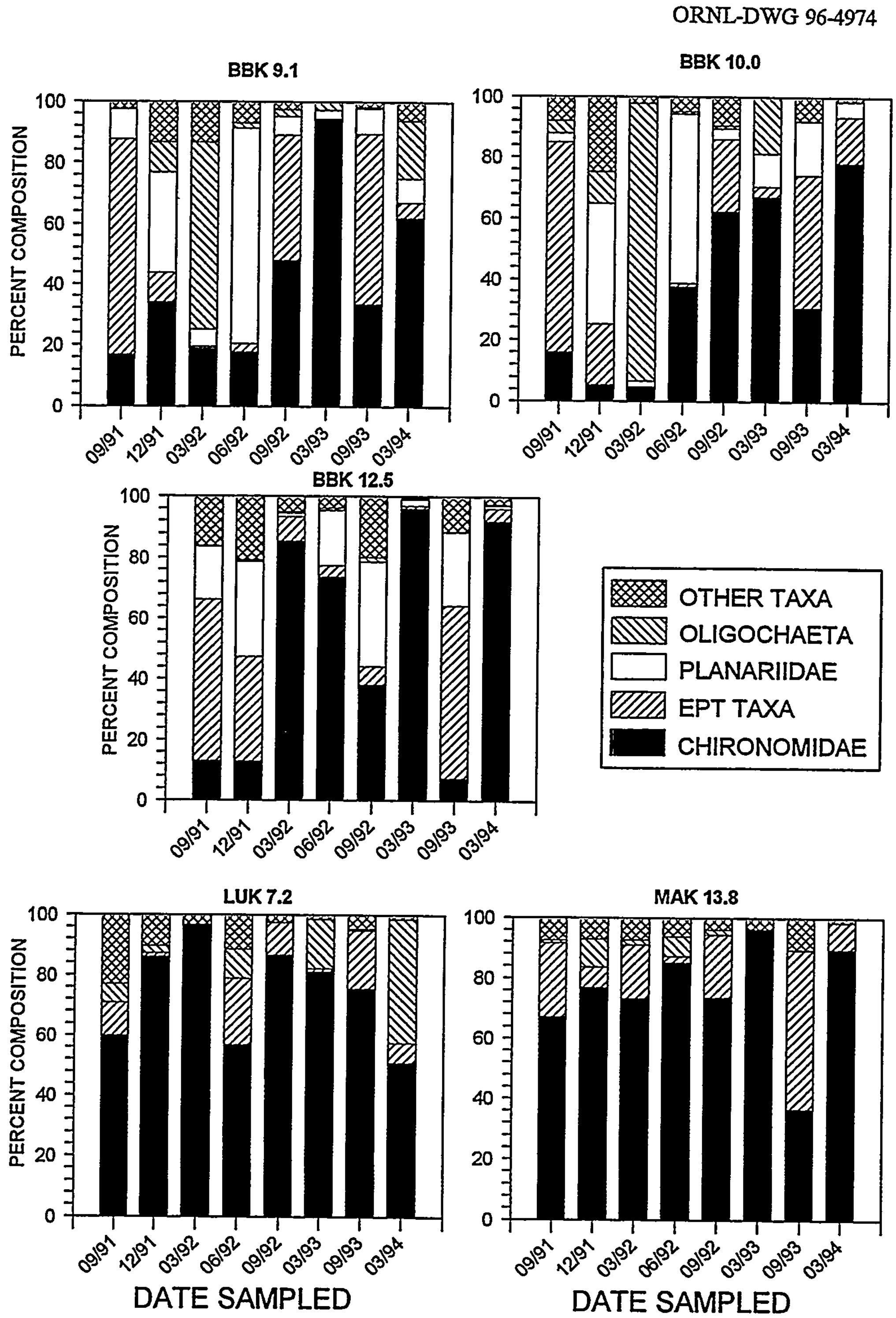

Fig. 5.5. Mean relative abundance (i.e., percent density) of selected benthic macroinvertebrate taxa in Big Bayou Creek, Little Bayou Creek, and Massac Creek, September 1991. BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; MAK = Massac Creek kilometer.

1992, and September 1993). As at BBK 9.1, none of the "other taxa" present composed over 10% of the total number of organisms.

Chironomidae (midges) were the most numerically abundant taxa at BBK 12.5, the reference site on Big Bayou Creek, on five of the eight sampling dates (March 1992, June 1992, September 1992, March 1993, and March 1994), with the remaining three dates numerically dominated by EPT taxa. During each of the three March sampling periods, chironomids made up over 85% of the total number of organisms collected at this site. Coleoptera taxa contributed over 10% of total organisms/sample during the three September sampling periods (September 1991, September 1992, and September 1993) but were present in low numbers on all other sampling dates.

The site on Little Bayou Creek (LUK 7.2) was numerically dominated by Chironomidae throughout the study period, with percentages never falling below 50%. EPT taxa never exceeded 22% of total organisms, while Planariidae were absent on all but one date (June 1992), when they made up 0.2% of the total number of organisms collected. Oligochaetes were also present in low numbers on most dates, with contributions exceeding 10% on only two dates (March 1993 and March 1994). Coleoptera comprised 15.6% of the total number of organisms present during the September 1991 sampling period, but in subsequent periods never exceeded 3% of total organisms. With few exceptions, most taxa categorized with the "other taxa" generally comprised much less than 5% of the total density.

Chironomidae were the numerically dominant taxonomic group at MAK 13.8, the reference site on Massac Creek on all but one sampling date. EPT taxa were the numerically dominant organisms on one sampling date (September 1993), when they accounted for 52.9% of the total number of organisms present, and except for June 1992 and March 1993, they comprised from 6.8 to 52.9% of the total. Oligochaetes were minor contributors to overall densities at this site, with the highest percentage being 9.2% in December 1991.

5.2.3.3 Richness

Total Richness. Total richness generally exhibited temporal variations at most sites, with some seasonal trends apparently developing after September 1992 (Fig. 5.4).

BBK 9.1 had the highest mean number of taxa/0.1 m^2 of all sites on two sampling dates (December 1991 and March 1992). Richness values during the September sampling periods were stable from year to year, with a difference of only 1.3 between the low and high mean values. This site exhibited a substantial reduction in richness from September 1992 to March 1993 (6.5X decrease), and a much lesser drop from September 1993 to March of 1994 (2.4X decrease).

Throughout the study, BBK 10.0 exhibited the highest total richness values of any site in each September sampling period, with the number of taxa/sample varying by only a factor of 1.4. A notable reduction in taxa/0.1 m^2 was observed from September to March of both 1993 and 1994, as was the case at BBK 9.1.

Although the reference site, BBK 12.5, had the highest number of taxa/0.1 m^2 on only one sampling date (March 1994), total richness at this site did not exhibit the level of fluctuation observed at the other Big Bayou Creek sites. Lowest total richness was observed in March 1993 (7.0 taxa/0.1 m^2), while highest richness values occurred in March of 1992 (19.0 taxa/0.1 m^2), a difference of only 2.7X. In contrast, BBK 9.1 exhibited a 10.6X difference between highest (28.3 in December 1991) and lowest total richness (2.67 in March 1993), and the difference between highest (28.3 in September 1991) and lowest total richness (3.33 in March 1993) at BBK 10.0 was 8.5X.

Total richness values at LUK 7.2 were more stable than at any other site in the study, with only a 2.4X difference between the highest (19.3 in both June 1992 and September 1993) and lowest total richness value (8.0 in March 1993). However, total richness values were also among the lowest on many sampling dates (September 1991, December 1991, March 1992, and September 1992).

MAK 13.8 exhibited a moderate amount of seasonal fluctuation prior to March 1993. Richness values at this site were generally among the lowest recorded among all sites and sampling dates. Richness levels were highest at this site during the September sampling dates, while richness numbers during the March sampling periods were generally among the lowest levels observed at any site (Fig. 5.4).

EPT Richness. Overall trends in EPT richness were similar to those seen in total richness at most sites, with numbers generally highest in September and lowest in March of each year (Fig. 5.4). With the exception of LUK 7.2, all sites experienced their lowest numbers of EPT taxa in March 1993 (ranging from 0 taxa/0.1 m^2 at BBK 9.1 and

MAK 13.8 to 1.33/0.1 m^2 at BBK 12.5). EPT richness at LUK 7.2 was the lowest in December 1991 (0.67 taxa/0.1 m^2).

BBK 9.1 had the greatest number of EPT taxa/0.1 m^2 on three of the eight sampling dates (September 1991, December 1991, and September 1992). As was the case with total richness, EPT richness remained fairly stable across the September sampling periods, while being much more variable across the March sampling periods.

BBK 10.0 exhibited seasonal patterns similar to BBK 9.1, in that EPT richness was generally highest in September and lowest in March of each year. BBK 10.0 had the highest numbers of EPT taxa/0.1 m^2 of any site in September 1993, although numbers in the following sampling period were among the lowest of any site.

EPT taxa values at BBK 12.5 appeared to vary more from year to year than seasonally. For example, the difference in EPT taxa/0.1 m^2 between September 1991 and March 1992 was 0.4 taxa/0.1 m^2 and the difference in EPT taxa/0.1 m^2 between September 1992 and March 1993 was 1.0 taxa/0.1 m^2, while the difference from September 1991 to September 1992 was 4.3 taxa/0.1 m^2, and from March 1991 to March 1992 was 5.0. BBK 12.5 had the highest number of EPT taxa/0.1 m^2, of any site in March 1992, March 1993, and March 1994.

The number of EPT taxa/0.1 m^2 was generally low at LUK 7.2 relative to the other sites, with this site having either the lowest number of EPT taxa (September 1991, December 1991, and March 1992) or sharing the lowest number with another site (September 1992 with BBK 12.5 and March 1994 with BBK 10.0) on five of the eight sampling dates.

MAK 13.8 experienced seasonal fluctuations in EPT taxa numbers, with the greatest number of taxa being found in September of each year. Levels generally fell within the ranges observed at the other sites in each sampling period, except in March 1993 when no EPT taxa were collected.

5.2.4 Discussion

Densities were generally higher during most of the study period at BBK 9.1 and BBK 10.0, when compared to the reference sites, suggesting nutrient enrichment. In addition, the substantial increase in density, which occurred at both sites in March 1992, suggests a substantial increase in nutrient availability occurring from December 1991 to

March 1992. Both BBK 9.1 and BBK 10.0 had relatively high total and EPT richness levels compared to the other sites, and although there was more seasonal fluctuation occurring at these sites relative to the reference sites utilized in this study, the benthic macroinvertebrate communities at both BBK 9.1 and BBK 10.0 appear to be relatively stable.

Conversely, LUK 7.2 exhibited relatively low densities/0.1 m^2 and EPT richness throughout the study. The Chironomidae constituted the majority of organisms present, and as noted by Hynes (1974), some taxa within this group are able to exploit areas unsuitable for organisms sensitive to adverse changes in water quality. These results strongly suggest that this site is impacted, which in a previous report (Kszos et al. 1994) was attributed to the effluents originating at outfall 011. However, a possible factor contributing to the depauperate community at this site may be a lack of suitable substrate. Bedrock was the primary substrate occurring at this site, with gravel and rubble being sparsely distributed. Substrate is one of the primary factors determining the population, composition, structure, and distribution of aquatic insects (e.g., Hynes 1970, Minshall 1984). The bedrock that predominated at this site may have had some effect on both the numbers and diversity of organisms present.

Taxonomic composition at the reference site on Massac Creek (MAK 13.8) was similar to that of LUK 7.2, with Chironomidae taxa being the most prevalent on seven of eight sampling dates. Densities tended to be among the lowest observed at any site throughout the study, however, EPT and total richness values were not substantially lower than those observed at the other reference site (BBK 12.5) on any sampling date. The persistently low densities and predominance of chironomids in combination with a relatively diverse benthic and fish community (see Sect. 5.1) suggest that this site is probably moderately impacted but is still able to support a relatively healthy fish community.

Finally, a substantial reduction in density/0.1 m^2, total richness, and EPT richness occurred at most sites included in this study in March 1993. A precipitation event, including both rain (1.10 inches) and snow (7.2 inches), occurred on February 25, 1993, and is a possible contributing factor to the observed decreases. This reduction was ephemeral, as all parameters had returned to near pre-March 1993 levels by the following sampling period, indicating no long-term impacts to the study sites.

5.2.5 Summary and Conclusions

Analysis of benthic macroinvertebrate data for the Big Bayou Creek sites indicates that, although there are differences between the three sampling locations on this stream, there is no strong evidence for a significant impact at any site. High densities at both BBK 9.1 and BBK 10.0, relative to the reference sites, suggest the presence of an organically enriched environment.

The site located on Little Bayou Creek (LUK 7.2) appears to be moderately impacted by a toxicant, as evidenced by low density and richness values. The suspected source of this toxicant has been identified as outfall 011. However, the presence of poor habitat at this site cannot be discounted.

Although MAK 13.8 does not appear to support large numbers of benthic macroinvertebrates, the relatively diverse community present validates its usefulness as a reference site.

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Appendix A

SUMMARY STATISTICS FOR WATER QUALITY PARAMETERS AT KPDES PERMITTED OUTFALLS

Table A.1. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall K-001 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	ANION	Bromide	mg/L	2	<	1.0000	1.0000	1.0000
K001	ANION	Chloride	mg/L	2		85.5000	84.0000	87.0000
K001	ANION	Chlorine, Total Residual	mg/L	54	<	0.0452	0.0300	0.0500
K001	ANION	Cyanide	mg/L	2	<	0.0200	0.0200	0.0200
K001	ANION	Fluoride	mg/L	2		0.5700	0.5700	0.5700
K001	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	54		394.0185	256.0000	525.0000
K001	ANION	Nitrate-Nitrite	mg/L	2		2.3500	2.3000	2.4000
K001	ANION	Sulfate	mg/L	2		415.5000	413.0000	418.0000
K001	ANION	Sulfide	mg/L	2		1.0000	1.0000	1.0000
K001	ANION	Sulfite	mg/L	2	<	3.0000	3.0000	3.0000
K001	CATION	Ammonia as Nitrogen	mg/L	2	<	0.2000	0.2000	0.2000
K001	CHEM	Hexavalent Chromium	mg/L	25	<	0.0100	0.0100	0.0100
K001	CHEM	Total Organic Carbon	mg/L	2		7.0000	7.0000	7.0000
K001	CHEM	Total Organic Nitrogen	mg/L	2		1.0450	0.8900	1.2000
K001	MAA	Arsenic	mg/L	4	<	0.0225	0.0050	0.0400
K001	MAA	Mercury	mg/L	2	<	0.0002	0.0002	0.0002
K001	MAA	Selenium	mg/L	4	<	0.0525	0.0050	0.1000
K001	MICP	Aluminum	mg/L	28		0.7719	0.3700	1.7400
K001	MICP	Antimony	mg/L	2	<	0.0600	0.0600	0.0600
K001	MICP	Barium	mg/L	4		0.0262	0.0260	0.0265
K001	MICP	Beryllium	mg/L	4	<	0.0027	0.0004	0.0050
K001	MICP	Boron	mg/L	2		0.1095	0.1070	0.1120
K001	MICP	Cadmium	mg/L	28	<	0.0079	0.0005	0.0200
K001	MICP	Calcium	mg/L	2		112.5000	112.0000	113.0000
K001	MICP	Cerium	mg/L	2	<	0.0200	0.0200	0.0200
K001	MICP	Chromium	mg/L	9	<	0.0180	0.0060	0.0500
K001	MICP	Cobalt	mg/L	4	<	0.0260	0.0020	0.0500
K001	MICP	Copper	mg/L	28	<	0.0121	0.0070	0.0300
K001	MICP	Gallium	mg/L	2	<	0.0200	0.0200	0.0200
K001	MICP	Iron	mg/L	28	<	0.4073	0.1540	1.0900

Table A.1 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	MICP	Lead	mg/L	28		0.1449	0.0030	0.2000
K001	MICP	Lithium	mg/L	2	<	0.0200	0.0200	0.0200
K001	MICP	Magnesium	mg/L	4		21.9500	20.0000	24.0000
K001	MICP	Manganese	mg/L	4		0.0485	0.0420	0.0520
K001	MICP	Molybdenum	mg/L	4		0.0285	0.0070	0.0500
K001	MICP	Nickel	mg/L	28	<	0.0506	0.0080	0.1000
K001	MICP	Niobium	mg/L	2	<	0.0100	0.0100	0.0100
K001	MICP	Phosphorus (P)	mg/L	54		0.2565	0.1600	0.5100
K001	MICP	Potassium	mg/L	2		19.9000	19.8000	20.0000
K001	MICP	Silver	mg/L	4	<	0.0180	0.0060	0.0300
K001	MICP	Sodium	mg/L	2		96.5000	96.0000	97.0000
K001	MICP	Strontium	mg/L	2		0.3240	0.3230	0.3250
K001	MICP	Thallium	mg/L	4	<	0.0450	0.0300	0.0600
K001	MICP	Thorium	mg/L	2	<	0.0100	0.0100	0.0100
K001	MICP	Tin	mg/L	2	<	0.0500	0.0500	0.0500
K001	MICP	Titanium	mg/L	4	<	0.0350	0.0200	0.0500
K001	MICP	Vanadium	mg/L	2	<	0.0040	0.0040	0.0040
K001	MICP	Zinc	mg/L	28	<	0.0150	0.0050	0.0400
K001	MICP	Zirconium	mg/L	2	<	0.0040	0.0040	0.0040
K001	OROTH	Surfactants	mg/L	2	<	0.0800	0.0800	0.0800
K001	OROTH	TOX	µg/L	104		196.9038	21.0000	348.0000
K001	PHYSC	BOD	mg/L	2	<	5.0000	5.0000	5.0000
K001	PHYSC	COD	mg/L	2		19.0000	18.0000	20.0000
K001	PHYSC	Color	Units	2		23.0000	23.0000	23.0000
K001	PHYSC	Fecal Coliform	co/100mL	6		17.3333	1.0000	73.0000
K001	PHYSC	Flow	MLD	93		8.0008	2.7141	22.6367
K001	PHYSC	Oil and Grease	mg/L	54	<	5.0000	5.0000	5.0000
K001	PHYSC	pH	SU	54		8.9778	7.4000	9.9000
K001	PHYSC	Specific conductance	µmhos/cm	103		1273.0291	789.0000	1730.0000
K001	PHYSC	Temperature	C	54		19.7427	2.7777	32.2222

Table A.1 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	PHYSC	Total Suspended Solids	mg/L	54		23.0000	5.0000	100.0000
K001	PPCB	Acenaphthene	μg/L	2	<	10.0000	10.0000	10.0000
K001	PPCB	Acenaphthylene	μg/L	2	<	10.0000	10.0000	10.0000
K001	PPCB	PCB	μg/L	13	<	0.0973	0.0650	0.1000
K001	RADS	% U-235	Wt %	34		0.5492	0.4010	0.7310
K001	RADS	% U-235	Wt %	6		0.4535	0.3000	0.5730
K001	RADS	Gross Alpha	pCi/L	2		5.5000	5.4000	5.6000
K001	RADS	Gross Beta	pCi/L	2		76.0000	73.0000	79.0000
K001	RADS	Neptunium-237	pCi/L	4		-0.0500	-0.6000	0.6000
K001	RADS	Plutonium-239	pCi/L	5		0.0200	0.0000	0.1000
K001	RADS	Rad Alpha	pCi/ml	13	<	1.0000	1.0000	1.0000
K001	RADS	Rad Beta	pCi/ml	13	<	1.0000	1.0000	1.0000
K001	RADS	Radium-226	pCi/L	2		0.0000	0.0000	0.0000
K001	RADS	Suspended Alpha	pCi/L	42		1.2071	-1.4000	6.6000
K001	RADS	Suspended Beta	pCi/L	42		5.8881	-1.0000	22.0000
K001	RADS	Technetium-99	pCi/L	52		21.3846	1.0000	53.0000
K001	RADS	Thorium-230	pCi/L	5		0.2000	0.0000	0.8000
K001	RADS	Total Radium	pCi/L	2		2.2500	1.8000	2.7000
K001	RADS	Uranium	mg/L	108		0.0266	0.0010	0.1400
K001	RADSD	Dissolved Alpha	pCi/L	42		4.7286	-0.2000	36.8000
K001	RADSD	Dissolved Beta	pCi/L	42		83.6905	5.0000	118.0000
K001	SVOA	1,2,4-Trichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	1,2-Diphenylhydrazine	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,4,6-Trichlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,4-Dichlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,4-Dimethylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,4-Dinitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,4-Dinitrotoluene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2,6-Dinitrotoluene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2-Chloroethyl Vinyl Ether	μg/L	2	<	10.0000	10.0000	10.0000

Table A.1 (continued)

Station	Analype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	SVOA	2-Chloronaphthalene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2-Chlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	2-Nitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	3,3'-Dichlorobenzidine	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	4,6-Dinitro-2-methylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	4-Bromophenyl-phenylether	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	4-Chloro-3-methylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	4-Chlorophenyl-phenylether	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	4-Nitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzo(a)anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzo(a)pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzo(b)fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzo(g,h,i)perylene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzo(k)fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Benzyl Butyl Phthalate	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	bis(2-Chloroethoxy)methane	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	bis(2-Chloroethyl)ether	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	bis(2-Chloroisopropyl)ether	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	2		1.0000	1.0000	1.0000
K001	SVOA	Chrysene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Di-n-butylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Di-n-octylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Dibenzo(a,h)anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Diethylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Dimethylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Fluorene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Hexachlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Hexachlorobutadiene	μg/L	2	<	10.0000	10.0000	10.0000

Table A.1 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	SVOA	Hexachlorocyclopentadiene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Hexachloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Isophorone	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	N-Nitroso-di-n-propylamine	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	N-Nitrosodimethylamine	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	N-Nitrosodiphenylamine	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Naphthalene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Nitrobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Pentachlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Phenanthrene	μg/L	2	<	10.0000	10.0000	10.0000
K001	SVOA	Phenol	μg/L	4	<	7.5000	5.0000	10.0000
K001	SVOA	Pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,1,1-Trichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,1,2,2-Tetrachloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,1,2-Trichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,1-Dichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,1-Dichloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,2-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,2-Dichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,2-Dichloropropane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,3-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	1,4-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Acetone	μg/L	12	<	1000.0000	1000.0000	1000.0000
K001	VOA	Acrolein	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Acrylonitrile	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Benzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Benzidine	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Bromodichloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Bromoform	μg/L	2	<	10.0000	10.0000	10.0000

Table A.1 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K001	VOA	Bromomethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Carbon Tetrachloride	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Chlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Chloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Chloroform	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Chloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	cis-1,3-Dichloropropene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Dibromochloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Dichlorodifluoromethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Ethylbenzene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Isopropanol	μg/L	12	<	1000.0000	1000.0000	1000.0000
K001	VOA	Methylene Chloride	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	2	<	0.7300	0.6100	0.8500
K001	VOA	Tetrachloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Toluene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Trans-1,2-Dichloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Trans-1,3-Dichloropropene	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Trichloroethene	μg/L	15	<	2.2000	1.0000	10.0000
K001	VOA	Trichlorofluoromethane	μg/L	2	<	10.0000	10.0000	10.0000
K001	VOA	Vinyl Chloride	μg/L	2	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.2. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 002 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K002	ANION	Chloride	mg/L	1		7.0000	7.0000	7.0000
K002	ANION	Chlorine, Total Residual	mg/L	15	<	0.0493	0.0300	0.1000
K002	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K002	ANION	Fluoride	mg/L	1		0.2400	0.2400	0.2400
K002	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	14		99.4286	32.0000	316.0000
K002	ANION	Nitrate-Nitrite	mg/L	1		0.3100	0.3100	0.3100
K002	ANION	Sulfate	mg/L	1		31.0000	31.0000	31.0000
K002	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K002	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K002	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K002	CHEM	Total Organic Carbon	mg/L	1		8.0000	8.0000	8.0000
K002	CHEM	Total Organic Nitrogen	mg/L	1		0.6700	0.6700	0.6700
K002	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K002	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K002	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K002	MICP	Aluminum	mg/L	15		2.6600	1.0200	9.8900
K002	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K002	MICP	Barium	mg/L	2		0.0497	0.0494	0.0500
K002	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K002	MICP	Boron	mg/L	1		0.0340	0.0340	0.0340
K002	MICP	Cadmium	mg/L	15	<	0.0085	0.0005	0.0120
K002	MICP	Calcium	mg/L	1		29.7000	29.7000	29.7000
K002	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K002	MICP	Chromium	mg/L	15	<	0.0536	0.0070	0.2470
K002	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K002	MICP	Copper	mg/L	15		0.0287	0.0090	0.2220
K002	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K002	MICP	Iron	mg/L	15		2.7434	0.6490	16.6000

Table A.2 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	MICP	Lead	mg/L	15	<	0.1771	0.0030	0.5100
K002	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K002	MICP	Magnesium	mg/L	2		4.7850	4.6100	4.9600
K002	MICP	Manganese	mg/L	2		0.0240	0.0230	0.0250
K002	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K002	MICP	Nickel	mg/L	15	<	0.0505	0.0080	0.1000
K002	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K002	MICP	Phosphorus (P)	mg/L	14		0.6343	0.1500	4.7900
K002	MICP	Potassium	mg/L	1		3.1000	3.1000	3.1000
K002	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K002	MICP	Sodium	mg/L	1		8.6600	8.6600	8.6600
K002	MICP	Strontium	mg/L	1		0.1440	0.1440	0.1440
K002	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K002	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K002	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K002	MICP	Titanium	mg/L	2		0.0350	0.0200	0.0500
K002	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K002	MICP	Zinc	mg/L	15		0.0461	0.0120	0.2730
K002	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K002	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K002	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K002	PHYSC	COD	mg/L	1		25.0000	25.0000	25.0000
K002	PHYSC	Color	Units	1		60.0000	60.0000	60.0000
K002	PHYSC	Dissolved Oxygen	mg/L	53		4.5051	3.9300	8.0300
K002	PHYSC	Fecal Coliform	co/100mL	2		1955.0000	410.0000	3500.0000
K002	PHYSC	Flow	MLD	43		1.2621	0.0113	7.7979
K002	PHYSC	Oil and Grease	mg/L	14	<	5.1357	5.0000	6.9000
K002	PHYSC	pH	SU	14		7.7643	6.4000	8.9000
K002	PHYSC	Temperature	C	68		31.0612	1.6666	37.7222
K002	PHYSC	Total Suspended Solids	mg/L	14		62.5000	4.0000	592.0000

Table A.2 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	PPCB	Acenaphthene	μg/L	1	<	10.0000	10.0000	10.0000
K002	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K002	PPCB	PCB	μg/L	14	<	0.0850	0.0650	0.1000
K002	RADS	% U-235	Wt %	3		0.5743	0.5140	0.6630
K002	RADS	% U-235	Wt %	2		0.2255	0.2120	0.2390
K002	RADS	Gross Alpha	pCi/L	1		1.7000	1.7000	1.7000
K002	RADS	Gross Beta	pCi/L	1		8.0000	8.0000	8.0000
K002	RADS	Neptunium-237	pCi/L	7		0.1000	-0.4000	0.7000
K002	RADS	Plutonium-239	pCi/L	7		0.0000	0.0000	0.0000
K002	RADS	Rad Alpha	pCi/ml	3	<	1.0000	1.0000	1.0000
K002	RADS	Rad Beta	pCi/ml	3	<	1.0000	1.0000	1.0000
K002	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K002	RADS	Suspended Alpha	pCi/L	7		0.8857	-1.0000	3.2000
K002	RADS	Suspended Beta	pCi/L	7		3.8571	-2.0000	9.0000
K002	RADS	Technetium-99	pCi/L	7		10.1429	2.0000	33.0000
K002	RADS	Thorium-230	pCi/L	7		0.2000	0.1000	0.6000
K002	RADS	Total Radium	pCi/L	1		0.7000	0.7000	0.7000
K002	RADS	Uranium	mg/L	9		0.0212	0.0010	0.0970
K002	RADSD	Dissolved Alpha	pCi/L	7		1.7429	0.7000	2.6000
K002	RADSD	Dissolved Beta	pCi/L	7		9.0000	4.0000	19.0000
K002	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.2 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	3,3'-Dichlorobenzidine	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	4,6-Dinitro-2-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	4-Bromophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	4-Chloro-3-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	4-Chlorophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	4-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzo(a)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzo(a)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		3.0000	3.0000	3.0000
K002	SVOA	Chrysene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Di-n-butylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Di-n-octylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Diethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Dimethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Fluorene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Hexachlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Hexachlorobutadiene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.2 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	SVOA	Hexachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000
K002	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K002	SVOA	Total Trihalomethanes	μg/L	1		7.0000	7.0000	7.0000
K002	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.2 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K002	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Chloroform	μg/L	2		10.0000	10.0000	10.0000
K002	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	2	<	0.7450	0.2900	1.2000
K002	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K002	VOA	Trichloroethene	μg/L	14	<	1.6429	1.0000	10.0000
K002	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.3. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 004 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K004	ANION	Chloride	mg/L	1		24.0000	24.0000	24.0000
K004	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K004	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K004	ANION	Fluoride	mg/L	1		0.1600	0.1600	0.1600
K004	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	1		92.0000	92.0000	92.0000
K004	ANION	Nitrate-Nitrite	mg/L	1		2.1000	2.1000	2.1000
K004	ANION	Sulfate	mg/L	1		29.0000	29.0000	29.0000
K004	ANION	Sulfide	mg/L	1		2.0000	2.0000	2.0000
K004	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K004	CATION	Ammonia as Nitrogen	mg/L	1	<	1.7000	1.7000	1.7000
K004	CHEM	Total Organic Carbon	mg/L	1		7.0000	7.0000	7.0000
K004	CHEM	Total Organic Nitrogen	mg/L	1		2.8000	2.8000	2.8000
K004	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K004	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K004	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K004	MICP	Aluminum	mg/L	2		0.1150	0.0700	0.1600
K004	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K004	MICP	Barium	mg/L	2		0.0175	0.0160	0.0190
K004	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K004	MICP	Boron	mg/L	1		0.0190	0.0190	0.0190
K004	MICP	Cadmium	mg/L	2	<	0.0070	0.0040	0.0100
K004	MICP	Calcium	mg/L	1		20.2000	20.2000	20.2000
K004	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K004	MICP	Chromium	mg/L	2	<	0.0280	0.0060	0.0500
K004	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K004	MICP	Copper	mg/L	2		0.0115	0.0100	0.0130
K004	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K004	MICP	Iron	mg/L	2		0.4260	0.3620	0.4900

Table A.3 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	MICP	Lead	mg/L	2	<	0.1100	0.0200	0.2000
K004	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K004	MICP	Magnesium	mg/L	2		4.4100	4.1900	4.6300
K004	MICP	Manganese	mg/L	2		0.0410	0.0340	0.0480
K004	MICP	Molybdenum	mg/L	2		0.0295	0.0090	0.0500
K004	MICP	Nickel	mg/L	2	<	0.0290	0.0080	0.0500
K004	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K004	MICP	Phosphorus (P)	mg/L	1		1.0700	1.0700	1.0700
K004	MICP	Potassium	mg/L	1		4.5000	4.5000	4.5000
K004	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K004	MICP	Sodium	mg/L	1		28.0000	28.0000	28.0000
K004	MICP	Strontium	mg/L	1		0.1820	0.1820	0.1820
K004	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K004	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K004	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K004	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K004	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K004	MICP	Zinc	mg/L	2		0.0435	0.0400	0.0470
K004	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K004	OROTH	Surfactants	mg/L	1		0.1000	0.1000	0.1000
K004	PHYSC	BOD	mg/L	25		9.3200	5.0000	20.0000
K004	PHYSC	COD	mg/L	1		35.0000	35.0000	35.0000
K004	PHYSC	Color	Units	1		22.0000	22.0000	22.0000
K004	PHYSC	Fecal Coliform	co/100mL	27		3.4074	1.0000	12.0000
K004	PHYSC	Flow	MLD	25		1.1806	0.8971	1.8169
K004	PHYSC	Oil and Grease	mg/L	1	<	5.0000	5.0000	5.0000
K004	PHYSC	pH	SU	25		7.2280	6.6000	8.1000
K004	PHYSC	Temperature	C	1		14.4444	14.4444	14.4444
K004	PHYSC	Total Suspended Solids	mg/L	1		11.0000	11.0000	11.0000
K004	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.3 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K004	RADS	Gross Alpha	pCi/L	1		1.4000	1.4000	1.4000
K004	RADS	Gross Beta	pCi/L	1		12.0000	12.0000	12.0000
K004	RADS	Rad Alpha	pCi/ml	1	<	1.0000	1.0000	1.0000
K004	RADS	Rad Beta	pCi/ml	1	<	1.0000	1.0000	1.0000
K004	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K004	RADS	Total Radium	pCi/L	1		0.9000	0.9000	0.9000
K004	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	3,3'-Dichlorobenzidine	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	4,6-Dinitro-2-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	4-Bromophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	4-Chloro-3-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	4-Chlorophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	4-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Benzo(a)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Benzo(a)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.3 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		2.0000	2.0000	2.0000
K004	SVOA	Chrysene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Di-n-butylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Di-n-octylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Diethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Dimethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Fluorene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Hexachlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Hexachlorobutadiene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Hexachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K004	SVOA	Phenol	μg/L	2		7.5000	5.0000	10.0000
K004	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.3 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	VOA	1,1,2,2-Tetrachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,1,2-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,1-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,1-Dichloroethene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,2-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,2-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,2-Dichloropropane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,3-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	1,4-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Acetone	µg/L	1	<	1000.0000	1000.0000	1000.0000
K004	VOA	Acrolein	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Acrylonitrile	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Benzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Benzidine	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Bromodichloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Bromoform	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Bromomethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Carbon Tetrachloride	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Chlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Chloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Chloroform	µg/L	1		7.0000	7.0000	7.0000
K004	VOA	Chloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	cis-1,3-Dichloropropene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Dibromochloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Dichlorodifluoromethane	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Ethylbenzene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Methylene Chloride	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1	<	0.4700	0.4700	0.4700
K004	VOA	Tetrachloroethene	µg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Toluene	µg/L	1		2.0000	2.0000	2.0000

Table A.3 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K004	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Trichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K004	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.4. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 006 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K006	ANION	Chloride	mg/L	1		8.0000	8.0000	8.0000
K006	ANION	Chlorine, Total Residual	mg/L	53	<	0.0451	0.0300	0.0500
K006	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K006	ANION	Fluoride	mg/L	1		0.1000	0.1000	0.1000
K006	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	53		73.1887	54.0000	114.0000
K006	ANION	Nitrate-Nitrite	mg/L	1		0.4300	0.4300	0.4300
K006	ANION	Sulfate	mg/L	1		19.0000	19.0000	19.0000
K006	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K006	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K006	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K006	CHEM	Total Organic Carbon	mg/L	1		4.0000	4.0000	4.0000
K006	CHEM	Total Organic Nitrogen	mg/L	1		0.6800	0.6800	0.6800
K006	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K006	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K006	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K006	MICP	Aluminum	mg/L	26		0.5993	0.2100	1.1800
K006	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K006	MICP	Barium	mg/L	2		0.0219	0.0218	0.0220
K006	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K006	MICP	Boron	mg/L	1		0.0130	0.0130	0.0130
K006	MICP	Cadmium	mg/L	26	<	0.0080	0.0005	0.0200
K006	MICP	Calcium	mg/L	1		17.2000	17.2000	17.2000
K006	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K006	MICP	Chromium	mg/L	26	<	0.0391	0.0060	0.0500
K006	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K006	MICP	Copper	mg/L	26	<	0.0111	0.0060	0.0190
K006	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K006	MICP	Iron	mg/L	26		0.7371	0.3330	1.3000

Table A.4 (continued)

Station	Analytype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	MICP	Lead	mg/L	26	<	0.1477	0.0030	0.2000
K006	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K006	MICP	Magnesium	mg/L	2		6.5600	6.3200	6.8000
K006	MICP	Manganese	mg/L	2		0.0595	0.0580	0.0610
K006	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K006	MICP	Nickel	mg/L	26	<	0.0523	0.0080	0.1000
K006	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K006	MICP	Phosphorus (P)	mg/L	53		0.0818	0.0400	0.2200
K006	MICP	Potassium	mg/L	1		1.7000	1.7000	1.7000
K006	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K006	MICP	Sodium	mg/L	1		10.4000	10.4000	10.4000
K006	MICP	Strontium	mg/L	1		0.0710	0.0710	0.0710
K006	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K006	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K006	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K006	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K006	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K006	MICP	Zinc	mg/L	26		0.0159	0.0050	0.0550
K006	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K006	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K006	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K006	PHYSC	COD	mg/L	1		18.0000	18.0000	18.0000
K006	PHYSC	Color	Units	1		18.0000	18.0000	18.0000
K006	PHYSC	Fecal Coliform	co/100mL	1		7.0000	7.0000	7.0000
K006	PHYSC	Flow	MLD	63		2.6358	0.0719	9.0471
K006	PHYSC	Oil and Grease	mg/L	53	<	5.0019	5.0000	5.1000
K006	PHYSC	pH	SU	53		9.1142	8.5000	9.8000
K006	PHYSC	Temperature	C	3		10.1850	6.6666	12.7777
K006	PHYSC	Total Suspended Solids	mg/L	53		16.3774	4.0000	44.0000
K006	PHYSC	Turbidity	NTU	23		11.2783	3.9000	18.0000

Table A.4 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000
K006	PPCB	Acenaphthylene	µg/L	1	<	10.0000	10.0000	10.0000
K006	PPCB	PCB	µg/L	12	<	0.0942	0.0650	0.1000
K006	RADS	Gross Alpha	pCi/L	1		0.6000	0.6000	0.6000
K006	RADS	Gross Beta	pCi/L	1		4.0000	4.0000	4.0000
K006	RADS	Rad Alpha	pCi/ml	24	<	1.0000	1.0000	1.0000
K006	RADS	Rad Beta	pCi/ml	24	<	1.0000	1.0000	1.0000
K006	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K006	RADS	Total Radium	pCi/L	1		0.3000	0.3000	0.3000
K006	SVOA	1,2,4-Trichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	1,2-Diphenylhydrazine	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,4,6-Trichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,4-Dichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,4-Dimethylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,4-Dinitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,4-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2,6-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2-Chloroethyl Vinyl Ether	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2-Chloronaphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2-Chlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	2-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.4 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		1.0000	1.0000	1.0000
K006	SVOA	Chrysene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Di-n-butylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Di-n-octylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Diethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Dimethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Fluorene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Hexachlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Hexachlorobutadiene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Hexachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K006	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000

Table A.4 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Chloroform	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Tetrachlorodibenzo-p-dioxin	μg/L	1	<	0.8000	0.8000	0.8000
K006	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.4 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K006	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Trichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K006	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.5. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 008 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K008	ANION	Chloride	mg/L	1		19.0000	19.0000	19.0000
K008	ANION	Chlorine, Total Residual	mg/L	53	<	0.0451	0.0300	0.0500
K008	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K008	ANION	Fluoride	mg/L	1		0.1600	0.1600	0.1600
K008	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	53		65.0189	44.0000	94.0000
K008	ANION	Nitrate-Nitrite	mg/L	1		1.2000	1.2000	1.2000
K008	ANION	Sulfate	mg/L	1		36.0000	36.0000	36.0000
K008	ANION	Sulfide	mg/L	1		1.1000	1.1000	1.1000
K008	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K008	CATION	Ammonia as Nitrogen	mg/L	1		0.8200	0.8200	0.8200
K008	CHEM	Total Organic Carbon	mg/L	1		4.0000	4.0000	4.0000
K008	CHEM	Total Organic Nitrogen	mg/L	1		1.4000	1.4000	1.4000
K008	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K008	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K008	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K008	MICP	Aluminum	mg/L	26		0.3170	0.0800	0.8750
K008	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K008	MICP	Barium	mg/L	2		0.0159	0.0158	0.0160
K008	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K008	MICP	Boron	mg/L	1		0.0170	0.0170	0.0170
K008	MICP	Cadmium	mg/L	26	<	0.0082	0.0005	0.0250
K008	MICP	Calcium	mg/L	1		18.7000	18.7000	18.7000
K008	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K008	MICP	Chromium	mg/L	26	<	0.0391	0.0060	0.0500
K008	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K008	MICP	Copper	mg/L	26	<	0.0112	0.0060	0.0250
K008	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K008	MICP	Iron	mg/L	26		0.2530	0.1360	0.6900

Table A.5 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	MICP	Lead	mg/L	26	<	0.1476	0.0030	0.2000
K008	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K008	MICP	Magnesium	mg/L	2		4.0000	3.8600	4.1400
K008	MICP	Manganese	mg/L	2		0.0320	0.0300	0.0340
K008	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K008	MICP	Nickel	mg/L	26	<	0.0534	0.0080	0.1000
K008	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K008	MICP	Phosphorus (P)	mg/L	54		0.4783	0.2400	0.6600
K008	MICP	Potassium	mg/L	1		2.4000	2.4000	2.4000
K008	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K008	MICP	Sodium	mg/L	1		24.6000	24.6000	24.6000
K008	MICP	Strontium	mg/L	1		0.1370	0.1370	0.1370
K008	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K008	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K008	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K008	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K008	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K008	MICP	Zinc	mg/L	26		0.0243	0.0050	0.1100
K008	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K008	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K008	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K008	PHYSC	COD	mg/L	1		17.0000	17.0000	17.0000
K008	PHYSC	Color	Units	1		12.0000	12.0000	12.0000
K008	PHYSC	Fecal Coliform	co/100mL	1		15.0000	15.0000	15.0000
K008	PHYSC	Flow	MLD	65		3.1112	1.6466	10.0692
K008	PHYSC	Oil and Grease	mg/L	53	<	5.0000	5.0000	5.0000
K008	PHYSC	pH	SU	53		7.3491	6.9000	8.0000
K008	PHYSC	Temperature	C	53		20.5032	5.5555	30.0000
K008	PHYSC	Total Suspended Solids	mg/L	53		5.9811	4.0000	14.0000
K008	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.5 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	PPCB	Acenaphthylene	µg/L	1	<	10.0000	10.0000	10.0000
K008	PPCB	PCB	µg/L	12	<	0.0942	0.0650	0.1000
K008	RADS	% U-235	Wt %	5		0.5978	0.5520	0.6490
K008	RADS	% U-235	Wt %	2		0.6340	0.6110	0.6570
K008	RADS	Gross Alpha	pCi/L	1		5.0000	5.0000	5.0000
K008	RADS	Gross Beta	pCi/L	1		13.0000	13.0000	13.0000
K008	RADS	Neptunium-237	pCi/L	4		0.0000	-0.2000	0.2000
K008	RADS	Plutonium-239	pCi/L	5		0.0200	0.0000	0.1000
K008	RADS	Rad Alpha	pCi/ml	20	<	1.0000	1.0000	1.0000
K008	RADS	Rad Beta	pCi/ml	20	<	1.0000	1.0000	1.0000
K008	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K008	RADS	Suspended Alpha	pCi/L	5		0.3000	-0.9000	2.0000
K008	RADS	Suspended Beta	pCi/L	5		8.2000	2.0000	13.0000
K008	RADS	Technetium-99	pCi/L	12		10.1667	0.0000	30.0000
K008	RADS	Thorium-230	pCi/L	5		0.2600	0.1000	0.6000
K008	RADS	Total Radium	pCi/L	1		0.7000	0.7000	0.7000
K008	RADS	Uranium	mg/L	12		0.0143	0.0020	0.0710
K008	RADSD	Dissolved Alpha	pCi/L	5		2.2000	-1.0000	5.0000
K008	RADSD	Dissolved Beta	pCi/L	5		35.2000	8.0000	117.0000
K008	SVOA	1,2,4-Trichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	1,2-Diphenylhydrazine	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,4,6-Trichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,4-Dichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,4-Dimethylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,4-Dinitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,4-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2,6-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2-Chloroethyl Vinyl Ether	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2-Chloronaphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	2-Chlorophenol	µg/L	1	<	10.0000	10.0000	10.0000

Table A.5 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	SVOA	2-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzo(b)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzo(g,h,i)perylene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzo(k)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Benzyl Butyl Phthalate	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	bis(2-Chloroethoxy)methane	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	bis(2-Chloroethyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	bis(2-Chloroisopropyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	bis(2-Ethylhexyl)phthalate	µg/L	1		2.0000	2.0000	2.0000
K008	SVOA	Chrysene	µg/L	1		10.0000	10.0000	10.0000
K008	SVOA	Di-n-butylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Di-n-octylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Dibenzo(a,h)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Diethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Dimethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Fluorene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Hexachlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Hexachlorobutadiene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Hexachlorocyclopentadiene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Hexachloroethane	µg/L	1	<	10.0000	10.0000	10.0000

Table A.5 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Isophorone	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	N-Nitroso-di-n-propylamine	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	N-Nitrosodimethylamine	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	N-Nitrosodiphenylamine	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Naphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Nitrobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Pentachlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Phenanthrene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Phenol	µg/L	2	<	7.5000	5.0000	10.0000
K008	SVOA	Pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K008	SVOA	Total Trihalomethanes	µg/L	4		7.7500	5.0000	12.0000
K008	VOA	1,1,1-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,1,2,2-Tetrachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,1,2-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,1-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,1-Dichloroethene	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,2-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,2-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,2-Dichloropropane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,3-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	1,4-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Acetone	µg/L	1	<	1000.0000	1000.0000	1000.0000
K008	VOA	Acrolein	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Acrylonitrile	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Benzene	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Benzidine	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Bromodichloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Bromoform	µg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Bromomethane	µg/L	1	<	10.0000	10.0000	10.0000

Table A.5 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K008	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Chloroform	μg/L	2		5.5000	5.0000	6.0000
K008	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Tetrachlorodibenzo-p-dioxin	μg/L	1	<	0.6000	0.6000	0.6000
K008	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Tans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Trichloroethene	μg/L	14	<	1.6429	1.0000	10.0000
K008	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K008	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.6. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 009 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K009	ANION	Chloride	mg/L	1		75.0000	75.0000	75.0000
K009	ANION	Chlorine, Total Residual	mg/L	53	<	0.0451	0.0300	0.0500
K009	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K009	ANION	Fluoride	mg/L	1		0.1900	0.1900	0.1900
K009	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	53		75.8302	36.0000	140.0000
K009	ANION	Nitrate-Nitrite	mg/L	1		0.3200	0.3200	0.3200
K009	ANION	Sulfate	mg/L	1		28.0000	28.0000	28.0000
K009	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K009	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K009	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K009	CHEM	Total Organic Carbon	mg/L	1		4.0000	4.0000	4.0000
K009	CHEM	Total Organic Nitrogen	mg/L	1		0.5900	0.5900	0.5900
K009	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K009	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K009	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K009	MICP	Aluminum	mg/L	26		0.5082	0.2400	1.3200
K009	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K009	MICP	Barium	mg/L	2		0.0327	0.0320	0.0333
K009	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K009	MICP	Boron	mg/L	1		0.0160	0.0160	0.0160
K009	MICP	Cadmium	mg/L	26	<	0.0080	0.0005	0.0200
K009	MICP	Calcium	mg/L	1		35.7000	35.7000	35.7000
K009	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K009	MICP	Chromium	mg/L	26	<	0.0391	0.0060	0.0500
K009	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K009	MICP	Copper	mg/L	26	<	0.0110	0.0060	0.0180
K009	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K009	MICP	Iron	mg/L	26		0.5671	0.2960	1.0500

Table A.6 (continued)

Station	Analype[b]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	MICP	Lead	mg/L	26	<	0.1476	0.0030	0.2000
K009	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K009	MICP	Magnesium	mg/L	2		7.5300	7.2400	7.8200
K009	MICP	Manganese	mg/L	2		0.1155	0.1140	0.1170
K009	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K009	MICP	Nickel	mg/L	26	<	0.0534	0.0080	0.1000
K009	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K009	MICP	Phosphorus (P)	mg/L	53		0.1426	0.0700	0.2500
K009	MICP	Potassium	mg/L	1		2.2000	2.2000	2.2000
K009	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K009	MICP	Sodium	mg/L	1		52.7000	52.7000	52.7000
K009	MICP	Strontium	mg/L	1		0.2830	0.2830	0.2830
K009	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K009	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K009	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K009	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K009	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K009	MICP	Zinc	mg/L	26		0.0292	0.0050	0.1190
K009	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K009	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K009	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K009	PHYSC	COD	mg/L	1		11.0000	11.0000	11.0000
K009	PHYSC	Color	Units	1		26.0000	26.0000	26.0000
K009	PHYSC	Fecal Coliform	co/100mL	1		25.0000	25.0000	25.0000
K009	PHYSC	Flow	MLD	65		0.8858	0.3823	12.0376
K009	PHYSC	Oil and Grease	mg/L	53	<	5.0000	5.0000	5.0000
K009	PHYSC	pH	SU	54		7.7870	7.0000	8.6000
K009	PHYSC	Temperature	C	53		16.7401	2.7777	28.8888
K009	PHYSC	Total Suspended Solids	mg/L	53		8.7358	4.0000	24.0000
K009	PHYSC	Turbidity	NTU	1		12.0000	12.0000	12.0000

Table A.6 (continued)

Station	Anatype[b]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	PPCB	Acenaphthene	μg/L	1	<	10.0000	10.0000	10.0000
K009	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K009	PPCB	PCB	μg/L	12	<	0.0942	0.0650	0.1000
K009	RADS	% U-235	Wt %	1		0.7150	0.7150	0.7150
K009	RADS	Gross Alpha	pCi/L	1		6.8000	6.8000	6.8000
K009	RADS	Gross Beta	pCi/L	1		28.0000	28.0000	28.0000
K009	RADS	Neptunium-237	pCi/L	4		0.0500	-0.1000	0.2000
K009	RADS	Plutonium-239	pCi/L	5		0.0200	0.0000	0.1000
K009	RADS	Rad Alpha	pCi/ml	25	<	1.0000	1.0000	1.0000
K009	RADS	Rad Beta	pCi/ml	25	<	1.0000	1.0000	1.0000
K009	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K009	RADS	Suspended Alpha	pCi/L	5		-0.0200	-1.2000	1.2000
K009	RADS	Suspended Beta	pCi/L	5		4.8000	1.0000	7.0000
K009	RADS	Technetium-99	pCi/L	12		8.6667	0.0000	20.0000
K009	RADS	Thorium-230	pCi/L	5		0.1000	0.0000	0.3000
K009	RADS	Total Radium	pCi/L	1		1.9000	1.9000	1.9000
K009	RADS	Uranium	mg/L	12		0.0021	0.0010	0.0050
K009	RADSD	Dissolved Alpha	pCi/L	5		1.5600	-1.4000	4.3000
K009	RADSD	Dissolved Beta	pCi/L	5		15.4000	9.0000	27.0000
K009	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000

Table A.6 (continued)

Station	Anatype[b]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	3,3'-Dichlorobenzidine	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	4,6-Dinitro-2-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	4-Bromophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	4-Chloro-3-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	4-Chlorophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	4-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzo(a)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzo(a)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		1.0000	1.0000	1.0000
K009	SVOA	Chrysene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Di-n-butylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Di-n-octylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Diethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Dimethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Fluorene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Hexachlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Hexachlorobutadiene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Hexachloroethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.6 (continued)

Station	Anatype[b]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Isophorone	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	N-Nitroso-di-n-propylamine	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	N-Nitrosodimethylamine	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	N-Nitrosodiphenylamine	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Naphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Nitrobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Pentachlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Phenanthrene	µg/L	1	<	10.0000	10.0000	10.0000
K009	SVOA	Phenol	µg/L	2	<	7.5000	5.0000	10.0000
K009	SVOA	Pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,1,1-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,1,2,2-Tetrachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,1,2-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,1-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,1-Dichloroethene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,2-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,2-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,2-Dichloropropane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,3-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	1,4-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Acrolein	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Acrylonitrile	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Benzene	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Benzidine	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Bromodichloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Bromoform	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Bromomethane	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Carbon Tetrachloride	µg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Chlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.6 (continued)

Station	Anatype[b]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K009	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Chloroform	μg/L	1	<	1.0000	1.0000	1.0000
K009	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1	<	0.7400	0.7400	0.7400
K009	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Tans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Trichloroethene	μg/L	13	<	1.6923	1.0000	10.0000
K009	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K009	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.7. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 010 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K010	ANION	Chloride	mg/L	1		14.0000	14.0000	14.0000
K010	ANION	Chlorine, Total Residual	mg/L	41	<	0.0432	0.0300	0.0500
K010	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K010	ANION	Fluoride	mg/L	1		0.3200	0.3200	0.3200
K010	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	41		75.5122	49.0000	122.0000
K010	ANION	Nitrate-Nitrite	mg/L	1		0.2200	0.2200	0.2200
K010	ANION	Sulfate	mg/L	1		19.0000	19.0000	19.0000
K010	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K010	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K010	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K010	CHEM	Total Organic Carbon	mg/L	1		5.0000	5.0000	5.0000
K010	CHEM	Total Organic Nitrogen	mg/L	1		0.7800	0.7800	0.7800
K010	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K010	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K010	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K010	MICP	Aluminum	mg/L	24		0.9567	0.1040	3.3600
K010	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K010	MICP	Barium	mg/L	2		0.0527	0.0523	0.0530
K010	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K010	MICP	Boron	mg/L	1		0.0170	0.0170	0.0170
K010	MICP	Cadmium	mg/L	24	<	0.0079	0.0005	0.0200
K010	MICP	Calcium	mg/L	1		29.3000	29.3000	29.3000
K010	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K010	MICP	Chromium	mg/L	24	<	0.0373	0.0060	0.0500
K010	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K010	MICP	Copper	mg/L	24	<	0.0111	0.0060	0.0140
K010	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K010	MICP	Iron	mg/L	24		0.7691	0.1670	2.2600

Table A.7 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	MICP	Lead	mg/L	24	<	0.1400	0.0030	0.2000
K010	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K010	MICP	Magnesium	mg/L	2		5.0250	4.8900	5.1600
K010	MICP	Manganese	mg/L	2		0.0670	0.0670	0.0670
K010	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K010	MICP	Nickel	mg/L	24	<	0.0524	0.0080	0.1000
K010	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K010	MICP	Phosphorus (P)	mg/L	41		0.3049	0.1100	0.6500
K010	MICP	Potassium	mg/L	1		1.6000	1.6000	1.6000
K010	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K010	MICP	Sodium	mg/L	1		13.0000	13.0000	13.0000
K010	MICP	Strontium	mg/L	1		0.2970	0.2970	0.2970
K010	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K010	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K010	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K010	MICP	Titanium	mg/L	2		0.0740	0.0200	0.1280
K010	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K010	MICP	Zinc	mg/L	23		0.0453	0.0050	0.2700
K010	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K010	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K010	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K010	PHYSC	COD	mg/L	1		18.0000	18.0000	18.0000
K010	PHYSC	Color	Units	1		85.0000	85.0000	85.0000
K010	PHYSC	Fecal Coliform	co/100mL	3		441.3333	4.0000	1050.0000
K010	PHYSC	Flow	MLD	66		4.0826	0.0038	25.7029
K010	PHYSC	Oil and Grease	mg/L	41	<	5.0000	5.0000	5.0000
K010	PHYSC	pH	SU	41		7.8288	7.0000	9.8000
K010	PHYSC	Temperature	C	41		22.9539	1.6666	33.3333
K010	PHYSC	Total Suspended Solids	mg/L	41		11.1220	4.0000	52.0000
K010	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.7 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K010	PPCB	PCB	μg/L	13	<	0.0892	0.0650	0.1000
K010	RADS	% U-235	Wt %	18		0.3766	0.2330	0.6510
K010	RADS	% U-235	Wt %	6		0.3392	0.2130	0.5240
K010	RADS	Gross Alpha	pCi/L	1		6.4000	6.4000	6.4000
K010	RADS	Gross Beta	pCi/L	1		27.0000	27.0000	27.0000
K010	RADS	Neptunium-237	pCi/L	5		0.2600	-0.1000	0.6000
K010	RADS	Plutonium-239	pCi/L	6		0.0167	0.0000	0.1000
K010	RADS	Rad Alpha	pCi/ml	10	<	1.0000	1.0000	1.0000
K010	RADS	Rad Beta	pCi/ml	10	<	1.0000	1.0000	1.0000
K010	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K010	RADS	Suspended Alpha	pCi/L	11		0.4545	-1.3000	1.5000
K010	RADS	Suspended Beta	pCi/L	11		5.0909	2.0000	9.0000
K010	RADS	Technetium-99	pCi/L	40		8.7750	0.0000	26.0000
K010	RADS	Thorium-230	pCi/L	5		0.2200	0.0000	0.8000
K010	RADS	Total Radium	pCi/L	1		0.6000	0.6000	0.6000
K010	RADS	Uranium	mg/L	44		0.0096	0.0010	0.0260
K010	RADSD	Dissolved Alpha	pCi/L	11		2.6636	0.5000	5.4000
K010	RADSD	Dissolved Beta	pCi/L	11		65.8182	2.0000	620.0000
K010	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000

Table A.7 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	SVOA	2-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzo(b)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzo(g,h,i)perylene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzo(k)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Benzyl Butyl Phthalate	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	bis(2-Chloroethoxy)methane	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	bis(2-Chloroethyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	bis(2-Chloroisopropyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	bis(2-Ethylhexyl)phthalate	µg/L	1		2.0000	2.0000	2.0000
K010	SVOA	Chrysene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Di-n-butylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Di-n-octylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Dibenzo(a,h)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Diethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Dimethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Fluorene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Hexachlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Hexachlorobutadiene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Hexachlorocyclopentadiene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Hexachloroethane	µg/L	1	<	10.0000	10.0000	10.0000

Table A.7 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Isophorone	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	N-Nitroso-di-n-propylamine	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	N-Nitrosodimethylamine	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	N-Nitrosodiphenylamine	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Naphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Nitrobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Pentachlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Phenanthrene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Phenol	µg/L	2	<	7.5000	5.0000	10.0000
K010	SVOA	Pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K010	SVOA	Total Trihalomethanes	µg/L	3		6.6667	5.0000	9.0000
K010	VOA	1,1,1-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,1,2,2-Tetrachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,1,2-Trichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,1-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,1-Dichloroethene	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,2-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,2-Dichloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,2-Dichloropropane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,3-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	1,4-Dichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Acrolein	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Acrylonitrile	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Benzene	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Benzidine	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Bromodichloromethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Bromoform	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Bromomethane	µg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Carbon Tetrachloride	µg/L	1	<	10.0000	10.0000	10.0000

Table A.7 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K010	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Chloroform	μg/L	4		8.5000	5.0000	14.0000
K010	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Dichlorodifluoromethane	μg/L	2		7.5000	5.0000	10.0000
K010	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	2	<	0.8100	0.4200	1.2000
K010	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Trichloroethene	μg/L	15	<	1.7333	1.0000	10.0000
K010	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K010	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.8. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 011 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	ANION	Bromide	mg/L	1	<	1	1.0000	1.0000
K011	ANION	Chloride	mg/L	1		23	23.0000	23.0000
K011	ANION	Chlorine, Total Residual	mg/L	27	<	0.0474	0.0100	0.0600
K011	ANION	Cyanide	mg/L	1	<	0.02	0.0200	0.0200
K011	ANION	Fluoride	mg/L	1		0.32	0.3200	0.3200
K011	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	27		84.9259	32.0000	152.0000
K011	ANION	Nitrate-Nitrite	mg/L	1		0.95	0.9500	0.9500
K011	ANION	Sulfate	mg/L	1		75	75.0000	75.0000
K011	ANION	Sulfide	mg/L	1	<	1	1.0000	1.0000
K011	ANION	Sulfite	mg/L	1	<	3	3.0000	3.0000
K011	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2	0.2000	0.2000
K011	CHEM	Total Organic Carbon	mg/L	1		5	5.0000	5.0000
K011	CHEM	Total Organic Nitrogen	mg/L	1		0.71	0.7100	0.7100
K011	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K011	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K011	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K011	MICP	Aluminum	mg/L	18		0.6143	0.2360	1.6000
K011	MICP	Antimony	mg/L	1	<	0.06	0.0600	0.0600
K011	MICP	Barium	mg/L	2		0.0352	0.0344	0.0360
K011	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K011	MICP	Boron	mg/L	1		0.032	0.0320	0.0320
K011	MICP	Cadmium	mg/L	18	<	0.0081	0.0005	0.0100
K011	MICP	Calcium	mg/L	1		34.4	34.4000	34.4000
K011	MICP	Cerium	mg/L	1	<	0.02	0.0200	0.0200
K011	MICP	Chromium	mg/L	18	<	0.0412	0.0100	0.0500
K011	MICP	Cobalt	mg/L	2	<	0.026	0.0020	0.0500
K011	MICP	Copper	mg/L	18	<	0.0123	0.0100	0.0330
K011	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K011	MICP	Iron	mg/L	18		0.6173	0.3100	1.6200

Table A.8 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	MICP	Lead	mg/L	18	<	0.1572	0.0030	0.2000
K011	MICP	Lithium	mg/L	1	<	0.02	0.0200	0.0200
K011	MICP	Magnesium	mg/L	2		7.61	7.4400	7.7800
K011	MICP	Manganese	mg/L	2		0.0355	0.0270	0.0440
K011	MICP	Molybdenum	mg/L	2	<	0.028	0.0060	0.0500
K011	MICP	Nickel	mg/L	18	<	0.0477	0.0080	0.0500
K011	MICP	Niobium	mg/L	1	<	0.01	0.0100	0.0100
K011	MICP	Phosphorus (P)	mg/L	27		0.3207	0.1300	0.5300
K011	MICP	Potassium	mg/L	1		4	4.0000	4.0000
K011	MICP	Silver	mg/L	2	<	0.018	0.0060	0.0300
K011	MICP	Sodium	mg/L	1		31.8	31.8000	31.8000
K011	MICP	Strontium	mg/L	1		0.276	0.2760	0.2760
K011	MICP	Thallium	mg/L	2	<	0.045	0.0300	0.0600
K011	MICP	Thorium	mg/L	1	<	0.01	0.0100	0.0100
K011	MICP	Tin	mg/L	1	<	0.05	0.0500	0.0500
K011	MICP	Titanium	mg/L	2	<	0.035	0.0200	0.0500
K011	MICP	Vanadium	mg/L	1	<	0.004	0.0040	0.0040
K011	MICP	Zinc	mg/L	18		0.0302	0.0090	0.0500
K011	MICP	Zirconium	mg/L	1	<	0.004	0.0040	0.0040
K011	OROTH	Surfactants	mg/L	1	<	0.08	0.0800	0.0800
K011	PHYSC	BOD	mg/L	1	<	5	5.0000	5.0000
K011	PHYSC	COD	mg/L	1		12	12.0000	12.0000
K011	PHYSC	Color	Units	1		26	26.0000	26.0000
K011	PHYSC	Fecal Coliform	co/100mL	5		597	20.0000	2700.0000
K011	PHYSC	Flow	MLD	41		2.3632	0.0075	11.6212
K011	PHYSC	Oil and Grease	mg/L	27	<	5	5.0000	5.0000
K011	PHYSC	pH	SU	27		8.1222	7.3000	9.5000
K011	PHYSC	Temperature	C	29		20.6897	8.3333	31.1111
K011	PHYSC	Total Suspended Solids	mg/L	27		8.8889	4.0000	18.0000
K011	PPCB	Acenaphthene	μg/L	1	<	10	10.0000	10.0000

Table A.8 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	PPCB	Acenaphthylene	µg/L	1	<	10	10.0000	10.0000
K011	PPCB	PCB	µg/kg[c]	9		8844.4444	1600.0000	27500.0000
K011	PPCB	PCB	µg/L	18		0.1396	0.0650	0.6000
K011	PPCB	PCB-1248	µg/kg[c]	5		6380	2100.0000	14000.0000
K011	PPCB	PCB-1248	µg/L	2		0.09	0.0800	0.1000
K011	PPCB	PCB-1254	µg/kg[c]	8		2587.5	700.0000	6000.0000
K011	PPCB	PCB-1260	µg/kg[c]	9		3000	900.0000	7500.0000
K011	PPCB	PCB-1260	µg/L	10		0.1702	0.0700	0.6000
K011	RADS	% U-235	Wt %	25		0.2361	0.1840	0.3980
K011	RADS	% U-235	Wt %	1		0.205	0.2050	0.2050
K011	RADS	Gross Alpha	pCi/L	2		19.75	5.2000	34.3000
K011	RADS	Gross Beta	pCi/L	2		27	27.0000	27.0000
K011	RADS	Neptunium-237	pCi/L	6		0.1	-0.4000	0.6000
K011	RADS	Plutonium-239	pCi/L	6		0	0.0000	0.0000
K011	RADS	Rad Alpha	pCi/kg	9		144566.667	45500.0000	330200.0000
K011	RADS	Rad Alpha	pCi/ml	13	<	1	1.0000	1.0000
K011	RADS	Rad Beta	pCi/kg	9		185622.222	61600.0000	514700.0000
K011	RADS	Rad Beta	pCi/ml	13	<	1	1.0000	1.0000
K011	RADS	Radium-226	pCi/L	1		0	0.0000	0.0000
K011	RADS	Suspended Alpha	pCi/L	14		1.4	-2.1000	4.9000
K011	RADS	Suspended Beta	pCi/L	14		8.9286	1.0000	29.0000
K011	RADS	Technetium-99	pCi/L	26		5.5769	0.0000	22.0000
K011	RADS	Thorium-230	pCi/L	6		0.1167	0.0000	0.4000
K011	RADS	Total Radium	pCi/L	1		0.4	0.4000	0.4000
K011	RADS	Uranium	mg/L	27		0.0706	0.0150	0.2100
K011	RADSD	Dissolved Alpha	pCi/L	14		7.3143	1.4000	46.2000
K011	RADSD	Dissolved Beta	pCi/L	14		18.6429	9.0000	41.0000
K011	SVOA	1,2,4-Trichlorobenzene	µg/L	1	<	10	10.0000	10.0000
K011	SVOA	1,2-Diphenylhydrazine	µg/L	1	<	10	10.0000	10.0000
K011	SVOA	2,4,6-Trichlorophenol	µg/L	1	<	10	10.0000	10.0000

Table A.8 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	SVOA	2,4-Dichlorophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2,4-Dimethylphenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2,4-Dinitrophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2-Chloronaphthalene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2-Chlorophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	2-Nitrophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	3,3'-Dichlorobenzidine	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	4,6-Dinitro-2-methylphenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	4-Bromophenyl-phenylether	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	4-Chloro-3-methylphenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	4-Chlorophenyl-phenylether	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	4-Nitrophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Anthracene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzo(a)anthracene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzo(a)pyrene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		2.0000	2.0000	2.0000
K011	SVOA	Chrysene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Di-n-butylphthalate	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Di-n-octylphthalate	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10	10.0000	10.0000

Table A.8 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	SVOA	Diethylphthalate	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Dimethylphthalate	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Fluoranthene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Fluorene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Hexachlorobenzene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Hexachlorobutadiene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Hexachloroethane	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Isophorone	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K011	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Naphthalene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Nitrobenzene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Pentachlorophenol	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Phenanthrene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Phenol	μg/L	2	<	7.5	5.0000	10.0000
K011	SVOA	Pyrene	μg/L	1	<	10	10.0000	10.0000
K011	SVOA	Total Trihalomethanes	μg/L	2		7.5	7.0000	8.0000
K011	VOA	1,1,1-Trichloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,1,2-Trichloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,1-Dichloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,1-Dichloroethene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K011	VOA	1,2-Dichloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,2-Dichloropropane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,3-Dichlorobenzene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	1,4-Dichlorobenzene	μg/L	1	<	10	10.0000	10.0000

Table A.8 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K011	VOA	Acrolein	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Acrylonitrile	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Benzene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Benzidine	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Bromodichloromethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Bromoform	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Bromomethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Carbon Tetrachloride	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Chlorobenzene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Chloroethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Chloroform	μg/L	3		4.6667	2.0000	8.0000
K011	VOA	Chloromethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	cis-1,2-dichloroethene	μg/L	2		5	3.0000	7.0000
K011	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Dibromochloromethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Dichlorodifluoromethane	μg/L	2		7	4.0000	10.0000
K011	VOA	Ethylbenzene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Methylene Chloride	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	2	<	0.68	0.2600	1.1000
K011	VOA	Tetrachloroethene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Toluene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Trichloroethene	μg/L	14		3	1.0000	8.0000
K011	VOA	Trichlorofluoromethane	μg/L	1	<	10	10.0000	10.0000
K011	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

[c]Sediment data.

Table A.9. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 012

Station	Analype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K012	ANION	Chloride	mg/L	1	<	16.0000	16.0000	16.0000
K012	ANION	Chlorine, Total Residual	mg/L	12	<	0.0450	0.0300	0.0500
K012	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K012	ANION	Fluoride	mg/L	1	<	0.3200	0.3200	0.3200
K012	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	11	<	107.6364	60.0000	166.0000
K012	ANION	Nitrate-Nitrite	mg/L	1	<	0.3600	0.3600	0.3600
K012	ANION	Sulfate	mg/L	1	<	29.0000	29.0000	29.0000
K012	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K012	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K012	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K012	CHEM	Total Organic Carbon	mg/L	1	<	6.0000	6.0000	6.0000
K012	CHEM	Total Organic Nitrogen	mg/L	1	<	0.7000	0.7000	0.7000
K012	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K012	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K012	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K012	MICP	Aluminum	mg/L	12	<	1.5579	0.4510	5.4000
K012	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K012	MICP	Barium	mg/L	2	<	0.0638	0.0630	0.0645
K012	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K012	MICP	Boron	mg/L	1	<	0.0230	0.0230	0.0230
K012	MICP	Cadmium	mg/L	12	<	0.0071	0.0005	0.0100
K012	MICP	Calcium	mg/L	1	<	43.3000	43.3000	43.3000
K012	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K012	MICP	Chromium	mg/L	12	<	0.0398	0.0060	0.0920
K012	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K012	MICP	Copper	mg/L	12	<	0.0122	0.0060	0.0300
K012	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K012	MICP	Iron	mg/L	12	<	1.3170	0.3800	4.3000
K012	MICP	Lead	mg/L	12	<	0.1358	0.0030	0.2000

Table A.9 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K012	MICP	Magnesium	mg/L	2	<	6.7550	6.5200	6.9900
K012	MICP	Manganese	mg/L	2	<	0.1715	0.1680	0.1750
K012	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K012	MICP	Nickel	mg/L	12	<	0.0528	0.0080	0.1250
K012	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K012	MICP	Phosphorus (P)	mg/L	12	<	0.2542	0.1200	0.6400
K012	MICP	Potassium	mg/L	1	<	1.2000	1.2000	1.2000
K012	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K012	MICP	Sodium	mg/L	1	<	20.9000	20.9000	20.9000
K012	MICP	Strontium	mg/L	1	<	0.3330	0.3330	0.3330
K012	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K012	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K012	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K012	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K012	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K012	MICP	Zinc	mg/L	12	<	0.0982	0.0360	0.3570
K012	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K012	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K012	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K012	PHYSC	COD	mg/L	1	<	11.0000	11.0000	11.0000
K012	PHYSC	Color	Units	1	<	55.0000	55.0000	55.0000
K012	PHYSC	Fecal Coliform	co/100mL	2	<	660.0000	270.0000	1050.0000
K012	PHYSC	Flow	MLD	12	<	7.0400	0.2082	22.0689
K012	PHYSC	Oil and Grease	mg/L	13	<	5.8615	5.0000	14.6000
K012	PHYSC	pH	SU	11	<	7.5091	7.4000	8.0000
K012	PHYSC	Temperature	C	11	<	14.7475	2.7778	30.5556
K012	PHYSC	Total Suspended Solids	mg/L	12	<	94.2500	7.0000	813.0000
K012	PPCB	Acenaphthene	ug/L	1	<	10.0000	10.0000	10.0000

Table A.9 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	PPCB	Acenaphthylene	ug/L	1	<	10.0000	10.0000	10.0000
K012	PPCB	PCB	ug/L	12	<	0.1029	0.0650	0.2600
K012	PPCB	PCB-1016	ug/L	1	<	0.2600	0.2600	0.2600
K012	PPCB	PCB-1260	ug/L	1	<	0.0800	0.0800	0.0800
K012	RADS	% .U-235	Wt %	1	<	0.3820	0.3820	0.3820
K012	RADS	Gross Alpha	pCi/L	1	<	2.5000	2.5000	2.5000
K012	RADS	Gross Beta	pCi/L	1	<	4.0000	4.0000	4.0000
K012	RADS	Neptunium-237	pCi/L	4	<	0.0750	-0.2000	0.3000
K012	RADS	Plutonium-239	pCi/L	4	<	0.0000	0.0000	0.0000
K012	RADS	Rad Alpha	pCi/ml	3	<	1.0000	1.0000	1.0000
K012	RADS	Rad Beta	pCi/ml	3	<	1.0000	1.0000	1.0000
K012	RADS	Radium-226	pCi/L	1	<	0.0000	0.0000	0.0000
K012	RADS	Suspended Alpha	pCi/L	4	<	-0.1750	-1.5000	1.1000
K012	RADS	Suspended Beta	pCi/L	4	<	3.7500	-1.0000	6.0000
K012	RADS	Technetium-99	pCi/L	4	<	10.2500	0.0000	21.0000
K012	RADS	Thorium-230	pCi/L	4	<	0.1750	0.1000	0.4000
K012	RADS	Total Radium	pCi/L	1	<	0.6000	0.6000	0.6000
K012	RADS	Uranium	mg/L	4	<	0.0070	0.0050	0.0090
K012	RADSD	Dissolved Alpha	pCi/L	4	<	0.8750	-1.5000	2.4000
K012	RADSD	Dissolved Beta	pCi/L	4	<	7.2500	2.0000	13.0000
K012	SVOA	1,2,4-Trichlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	1,2-Diphenylhydrazine	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,4,6-Trichlorophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,4-Dichlorophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,4-Dimethylphenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,4-Dinitrophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,4-Dinitrotoluene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2,6-Dinitrotoluene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2-Chloroethyl Vinyl Ether	ug/L	1	<	10.0000	10.0000	10.0000

Table A.9 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	SVOA	2-Chloronaphthalene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2-Chlorophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	2-Nitrophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	3,3'-Dichlorobenzidine	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	4,6-Dinitro-2-methylphenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	4-Bromophenyl-phenylether	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	4-Chloro-3-methylphenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	4-Chlorophenyl-phenylether	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	4-Nitrophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Anthracene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzo(a)anthracene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzo(a)pyrene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzo(b)fluoranthene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzo(g,h,i)perylene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzo(k)fluoranthene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Benzyl Butyl Phthalate	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	bis(2-Chloroethoxy)methane	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	bis(2-Chloroethyl)ether	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	bis(2-Chloroisopropyl)ether	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	bis(2-Ethylhexyl)phthalate	ug/L	1	<	2.0000	2.0000	2.0000
K012	SVOA	Chrysene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Di-n-butylphthalate	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Di-n-octylphthalate	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Dibenzo(a,h)anthracene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Diethylphthalate	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Dimethylphthalate	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Fluoranthene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Fluorene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Hexachlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000

Table A.9 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	SVOA	Hexachlorobutadiene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Hexachlorocyclopentadiene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Hexachloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Indeno(1,2,3-cd)pyrene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Isophorone	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	N-Nitroso-di-n-propylamine	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	N-Nitrosodimethylamine	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	N-Nitrosodiphenylamine	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Naphthalene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Nitrobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Pentachlorophenol	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Phenanthrene	ug/L	1	<	10.0000	10.0000	10.0000
K012	SVOA	Phenol	ug/L	2	<	7.5000	5.0000	10.0000
K012	SVOA	Pyrene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,1,1-Trichloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,1,2,2-Tetrachloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,1,2-Trichloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,1-Dichloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,1-Dichloroethene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,2-Dichlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,2-Dichloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,2-Dichloropropane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,3-Dichlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	1,4-Dichlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Acrolein	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Acrylonitrile	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Benzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Benzidine	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Bromodichloromethane	ug/L	1	<	10.0000	10.0000	10.0000

Table A.9 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K012	VOA	Bromoform	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Bromomethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Carbon Tetrachloride	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Chlorobenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Chloroethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Chloroform	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Chloromethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	cis-1,3-Dichloropropene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Dibromochloromethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Dichlorodifluoromethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Ethylbenzene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Methylene Chloride	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	2	<	0.6200	0.2600	0.9800
K012	VOA	Tetrachloroethene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Toluene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Trans-1,2-Dichloroethene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	trans-1,3-Dichloropropene	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Trichloroethene	ug/L	11	<	1.8182	1.0000	10.0000
K012	VOA	Trichlorofluoromethane	ug/L	1	<	10.0000	10.0000	10.0000
K012	VOA	Vinyl Chloride	ug/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.10. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 013 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	ANION	Bromide	mg/L	2	<	1.0000	1.0000	1.0000
K013	ANION	Chloride	mg/L	2		5.5000	5.0000	6.0000
K013	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K013	ANION	Cyanide	mg/L	2	<	0.0200	0.0200	0.0200
K013	ANION	Fluoride	mg/L	2		0.2650	0.2600	0.2700
K013	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	12		114.6667	56.0000	200.0000
K013	ANION	Nitrate-Nitrite	mg/L	2		0.4150	0.4100	0.4200
K013	ANION	Sulfate	mg/L	2		21.0000	21.0000	21.0000
K013	ANION	Sulfide	mg/L	2	<	1.0000	1.0000	1.0000
K013	ANION	Sulfite	mg/L	2	<	3.0000	3.0000	3.0000
K013	CATION	Ammonia as Nitrogen	mg/L	2	<	0.2000	0.2000	0.2000
K013	CHEM	Total Organic Carbon	mg/L	2		8.5000	8.0000	9.0000
K013	CHEM	Total Organic Nitrogen	mg/L	2		1.0500	1.0000	1.1000
K013	MAA	Arsenic	mg/L	4	<	0.0225	0.0050	0.0400
K013	MAA	Mercury	mg/L	2	<	0.0002	0.0002	0.0002
K013	MAA	Selenium	mg/L	4	<	0.0525	0.0050	0.1000
K013	MICP	Aluminum	mg/L	14		3.7443	0.2830	10.4000
K013	MICP	Antimony	mg/L	2	<	0.0600	0.0600	0.0600
K013	MICP	Barium	mg/L	4		0.0711	0.0680	0.0731
K013	MICP	Beryllium	mg/L	4	<	0.0027	0.0004	0.0050
K013	MICP	Boron	mg/L	2		0.0280	0.0270	0.0290
K013	MICP	Cadmium	mg/L	14	<	0.0079	0.0005	0.0120
K013	MICP	Calcium	mg/L	2		24.1000	24.1000	24.1000
K013	MICP	Cerium	mg/L	2	<	0.0200	0.0200	0.0200
K013	MICP	Chromium	mg/L	14	<	0.0366	0.0060	0.0500
K013	MICP	Cobalt	mg/L	4	<	0.0260	0.0020	0.0500
K013	MICP	Copper	mg/L	14	<	0.0100	0.0060	0.0120
K013	MICP	Gallium	mg/L	2	<	0.0200	0.0200	0.0200
K013	MICP	Iron	mg/L	14		2.8021	0.0940	8.5700
K013	MICP	Lead	mg/L	14	<	0.1405	0.0030	0.2000

Table A.10 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	MICP	Lithium	mg/L	2	<	0.0200	0.0200	0.0200
K013	MICP	Magnesium	mg/L	4		4.3375	4.0100	4.5700
K013	MICP	Manganese	mg/L	4		0.0845	0.0800	0.0890
K013	MICP	Molybdenum	mg/L	4	<	0.0280	0.0060	0.0500
K013	MICP	Nickel	mg/L	14	<	0.0440	0.0080	0.0500
K013	MICP	Niobium	mg/L	2	<	0.0100	0.0100	0.0100
K013	MICP	Phosphorus (P)	mg/L	2		0.1900	0.1300	0.2500
K013	MICP	Potassium	mg/L	2		1.9000	1.9000	1.9000
K013	MICP	Silver	mg/L	4	<	0.0180	0.0060	0.0300
K013	MICP	Sodium	mg/L	2		6.4700	6.4400	6.5000
K013	MICP	Strontium	mg/L	2		1.4300	1.4300	1.4300
K013	MICP	Thallium	mg/L	4	<	0.0450	0.0300	0.0600
K013	MICP	Thorium	mg/L	2	<	0.0100	0.0100	0.0100
K013	MICP	Tin	mg/L	2	<	0.0500	0.0500	0.0500
K013	MICP	Titanium	mg/L	4		0.0473	0.0300	0.0790
K013	MICP	Vanadium	mg/L	2		0.0050	0.0050	0.0050
K013	MICP	Zinc	mg/L	14		0.0236	0.0050	0.0400
K013	MICP	Zirconium	mg/L	2	<	0.0040	0.0040	0.0040
K013	OROTH	Surfactants	mg/L	2	<	0.0800	0.0800	0.0800
K013	OROTH	TOX	µg/L	19		11.8947	5.0000	25.0000
K013	PHYSC	BOD	mg/L	2	<	5.0000	5.0000	5.0000
K013	PHYSC	COD	mg/L	2		28.5000	28.0000	29.0000
K013	PHYSC	Color	Units	2		120.0000	120.0000	120.0000
K013	PHYSC	Fecal Coliform	co/100mL	4		682.5000	240.0000	1500.0000
K013	PHYSC	Flow	MLD	12		4.1643	0.2952	20.3277
K013	PHYSC	Oil and Grease	mg/L	12	<	5.2333	5.0000	7.8000
K013	PHYSC	pH	SU	11		7.7545	7.3000	8.8000
K013	PHYSC	Specific conductance	µmhos/cm	18		252.3889	134.0000	443.0000
K013	PHYSC	Temperature	C	2		9.4444	7.7777	11.1111
K013	PHYSC	Total Suspended Solids	mg/L	12		50.3333	4.0000	286.0000

Table A.10 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	PPCB	Acenaphthene	μg/L	2	<	10.0000	10.0000	10.0000
K013	PPCB	Acenaphthylene	μg/L	2	<	10.0000	10.0000	10.0000
K013	PPCB	PCB	μg/L	11	<	0.0905	0.0650	0.1000
K013	RADS	% U-235	Wt %	1		0.6950	0.6950	0.6950
K013	RADS	Gross Alpha	pCi/L	2		2.4000	1.8000	3.0000
K013	RADS	Gross Beta	pCi/L	2		7.5000	7.0000	8.0000
K013	RADS	Neptunium-237	pCi/L	4		0.1250	-0.1000	0.5000
K013	RADS	Plutonium-239	pCi/L	4		0.0000	0.0000	0.0000
K013	RADS	Rad Alpha	pCi/ml	7	<	1.0000	1.0000	1.0000
K013	RADS	Rad Beta	pCi/ml	7	<	1.0000	1.0000	1.0000
K013	RADS	Radium-226	pCi/L	2		0.0000	0.0000	0.0000
K013	RADS	Suspended Alpha	pCi/L	4		-0.7750	-1.8000	0.7000
K013	RADS	Suspended Beta	pCi/L	4		3.5000	3.0000	4.0000
K013	RADS	Technetium-99	pCi/L	4		5.0000	0.0000	8.0000
K013	RADS	Thorium-230	pCi/L	4		0.0750	0.0000	0.1000
K013	RADS	Total Radium	pCi/L	2		0.6000	0.6000	0.6000
K013	RADS	Uranium	mg/L	8		0.0020	0.0010	0.0030
K013	RADSD	Dissolved Alpha	pCi/L	4		1.4250	0.2000	2.4000
K013	RADSD	Dissolved Beta	pCi/L	4		5.2500	3.0000	9.0000
K013	SVOA	1,2,4-Trichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	1,2-Diphenylhydrazine	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,4,6-Trichlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,4-Dichlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,4-Dimethylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,4-Dinitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,4-Dinitrotoluene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2,6-Dinitrotoluene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2-Chloroethyl Vinyl Ether	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2-Chloronaphthalene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	2-Chlorophenol	μg/L	2	<	10.0000	10.0000	10.0000

Table A.10 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	SVOA	2-Nitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	3,3'-Dichlorobenzidine	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	4,6-Dinitro-2-methylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	4-Bromophenyl-phenylether	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	4-Chloro-3-methylphenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	4-Chlorophenyl-phenylether	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	4-Nitrophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzo(a)anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzo(a)pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzo(b)fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzo(g,h,i)perylene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzo(k)fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Benzyl Butyl Phthalate	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	bis(2-Chloroethoxy)methane	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	bis(2-Chloroethyl)ether	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	bis(2-Chloroisopropyl)ether	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	2		4.0000	2.0000	6.0000
K013	SVOA	Chrysene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Di-n-butylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Di-n-octylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Dibenzo(a,h)anthracene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Diethylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Dimethylphthalate	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Fluoranthene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Fluorene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Hexachlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Hexachlorobutadiene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Hexachlorocyclopentadiene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Hexachloroethane	μg/L	2	<	10.0000	10.0000	10.0000

Table A.10 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Isophorone	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	N-Nitroso-di-n-propylamine	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	N-Nitrosodimethylamine	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	N-Nitrosodiphenylamine	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Naphthalene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Nitrobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Pentachlorophenol	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Phenanthrene	μg/L	2	<	10.0000	10.0000	10.0000
K013	SVOA	Phenol	μg/L	4	<	7.5000	5.0000	10.0000
K013	SVOA	Pyrene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,1,1-Trichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,1,2,2-Tetrachloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,1,2-Trichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,1-Dichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,1-Dichloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,2-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,2-Dichloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,2-Dichloropropane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,3-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	1,4-Dichlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Acrolein	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Acrylonitrile	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Benzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Benzidine	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Bromodichloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Bromoform	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Bromomethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Carbon Tetrachloride	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Chlorobenzene	μg/L	2	<	10.0000	10.0000	10.0000

Table A.10 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K013	VOA	Chloroethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Chloroform	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Chloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	cis-1,3-Dichloropropene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Dibromochloromethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Dichlorodifluoromethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Ethylbenzene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Methylene Chloride	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	4	<	0.4150	0.2300	0.7000
K013	VOA	Tetrachloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Toluene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Trans-1,2-Dichloroethene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Trans-1,3-Dichloropropene	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Trichloroethene	μg/L	12	<	2.5000	1.0000	10.0000
K013	VOA	Trichlorofluoromethane	μg/L	2	<	10.0000	10.0000	10.0000
K013	VOA	Vinyl Chloride	μg/L	2		10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.11. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 014 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K014	ANION	Chlorine, Total Residual	mg/L	19	<	0.0500	0.0500	0.0500
K014	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	19		72.4211	52.0000	130.0000
K014	MICP	Aluminum	mg/L	10		0.4809	0.1200	1.2900
K014	MICP	Cadmium	mg/L	10	<	0.0100	0.0100	0.0100
K014	MICP	Chromium	mg/L	10	<	0.0500	0.0500	0.0500
K014	MICP	Copper	mg/L	10	<	0.0108	0.0100	0.0180
K014	MICP	Iron	mg/L	10		1.1171	0.1680	3.0200
K014	MICP	Lead	mg/L	10	<	0.2000	0.2000	0.2000
K014	MICP	Nickel	mg/L	10	<	0.0500	0.0500	0.0500
K014	MICP	Phosphorus (P)	mg/L	10		0.2300	0.1300	0.3500
K014	MICP	Zinc	mg/L	10		0.0109	0.0050	0.0300
K014	PHYSC	Flow	MLD	17		0.7199	0.4088	0.9993
K014	PHYSC	Oil and Grease	mg/L	19	<	5.0000	5.0000	5.0000
K014	PHYSC	pH	SU	19		8.0053	7.0000	9.2000
K014	PHYSC	Total Suspended Solids	mg/L	19		7.4211	4.0000	27.0000
K014	PHYSC	Turbidity	NTU	15		3.6720	0.3800	7.1000
K014	PPCB	PCB	µg/L	5	<	0.1000	0.1000	0.1000
K014	RADS	Suspended Alpha	pCi/L	1		0.7000	0.7000	0.7000
K014	RADS	Suspended Beta	pCi/L	1		3.0000	3.0000	3.0000
K014	RADS	Uranium	mg/L	1	<	0.0010	0.0010	0.0010
K014	RADSD	Dissolved Alpha	pCi/L	1		1.1000	1.1000	1.1000
K014	RADSD	Dissolved Beta	pCi/L	1		3.0000	3.0000	3.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MICP = metals by inductively-coupled plasma/mass spectroscopy; PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.12. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 015 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K015	ANION	Chloride	mg/L	1		24.0000	24.0000	24.0000
K015	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K015	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K015	ANION	Fluoride	mg/L	1		0.7100	0.7100	0.7100
K015	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	11		140.0000	62.0000	260.0000
K015	ANION	Nitrate-Nitrite	mg/L	1		0.0600	0.0600	0.0600
K015	ANION	Sulfate	mg/L	1		88.0000	88.0000	88.0000
K015	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K015	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K015	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K015	CHEM	Total Organic Carbon	mg/L	1		7.0000	7.0000	7.0000
K015	CHEM	Total Organic Nitrogen	mg/L	1		0.7000	0.7000	0.7000
K015	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K015	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K015	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K015	MICP	Aluminum	mg/L	12		2.8890	0.6100	15.0000
K015	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K015	MICP	Barium	mg/L	2		0.0551	0.0540	0.0562
K015	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K015	MICP	Boron	mg/L	1		0.0370	0.0370	0.0370
K015	MICP	Cadmium	mg/L	12	<	0.0081	0.0005	0.0120
K015	MICP	Calcium	mg/L	1		72.2000	72.2000	72.2000
K015	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K015	MICP	Chromium	mg/L	12	<	0.0380	0.0060	0.0500
K015	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K015	MICP	Copper	mg/L	12	<	0.0110	0.0060	0.0180
K015	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K015	MICP	Iron	mg/L	12		2.7458	0.2950	14.0000

Table A.12 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	MICP	Lead	mg/L	12	<	0.1459	0.0030	0.2000
K015	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K015	MICP	Magnesium	mg/L	2		10.5500	10.1000	11.0000
K015	MICP	Manganese	mg/L	2		0.0150	0.0150	0.0150
K015	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K015	MICP	Nickel	mg/L	12	<	0.0465	0.0080	0.0500
K015	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K015	MICP	Phosphorus (P)	mg/L	1		0.1300	0.1300	0.1300
K015	MICP	Potassium	mg/L	1		1.3000	1.3000	1.3000
K015	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K015	MICP	Sodium	mg/L	1		22.6000	22.6000	22.6000
K015	MICP	Strontium	mg/L	1		0.6320	0.6320	0.6320
K015	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K015	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K015	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K015	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K015	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K015	MICP	Zinc	mg/L	12		0.0230	0.0100	0.0400
K015	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K015	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K015	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K015	PHYSC	COD	mg/L	1		20.0000	20.0000	20.0000
K015	PHYSC	Color	Units	1		55.0000	55.0000	55.0000
K015	PHYSC	Fecal Coliform	co/100mL	1		40.0000	40.0000	40.0000
K015	PHYSC	Flow	MLD	11		2.0831	0.3255	9.4635
K015	PHYSC	Oil and Grease	mg/L	11	<	5.0000	5.0000	5.0000
K015	PHYSC	pH	SU	11		7.7455	6.9000	8.2000
K015	PHYSC	Temperature	C	2		10.8333	7.2222	14.4444
K015	PHYSC	Total Suspended Solids	mg/L	11		44.0909	6.0000	161.0000
K015	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.12 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K015	PPCB	PCB	μg/L	10	<	0.0895	0.0650	0.1000
K015	RADS	% U-235	Wt %	9		0.2961	0.2330	0.4110
K015	RADS	% U-235	Wt %	1		0.2810	0.2810	0.2810
K015	RADS	Gross Alpha	pCi/L	1		8.8000	8.8000	8.8000
K015	RADS	Gross Beta	pCi/L	1		69.0000	69.0000	69.0000
K015	RADS	Neptunium-237	pCi/L	4		0.1000	-0.2000	0.3000
K015	RADS	Plutonium-239	pCi/L	4		0.0750	0.0000	0.1000
K015	RADS	Rad Alpha	pCi/ml	5	<	1.0000	1.0000	1.0000
K015	RADS	Rad Beta	pCi/ml	5	<	1.0000	1.0000	1.0000
K015	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K015	RADS	Suspended Alpha	pCi/L	4		2.2250	1.0000	4.8000
K015	RADS	Suspended Beta	pCi/L	4		11.2500	6.0000	17.0000
K015	RADS	Technetium-99	pCi/L	10		41.2000	14.0000	113.0000
K015	RADS	Thorium-230	pCi/L	4		0.4000	0.2000	0.7000
K015	RADS	Total Radium	pCi/L	1		0.7000	0.7000	0.7000
K015	RADS	Uranium	mg/L	10		0.1302	0.0130	0.5000
K015	RADSD	Dissolved Alpha	pCi/L	4		5.8000	3.1000	11.1000
K015	RADSD	Dissolved Beta	pCi/L	4		50.2500	36.0000	69.0000
K015	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000

Table A.12 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	3,3'-Dichlorobenzidine	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	4,6-Dinitro-2-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	4-Bromophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	4-Chloro-3-methylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	4-Chlorophenyl-phenylether	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	4-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzo(a)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzo(a)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzo(b)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzo(g,h,i)perylene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzo(k)fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Benzyl Butyl Phthalate	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	bis(2-Chloroethoxy)methane	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	bis(2-Chloroethyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	bis(2-Chloroisopropyl)ether	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	bis(2-Ethylhexyl)phthalate	μg/L	1		3.0000	3.0000	3.0000
K015	SVOA	Chrysene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Di-n-butylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Di-n-octylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Dibenzo(a,h)anthracene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Diethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Dimethylphthalate	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Fluoranthene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Fluorene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Hexachlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Hexachlorobutadiene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Hexachlorocyclopentadiene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Hexachloroethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.12 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	SVOA	Indeno(1,2,3-cd)pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K015	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000
K015	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.12 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K015	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Chloroform	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1	<	0.8000	0.8000	0.8000
K015	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Trichloroethene	μg/L	11	<	1.8182	1.0000	10.0000
K015	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K015	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.13. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 016 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K016	ANION	Chloride	mg/L	1		31.0000	31.0000	31.0000
K016	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K016	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K016	ANION	Fluoride	mg/L	1		0.3800	0.3800	0.3800
K016	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	11		182.0000	78.0000	306.0000
K016	ANION	Nitrate-Nitrite	mg/L	1		0.4900	0.4900	0.4900
K016	ANION	Sulfate	mg/L	1		45.0000	45.0000	45.0000
K016	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K016	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K016	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K016	CHEM	Total Organic Carbon	mg/L	1		6.0000	6.0000	6.0000
K016	CHEM	Total Organic Nitrogen	mg/L	1		0.9100	0.9100	0.9100
K016	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K016	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K016	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K016	MICP	Aluminum	mg/L	12		1.9698	0.4300	5.2100
K016	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K016	MICP	Barium	mg/L	2		0.0647	0.0630	0.0663
K016	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K016	MICP	Boron	mg/L	1		0.0190	0.0190	0.0190
K016	MICP	Cadmium	mg/L	12	<	0.0071	0.0005	0.0100
K016	MICP	Calcium	mg/L	1		51.7000	51.7000	51.7000
K016	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K016	MICP	Chromium	mg/L	12	<	0.0363	0.0060	0.0500
K016	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K016	MICP	Copper	mg/L	12	<	0.0108	0.0060	0.0160
K016	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K016	MICP	Iron	mg/L	12		1.4119	0.2600	3.5500

Table A.13 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	MICP	Lead	mg/L	12	<	0.1358	0.0030	0.2000
K016	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K016	MICP	Magnesium	mg/L	2		5.8900	5.5000	6.2800
K016	MICP	Manganese	mg/L	2		0.0570	0.0540	0.0600
K016	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K016	MICP	Nickel	mg/L	12	<	0.0465	0.0080	0.0500
K016	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K016	MICP	Phosphorus (P)	mg/L	1		0.3900	0.3900	0.3900
K016	MICP	Potassium	mg/L	1		3.1000	3.1000	3.1000
K016	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K016	MICP	Sodium	mg/L	1		25.4000	25.4000	25.4000
K016	MICP	Strontium	mg/L	1		1.2400	1.2400	1.2400
K016	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K016	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K016	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K016	MICP	Titanium	mg/L	2		0.0660	0.0400	0.0920
K016	MICP	Vanadium	mg/L	1		0.0070	0.0070	0.0070
K016	MICP	Zinc	mg/L	12		0.0510	0.0300	0.1700
K016	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K016	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K016	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K016	PHYSC	COD	mg/L	1		20.0000	20.0000	20.0000
K016	PHYSC	Color	Units	1		60.0000	60.0000	60.0000
K016	PHYSC	Fecal Coliform	co/100mL	1		300.0000	300.0000	300.0000
K016	PHYSC	Flow	MLD	12		0.4948	0.0030	1.6353
K016	PHYSC	Oil and Grease	mg/L	11	<	5.0000	5.0000	5.0000
K016	PHYSC	pH	SU	11		7.6000	6.5000	8.3000
K016	PHYSC	Temperature	C	2		11.6666	7.2222	16.1111
K016	PHYSC	Total Suspended Solids	mg/L	11		37.3636	4.0000	150.0000
K016	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.13 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K016	PPCB	PCB	μg/L	8	<	0.0913	0.0650	0.1000
K016	RADS	% U-235	Wt %	1		0.4260	0.4260	0.4260
K016	RADS	Gross Alpha	pCi/L	1		0.2000	0.2000	0.2000
K016	RADS	Gross Beta	pCi/L	1		16.0000	16.0000	16.0000
K016	RADS	Neptunium-237	pCi/L	4		0.0750	-0.1000	0.2000
K016	RADS	Plutonium-239	pCi/L	4		0.0000	0.0000	0.0000
K016	RADS	Rad Alpha	pCi/ml	6	<	1.0000	1.0000	1.0000
K016	RADS	Rad Beta	pCi/ml	6	<	1.0000	1.0000	1.0000
K016	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K016	RADS	Suspended Alpha	pCi/L	4		1.3750	-0.5000	3.1000
K016	RADS	Suspended Beta	pCi/L	4		3.7500	-3.0000	9.0000
K016	RADS	Technetium-99	pCi/L	4		8.2500	0.0000	19.0000
K016	RADS	Thorium-230	pCi/L	4		0.2500	0.1000	0.5000
K016	RADS	Total Radium	pCi/L	1		0.9000	0.9000	0.9000
K016	RADS	Uranium	mg/L	4		0.0040	0.0030	0.0050
K016	RADSD	Dissolved Alpha	pCi/L	4		0.7750	-0.5000	2.6000
K016	RADSD	Dissolved Beta	pCi/L	4		9.7500	6.0000	15.0000
K016	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000

Table A.13 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzo(b)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzo(g,h,i)perylene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzo(k)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Benzyl Butyl Phthalate	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	bis(2-Chloroethoxy)methane	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	bis(2-Chloroethyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	bis(2-Chloroisopropyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	bis(2-Ethylhexyl)phthalate	µg/L	1		3.0000	3.0000	3.0000
K016	SVOA	Chrysene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Di-n-butylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Di-n-octylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Dibenzo(a,h)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Diethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Dimethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Fluorene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Hexachlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Hexachlorobutadiene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Hexachlorocyclopentadiene	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Hexachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.13 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K016	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000
K016	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.13 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K016	VOA	Chloroform	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	cis-1,2-dichloroethene	μg/L	1		48.0000	48.0000	48.0000
K016	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1		0.4700	0.4700	0.4700
K016	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Trichloroethene	μg/L	11	<	1.8182	1.0000	10.0000
K016	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K016	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.14. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 017 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K017	ANION	Chloride	mg/L	1		12.0000	12.0000	12.0000
K017	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K017	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K017	ANION	Fluoride	mg/L	1		0.4900	0.4900	0.4900
K017	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	11		140.0000	64.0000	210.0000
K017	ANION	Nitrate-Nitrite	mg/L	1		0.2800	0.2800	0.2800
K017	ANION	Sulfate	mg/L	1		30.0000	30.0000	30.0000
K017	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K017	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K017	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K017	CHEM	Total Organic Carbon	mg/L	1		5.0000	5.0000	5.0000
K017	CHEM	Total Organic Nitrogen	mg/L	1		0.5600	0.5600	0.5600
K017	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K017	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K017	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K017	MICP	Aluminum	mg/L	12		1.0113	0.3900	2.2000
K017	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K017	MICP	Barium	mg/L	2		0.0589	0.0580	0.0598
K017	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K017	MICP	Boron	mg/L	1		0.0210	0.0210	0.0210
K017	MICP	Cadmium	mg/L	12	<	0.0071	0.0005	0.0100
K017	MICP	Calcium	mg/L	1		52.9000	52.9000	52.9000
K017	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K017	MICP	Chromium	mg/L	12	<	0.0363	0.0060	0.0500
K017	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K017	MICP	Copper	mg/L	12	<	0.0102	0.0060	0.0120
K017	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K017	MICP	Iron	mg/L	12		0.7240	0.1800	1.5000

Table A.14 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	MICP	Lead	mg/L	12	<	0.1358	0.0030	0.2000
K017	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K017	MICP	Magnesium	mg/L	2		7.6100	7.3400	7.8800
K017	MICP	Manganese	mg/L	2		0.0390	0.0360	0.0420
K017	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K017	MICP	Nickel	mg/L	12	<	0.0465	0.0080	0.0500
K017	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K017	MICP	Phosphorus (P)	mg/L	1		0.0800	0.0800	0.0800
K017	MICP	Potassium	mg/L	1		1.3000	1.3000	1.3000
K017	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K017	MICP	Sodium	mg/L	1		12.7000	12.7000	12.7000
K017	MICP	Strontium	mg/L	1		0.8740	0.8740	0.8740
K017	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K017	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K017	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K017	MICP	Titanium	mg/L	2	<	0.0350	0.0200	0.0500
K017	MICP	Vanadium	mg/L	1	<	0.0040	0.0040	0.0040
K017	MICP	Zinc	mg/L	12		0.0212	0.0050	0.0550
K017	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K017	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K017	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K017	PHYSC	COD	mg/L	1		10.0000	10.0000	10.0000
K017	PHYSC	Color	Units	1		30.0000	30.0000	30.0000
K017	PHYSC	Fecal Coliform	co/100mL	1		40.0000	40.0000	40.0000
K017	PHYSC	Flow	MLD	12		2.2860	0.0833	11.0155
K017	PHYSC	Oil and Grease	mg/L	12	<	5.0000	5.0000	5.0000
K017	PHYSC	pH	SU	11		7.7000	7.1000	8.1000
K017	PHYSC	Temperature	C	2		11.3888	8.3333	14.4444
K017	PHYSC	Total Suspended Solids	mg/L	11		20.0000	6.0000	43.0000
K017	PPCB	Acenaphthene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.14 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	PPCB	Acenaphthylene	µg/L	1	<	10.0000	10.0000	10.0000
K017	PPCB	PCB	µg/L	10	<	0.0895	0.0650	0.1000
K017	RADS	Gross Alpha	pCi/L	1		2.1000	2.1000	2.1000
K017	RADS	Gross Beta	pCi/L	1		9.0000	9.0000	9.0000
K017	RADS	Neptunium-237	pCi/L	4		0.0750	0.0000	0.2000
K017	RADS	Plutonium-239	pCi/L	4		0.0000	0.0000	0.0000
K017	RADS	Rad Alpha	pCi/ml	5	<	1.0000	1.0000	1.0000
K017	RADS	Rad Beta	pCi/ml	5	<	1.0000	1.0000	1.0000
K017	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K017	RADS	Suspended Alpha	pCi/L	4		-0.2750	-1.3000	1.8000
K017	RADS	Suspended Beta	pCi/L	4		0.7500	-4.0000	5.0000
K017	RADS	Technetium-99	pCi/L	4		13.7500	0.0000	24.0000
K017	RADS	Thorium-230	pCi/L	4		0.7500	0.1000	2.3000
K017	RADS	Total Radium	pCi/L	1		0.7000	0.7000	0.7000
K017	RADS	Uranium	mg/L	4		0.0055	0.0040	0.0080
K017	RADSD	Dissolved Alpha	pCi/L	4		2.3000	0.7000	3.4000
K017	RADSD	Dissolved Beta	pCi/L	4		8.2500	2.0000	13.0000
K017	SVOA	1,2,4-Trichlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	1,2-Diphenylhydrazine	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,4,6-Trichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,4-Dichlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,4-Dimethylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,4-Dinitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,4-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2,6-Dinitrotoluene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2-Chloroethyl Vinyl Ether	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2-Chloronaphthalene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2-Chlorophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	2-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000

Table A.14 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzo(b)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzo(g,h,i)perylene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzo(k)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Benzyl Butyl Phthalate	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	bis(2-Chloroethoxy)methane	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	bis(2-Chloroethyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	bis(2-Chloroisopropyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	bis(2-Ethylhexyl)phthalate	µg/L	1	<	2.0000	2.0000	2.0000
K017	SVOA	Chrysene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Di-n-butylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Di-n-octylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Dibenzo(a,h)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Diethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Dimethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Fluorene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Hexachlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Hexachlorobutadiene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Hexachlorocyclopentadiene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Hexachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Isophorone	µg/L	1	<	10.0000	10.0000	10.0000

Table A.14 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K017	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000
K017	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Chloroform	μg/L	1	<	10.0000	10.0000	10.0000

Table A.14 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K017	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1	<	0.9100	0.9100	0.9100
K017	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Trichloroethene	μg/L	11	<	1.8182	1.0000	10.0000
K017	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K017	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Table A.15. Water quality parameters measured at Kentucky Pollutant Discharge Elimination System permitted outfall 018 in 1994

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	ANION	Bromide	mg/L	1	<	1.0000	1.0000	1.0000
K018	ANION	Chloride	mg/L	1		4.0000	4.0000	4.0000
K018	ANION	Chlorine, Total Residual	mg/L	1	<	0.0500	0.0500	0.0500
K018	ANION	Cyanide	mg/L	1	<	0.0200	0.0200	0.0200
K018	ANION	Fluoride	mg/L	1		0.3500	0.3500	0.3500
K018	ANION	Hardness as $CaCO_3$	mg/L $CaCO_3$	10		90.0000	56.0000	162.0000
K018	ANION	Nitrate-Nitrite	mg/L	1		0.2500	0.2500	0.2500
K018	ANION	Sulfate	mg/L	1		15.0000	15.0000	15.0000
K018	ANION	Sulfide	mg/L	1	<	1.0000	1.0000	1.0000
K018	ANION	Sulfite	mg/L	1	<	3.0000	3.0000	3.0000
K018	CATION	Ammonia as Nitrogen	mg/L	1	<	0.2000	0.2000	0.2000
K018	CHEM	Total Organic Carbon	mg/L	1		10.0000	10.0000	10.0000
K018	CHEM	Total Organic Nitrogen	mg/L	1		1.1000	1.1000	1.1000
K018	MAA	Arsenic	mg/L	2	<	0.0225	0.0050	0.0400
K018	MAA	Mercury	mg/L	1	<	0.0002	0.0002	0.0002
K018	MAA	Selenium	mg/L	2	<	0.0525	0.0050	0.1000
K018	MICP	Aluminum	mg/L	11		3.3991	0.5280	15.0000
K018	MICP	Antimony	mg/L	1	<	0.0600	0.0600	0.0600
K018	MICP	Barium	mg/L	2		0.0597	0.0580	0.0613
K018	MICP	Beryllium	mg/L	2	<	0.0027	0.0004	0.0050
K018	MICP	Boron	mg/L	1		0.0720	0.0720	0.0720
K018	MICP	Cadmium	mg/L	11	<	0.0079	0.0005	0.0120
K018	MICP	Calcium	mg/L	1		20.1000	20.1000	20.1000
K018	MICP	Cerium	mg/L	1	<	0.0200	0.0200	0.0200
K018	MICP	Chromium	mg/L	11	<	0.0369	0.0060	0.0500
K018	MICP	Cobalt	mg/L	2	<	0.0260	0.0020	0.0500
K018	MICP	Copper	mg/L	11	<	0.0106	0.0060	0.0130
K018	MICP	Gallium	mg/L	1	<	0.0200	0.0200	0.0200
K018	MICP	Iron	mg/L	11		2.6294	0.2850	11.0000

Table A.15 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	MICP	Lead	mg/L	11	<	0.1413	0.0030	0.2050
K018	MICP	Lithium	mg/L	1	<	0.0200	0.0200	0.0200
K018	MICP	Magnesium	mg/L	2		3.5500	3.4200	3.6800
K018	MICP	Manganese	mg/L	2		0.0555	0.0540	0.0570
K018	MICP	Molybdenum	mg/L	2	<	0.0280	0.0060	0.0500
K018	MICP	Nickel	mg/L	11	<	0.0462	0.0080	0.0500
K018	MICP	Niobium	mg/L	1	<	0.0100	0.0100	0.0100
K018	MICP	Phosphorus (P)	mg/L	1		0.2900	0.2900	0.2900
K018	MICP	Potassium	mg/L	1		2.6000	2.6000	2.6000
K018	MICP	Silver	mg/L	2	<	0.0180	0.0060	0.0300
K018	MICP	Sodium	mg/L	1		4.4000	4.4000	4.4000
K018	MICP	Strontium	mg/L	1		0.2210	0.2210	0.2210
K018	MICP	Thallium	mg/L	2	<	0.0450	0.0300	0.0600
K018	MICP	Thorium	mg/L	1	<	0.0100	0.0100	0.0100
K018	MICP	Tin	mg/L	1	<	0.0500	0.0500	0.0500
K018	MICP	Titanium	mg/L	2		0.0515	0.0300	0.0730
K018	MICP	Vanadium	mg/L	1		0.0050	0.0050	0.0050
K018	MICP	Zinc	mg/L	11		0.0292	0.0160	0.0450
K018	MICP	Zirconium	mg/L	1	<	0.0040	0.0040	0.0040
K018	OROTH	Surfactants	mg/L	1	<	0.0800	0.0800	0.0800
K018	PHYSC	BOD	mg/L	1	<	5.0000	5.0000	5.0000
K018	PHYSC	COD	mg/L	1		33.0000	33.0000	33.0000
K018	PHYSC	Color	Units	1		170.0000	170.0000	170.0000
K018	PHYSC	Fecal Coliform	co/100mL	1		370.0000	370.0000	370.0000
K018	PHYSC	Flow	MLD	11		6.8489	0.5905	26.1572
K018	PHYSC	Oil and Grease	mg/L	10	<	5.1200	5.0000	6.2000
K018	PHYSC	pH	SU	10		7.6900	7.2000	8.2000
K018	PHYSC	Temperature	C	2		10.8333	7.7777	13.8888
K018	PHYSC	Total Suspended Solids	mg/L	10		30.8000	4.0000	126.0000
K018	PPCB	Acenaphthene	μg/L	1	<	10.0000	10.0000	10.0000

Table A.15 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	PPCB	Acenaphthylene	μg/L	1	<	10.0000	10.0000	10.0000
K018	PPCB	PCB	μg/L	10	<	0.0930	0.0650	0.1000
K018	RADS	% U-235	Wt %	3		0.5830	0.4370	0.7110
K018	RADS	Gross Alpha	pCi/L	1		4.3000	4.3000	4.3000
K018	RADS	Gross Beta	pCi/L	1		14.0000	14.0000	14.0000
K018	RADS	Neptunium-237	pCi/L	4		0.1000	0.0000	0.3000
K018	RADS	Plutonium-239	pCi/L	4		0.0250	0.0000	0.1000
K018	RADS	Rad Alpha	pCi/ml	6	<	1.0000	1.0000	1.0000
K018	RADS	Rad Beta	pCi/ml	6	<	1.0000	1.0000	1.0000
K018	RADS	Radium-226	pCi/L	1		0.0000	0.0000	0.0000
K018	RADS	Suspended Alpha	pCi/L	4		-0.5500	-1.6000	0.7000
K018	RADS	Suspended Beta	pCi/L	4		2.7500	2.0000	4.0000
K018	RADS	Technetium-99	pCi/L	9		29.5556	0.0000	69.0000
K018	RADS	Thorium-230	pCi/L	4		0.4500	0.2000	1.0000
K018	RADS	Total Radium	pCi/L	1		0.9000	0.9000	0.9000
K018	RADS	Uranium	mg/L	9		0.0074	0.0030	0.0200
K018	RADSD	Dissolved Alpha	pCi/L	4		2.1500	-0.9000	3.8000
K018	RADSD	Dissolved Beta	pCi/L	4		16.5000	9.0000	24.0000
K018	SVOA	1,2,4-Trichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	1,2-Diphenylhydrazine	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,4,6-Trichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,4-Dichlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,4-Dimethylphenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,4-Dinitrophenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,4-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2,6-Dinitrotoluene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2-Chloroethyl Vinyl Ether	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2-Chloronaphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2-Chlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	2-Nitrophenol	μg/L	1	<	10.0000	10.0000	10.0000

Table A.15 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	SVOA	3,3'-Dichlorobenzidine	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	4,6-Dinitro-2-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	4-Bromophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	4-Chloro-3-methylphenol	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	4-Chlorophenyl-phenylether	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	4-Nitrophenol	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzo(a)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzo(a)pyrene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzo(b)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzo(g,h,i)perylenc	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzo(k)fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Benzyl Butyl Phthalate	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	bis(2-Chloroethoxy)methane	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	bis(2-Chloroethyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	bis(2-Chloroisopropyl)ether	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	bis(2-Ethylhexyl)phthalate	µg/L	1		2.0000	2.0000	2.0000
K018	SVOA	Chrysene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Di-n-butylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Di-n-octylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Dibenzo(a,h)anthracene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Diethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Dimethylphthalate	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Fluoranthene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Fluorene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Hexachlorobenzene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Hexachlorobutadiene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Hexachlorocyclopentadiene	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Hexachloroethane	µg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Indeno(1,2,3-cd)pyrene	µg/L	1	<	10.0000	10.0000	10.0000

Table A.15 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	SVOA	Isophorone	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	N-Nitroso-di-n-propylamine	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	N-Nitrosodimethylamine	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	N-Nitrosodiphenylamine	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Naphthalene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Nitrobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Pentachlorophenol	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Phenanthrene	μg/L	1	<	10.0000	10.0000	10.0000
K018	SVOA	Phenol	μg/L	2	<	7.5000	5.0000	10.0000
K018	SVOA	Pyrene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,1,1-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,1,2,2-Tetrachloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,1,2-Trichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,1-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,1-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,2-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,2-Dichloroethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,2-Dichloropropane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,3-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	1,4-Dichlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Acrolein	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Acrylonitrile	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Benzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Benzidine	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Bromodichloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Bromoform	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Bromomethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Carbon Tetrachloride	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Chlorobenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Chloroethane	μg/L	1	<	10.0000	10.0000	10.0000

Table A.15 (continued)

Station	Anatype[a]	Analysis	Units	No. Observ.	Qualifier[b]	Mean	Minimum	Maximum
K018	VOA	Chloroform	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Chloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	cis-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Dibromochloromethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Dichlorodifluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Ethylbenzene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Methylene Chloride	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Tetrachlorodibenzo-p-dioxin	ng/L	1		0.3800	0.3800	0.3800
K018	VOA	Tetrachloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Toluene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Trans-1,2-Dichloroethene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Trans-1,3-Dichloropropene	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Trichloroethene	μg/L	10	<	1.9000	1.0000	10.0000
K018	VOA	Trichlorofluoromethane	μg/L	1	<	10.0000	10.0000	10.0000
K018	VOA	Vinyl Chloride	μg/L	1	<	10.0000	10.0000	10.0000

Note: Data provided by L. S. Crabtree, Information Services, Paducah Gaseous Diffusion Plant.

[a]ANION = a negatively charged ion; CATION = a positively charged ion; CHEM = chemical parameters; MAA = metals by atomic absorption; MIC = metals by inductively-coupled plasma/mass spectroscopy; OROTH = other organics, PHYSC = physical and field measurements; PPCB = pesticides/polychlorinated biphenyls; RADS = radiochemical analysis; RADSD = radiochemical analysis, dissolved; SVOA = semivolatile organics; VOA = volatile organics.

[b]A "<" qualifier was added to the mean when ≥50% of the observations had "<" qualifiers.

Appendix B

TOXICITY MONITORING

Table B.1. Results of fathead minnow toxicity tests of continuously flowing effluents at the Paducah Gaseous Diffusion Plant
Tests conducted October 1991–November 1994

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
October 1991	Control	100	97.5	5.0	0.15	0.03
	001	6	100.0	0.0	0.18	0.01
		12	95.0	10.0	0.20	0.04
		25	97.5	5.0	0.18	0.01
		50	82.5	5.0	0.12	0.03
		100	92.5	5.0	0.22	0.04
	004	6	85.0	19.2	0.17	0.04
		12	97.5	5.0	0.19	0.04
		25	92.5	9.6	0.13	0.04
		50	87.5	12.6	0.18	0.01
		100	65.0	5.8	0.12	0.04
	006	6	100.0	0.0	0.22	0.05
		12	97.5	5.0	0.20	0.04
		25	97.5	5.0	0.23	0.03
		50	72.5	48.6	0.20	0.01
		100	92.5	9.6	0.16	0.05
	008	6	95.0	10.0	0.14	0.01
		12	77.5	15.0	0.12	0.04
		25	57.5	43.5	0.12	0.02
		50	90.0	14.1	0.13	0.03
		100	72.5	26.3	0.11	0.02
	009	6	87.5	12.6	0.16	0.03
		12	77.5	18.9	0.13	0.02
		25	82.5	9.6	0.13	0.06
		50	95.0	5.8	0.11	0.03
		100	95.0	5.8	0.13	0.03
	011	6	92.5	5.0	0.19	0.07
		12	95.0	5.8	0.13	0.06
		25	90.0	14.1	0.17	0.05
		50	90.0	8.2	0.18	0.02
		100	97.5	5.0	0.10	0.03
February 1992	Control	100	97.5	5.0	0.48	0.06
	001	25	97.5	5.0	0.50	0.08
		50	100.0	0.0	0.49	0.10
		100	87.5	12.6	0.63	0.07
	004	25	100.0	0.0	0.33	0.08

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	97.5	5.0	0.36	0.03
		100	95.0	5.8	0.38	0.09
	006	25	97.5	5.0	0.34	0.09
		50	97.5	5.0	0.39	0.09
		100	97.5	5.0	0.35	0.07
	008	12	60.0	42.4	0.47	0.06
		25	87.5	25.0	0.44	0.05
		50	80.0	21.6	0.44	0.03
		100	60.0	21.6	0.36	0.11
	009	25	60.0	33.7	0.36	0.04
		50	80.0	8.2	0.33	0.05
		100	82.5	17.1	0.38	0.06
	011	25	65.0	28.9	0.42	0.08
		50	65.0	5.8	0.30	0.08
		100	80.0	16.3	0.31	0.04
May 1992	Control	100	97.5	5.0	0.17	0.02
	001	12	100.0	0.0	0.19	0.04
		25	100.0	0.0	0.19	0.03
		50	92.5	9.6	0.23	0.04
		100	100.0	0.0	0.23	0.03
	004	12	85.0	5.8	0.20	0.02
		25	85.0	10.0	0.17	0.05
		50	97.5	5.0	0.18	0.02
		100	97.5	5.0	0.15	0.03
	006	12	72.5	22.2	0.26	0.06
		25	85.0	17.3	0.18	0.03
		50	97.5	5.0	0.16	0.03
		100	65.0	37.9	0.26	0.17
	008	12	87.5	12.6	0.22	0.06
		25	72.5	22.2	0.23	0.05
		50	75.0	12.9	0.23	0.04
		100	80.0	14.1	0.21	0.08
	009	12	92.5	5.0	0.24	0.02
		25	75.0	31.1	0.27	0.05
		50	60.0	39.2	0.30	0.08
		100	67.5	28.7	0.24	0.02
	011	12	100.0	0.0	0.22	0.02
		25	100.0	0.0	0.23	0.02
		50	95.0	10.0	0.27	0.03

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		100	97.5	5.0	0.20	0.04
August 1992	Control	100	100.0	0.0	0.68	0.11
	001	12	97.5	5.0	0.63	0.03
		25	90.0	8.2	0.67	0.09
		50	100.0	0.0	0.70	0.14
		100	100.0	0.0	0.68	0.07
	004	12	100.0	0.0	0.60	0.10
		25	97.5	5.0	0.58	0.13
		50	100.0	0.0	0.56	0.12
		100	97.5	5.0	0.59	0.03
	006	12	100.0	0.0	0.67	0.15
		25	100.0	0.0	0.67	0.03
		50	97.5	5.0	0.64	0.10
		100	100.0	0.0	0.62	0.10
	008	12	97.5	5.0	0.69	0.09
		25	97.5	5.0	0.65	0.05
		50	100.0	0.0	0.65	0.06
		100	92.5	9.6	0.60	0.06
	009	12	95.0	5.8	0.68	0.06
		25	97.5	5.0	0.61	0.11
		50	100.0	0.0	0.55	0.08
		100	100.0	0.0	0.65	0.05
	011	12	100.0	0.0	0.64	0.10
		25	100.0	0.0	0.63	0.03
		50	100.0	0.0	0.59	0.03
		100	95.0	5.8	0.56	0.10
October 1992	Control	100	100.0	0.0	0.47	0.02
	001	12	92.5	5.0	0.56	0.05
		25	97.5	5.0	0.55	0.03
		50	97.5	5.0	0.51	0.06
		100	97.5	5.0	0.63	0.03
	004	12	97.5	5.0	0.44	0.08
		25	100.0	0.0	0.48	0.04
		50	100.0	0.0	0.51	0.03
		100	100.0	0.0	0.48	0.02
	006	12	100.0	0.0	0.53	0.05
		25	97.5	5.0	0.57	0.02
		50	100.0	0.0	0.62	0.03
		100	95.0	10.0	0.47	0.05

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	008	12	100.0	0.0	0.49	0.04
		25	92.5	9.6	0.49	0.07
		50	100.0	0.0	0.52	0.07
		100	97.5	5.0	0.45	0.07
	009	12	95.0	5.8	0.53	0.08
		25	82.5	28.7	0.55	0.07
		50	70.0	25.8	0.50	0.05
		100	82.5	9.6	0.47	0.08
	011	12	90.0	8.2	0.51	0.05
		25	95.0	5.8	0.54	0.09
		50	97.5	5.0	0.49	0.02
		100	90.0	14.1	0.45	0.04
February 1993	Control	100	92.5	9.6	0.63	0.09
	001	6	92.5	5.0	0.68	0.07
		12	92.5	15.0	0.65	0.16
		25	87.5	15.0	0.62	0.03
		50	82.5	5.0	0.70	0.06
		100	92.5	5.0	0.68	0.03
	006	6	92.5	9.6	0.66	0.10
		12	90.0	14.1	0.69	0.02
		25	92.5	9.6	0.64	0.06
		50	95.0	5.8	0.61	0.12
		100	95.0	10.0	0.62	0.03
	008	6	85.0	12.9	0.73	0.06
		12	97.5	5.0	0.71	0.09
		25	97.5	5.0	0.77	0.11
		50	95.0	5.8	0.74	0.04
		100	95.0	5.8	0.70	0.07
	009	6	97.5	5.0	0.75	0.03
		12	82.5	5.0	0.88	0.07
		25	85.0	12.9	0.78	0.05
		50	95.0	5.8	0.86	0.06
		100	95.0	5.8	0.78	0.05
	011	6	82.5	9.6	0.79	0.04
		12	92.5	9.6	0.80	0.06
		25	97.5	5.0	0.80	0.06
		50	95.0	10.0	0.89	0.03
		100	97.5	5.0	0.75	0.02
May 1993	Control	100	100.0	0.0	0.43	0.02

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	001	6	87.5	9.6	0.37	0.01
		12	90.0	8.2	0.37	0.06
		25	92.5	5.0	0.43	0.05
		50	90.0	11.6	0.47	0.07
		100	92.5	9.6	0.49	0.10
	006	6	100.0	0.0	0.45	0.03
		12	100.0	0.0	0.40	0.02
		25	80.0	33.7	0.48	0.09
		50	80.0	21.6	0.48	0.04
		100	97.5	5.0	0.42	0.05
	008	6	90.0	14.1	0.47	0.05
		12	97.5	5.0	0.45	0.04
		25	90.0	0.0	0.52	0.07
		50	95.0	10.0	0.45	0.07
		100	92.5	9.6	0.52	0.08
	009	6	95.0	10.0	0.43	0.04
		12	95.0	5.8	0.52	0.07
		25	87.5	5.0	0.49	0.06
		50	92.5	5.0	0.47	0.04
		100	90.0	14.1	0.43	0.08
	011	6	100.0	0.0	0.47	0.02
		12	90.0	11.6	0.47	0.06
		25	90.0	8.2	0.46	0.04
		50	95.0	5.8	0.46	0.03
		100	95.0	10.0	0.37	0.02
August 1993	Control	100	97.5	5.0	0.36	0.05
	001	6	97.5	5.0	0.41	0.02
		12	100.0	0.0	0.40	0.02
		25	92.5	15.0	0.40	0.04
		50	92.5	9.6	0.43	0.06
		100	100.0	0.0	0.43	0.02
	006	6	95.0	5.8	0.40	0.04
		12	97.5	5.0	0.44	0.08
		25	97.5	5.0	0.44	0.03
		50	100.0	0.0	0.41	0.03
		100	92.5	9.6	0.43	0.07
	008	6	95.0	10.0	0.36	0.05
		12	92.5	9.6	0.45	0.08
		25	100.0	0.0	0.39	0.01

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	92.5	15.0	0.40	0.05
		100	100.0	0.0	0.37	0.03
	009	6	97.5	5.0	0.45	0.01
		12	95.0	5.8	0.41	0.02
		25	92.5	9.6	0.43	0.04
		50	90.0	8.2	0.48	0.03
		100	95.0	5.8	0.41	0.04
	011	6	95.0	5.8	0.38	0.06
		12	100.0	0.0	0.41	0.02
		25	100.0	0.0	0.40	0.05
		50	92.5	5.0	0.45	0.03
		100	95.0	5.8	0.39	0.05
October 1993	Control	100	100.0	0.0	0.49	0.03
	001	6	90.0	8.2	0.48	0.08
		12	100.0	0.0	0.46	0.02
		25	97.5	5.0	0.43	0.06
		50	92.5	9.6	0.42	0.06
		100	97.5	5.0	0.44	0.04
	006	6	92.5	9.6	0.49	0.06
		12	100.0	0.0	0.48	0.03
		25	100.0	0.0	0.47	0.04
		50	95.0	5.8	0.47	0.06
		100	95.0	10.0	0.44	0.08
	008	6	100.0	0.0	0.38	0.04
		12	100.0	0.0	0.42	0.01
		25	92.5	9.6	0.38	0.05
		50	97.5	5.0	0.39	0.04
		100	77.5	15.0	0.40	0.04
	009	6	100.0	0.0	0.45	0.03
		12	97.5	5.0	0.43	0.05
		25	97.5	5.0	0.41	0.05
		50	92.5	5.0	0.41	0.07
		100	100.0	0.0	0.39	0.10
	011	6	92.5	5.0	0.48	0.04
		12	90.0	14.1	0.47	0.02
		25	87.5	15.0	0.46	0.14
		50	85.0	12.9	0.44	0.05
		100	82.5	12.6	0.49	0.03
December 1993	Control	100	85.0	5.8	0.29	0.03

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	008	6	90.0	11.6	0.30	0.05
		12	80.0	33.7	0.34	0.08
		25	57.5	12.6	0.40	0.07
		50	97.5	5.0	0.34	0.05
		100	77.5	20.6	0.33	0.05
March 1994	Control	100	100.0	0.0	0.49	0.03
	001	6	92.5	9.6	0.47	0.07
		12	90.0	8.2	0.44	0.06
		25	92.5	5.0	0.53	0.04
		50	65.0	37.0	0.45	0.15
		100	77.5	15.0	0.62	0.07
	006	6	87.5	18.9	0.46	0.26
		12	97.5	5.0	0.48	0.03
		25	35.0	44.4	0.50	0.09
		50	57.5	39.5	0.53	0.09
		100	92.5	5.0	0.49	0.02
	008	6	92.5	9.6	0.41	0.05
		12	85.0	23.8	0.43	0.02
		25	92.5	9.6	0.49	0.03
		50	97.5	5.0	0.45	0.05
		100	92.5	15.0	0.46	0.02
	009	6	95.0	5.8	0.43	0.05
		12	97.5	5.0	0.42	0.02
		25	80.0	40.0	0.44	0.04
		50	97.5	5.0	0.45	0.04
		100	92.5	15.0	0.46	0.02
	011	6	57.5	46.5	0.41	0.03
		12	82.5	9.6	0.52	0.09
		25	62.5	28.7	0.54	0.05
		50	65.0	17.3	0.53	0.02
		100	62.5	35.0	0.59	0.16
March 1994	Control	100	97.5	5.0	0.37	0.05
	006	6	75.0	30.0	0.38	0.07
		12	40.0	35.6	0.44	0.16
		25	32.5	12.6	0.46	0.05
		50	35.0	12.9	0.45	0.05
		100	50.0	24.5	0.52	0.05
	011	6	57.5	28.7	0.37	0.11
		12	52.5	26.3	0.43	0.11

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%) Mean	Survival (%) SD	Growth (mg/larvae) Mean	Growth (mg/larvae) SD
		25	27.5	25.0	0.43	0.12
		50	40.0	24.5	0.29	0.08
		100	32.5	22.2	0.39	0.24
April 1994	Control	100	97.5	5.0	0.43	0.08
	006	6	97.5	5.0	0.34	0.03
		12	92.5	5.0	0.34	0.08
		25	97.5	5.0	0.34	0.04
		50	82.5	22.2	0.45	0.04
		100	90.0	8.2	0.44	0.11
	011	6	87.5	12.6	0.40	0.08
		12	92.5	5.0	0.42	0.13
		25	85.0	17.3	0.50	0.09
		50	100.0	0.0	0.44	0.04
		100	92.5	9.6	0.46	0.07
May 1994	Control	100	97.5	5.0	0.38	0.03
	001	6	92.5	9.6	0.48	0.05
		12	82.5	22.2	0.52	0.08
		25	97.5	5.0	0.53	0.04
		50	95.0	10.0	0.52	0.06
		100	95.0	10.0	0.51	0.05
	008	6	100.0	0.0	0.49	0.02
		12	97.5	5.0	0.53	0.01
		25	92.5	15.0	0.52	0.03
		50	90.0	11.6	0.51	0.09
		100	60.0	36.5	0.45	0.07
	009	6	95.0	5.8	0.51	0.05
		12	92.5	9.6	0.57	0.03
		25	75.0	12.9	0.57	0.05
		50	87.5	15.0	0.51	0.06
		100	77.5	9.6	0.43	0.02
June 1994	Control	100	92.5	15.0	0.38	0.02
	008	6	97.5	5.0	0.43	0.04
		12	92.5	5.0	0.43	0.08
		25	92.5	5.0	0.43	0.06
		50	95.0	10.0	0.40	0.02
		100	87.5	15.0	0.40	0.02
	009	6	92.5	9.6	0.46	0.08
		12	97.5	5.0	0.45	0.02
		25	97.5	5.0	0.40	0.05

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	100.0	0.0	0.43	0.11
		100	97.5	5.0	0.38	0.05
August 1994	Control	100	97.5	5.0	0.34	0.03
	001	6	97.5	5.0	0.47	0.03
		12	97.5	5.0	0.42	0.03
		25	100.0	0.0	0.44	0.05
		50	92.5	15.0	0.44	0.04
		100	97.5	5.0	0.45	0.06
	006	6	95.0	5.8	0.46	0.04
		12	100.0	0.0	0.45	0.03
		25	95.0	5.8	0.45	0.04
		50	100.0	0.0	0.45	0.06
		100	95.0	5.8	0.44	0.06
	008	6	100.0	0.0	0.45	0.02
		12	97.5	5.0	0.38	0.03
		25	90.0	11.6	0.33	0.16
		50	97.5	5.0	0.40	0.05
		100	62.5	29.9	0.36	0.03
	009	6	90.0	8.2	0.40	0.05
		12	100.0	0.0	0.42	0.04
		25	95.0	10.0	0.43	0.05
		50	80.0	27.1	0.38	0.13
		100	92.5	9.6	0.32	0.05
	010	6	100.0	0.0	0.39	0.04
		12	100.0	0.0	0.42	0.04
		25	92.5	5.0	0.47	0.05
		50	97.5	5.0	0.40	0.02
		100	95.0	10.0	0.43	0.05
September 1994	Control	100	100.0	0.0	0.50	0.03
	008	6	95.0	5.8	0.50	0.08
		12	97.5	5.0	0.49	0.01
		25	95.0	5.8	0.51	0.05
		50	97.5	5.0	0.47	0.04
		100	90.0	8.2	0.46	0.04
	009	6	100.0	0.0	0.50	0.05
		12	100.0	0.0	0.51	0.06
		25	97.5	5.0	0.50	0.05
		50	95.0	10.0	0.55	0.10
		100	85.0	17.3	0.57	0.07

Table B.1 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
October 1994	Control	100	100.0	0.0	0.53	0.04
	001	6	100.0	0.0	0.68	0.10
		12	97.5	5.0	0.69	0.01
		25	97.5	5.0	0.72	0.06
		50	95.0	5.8	0.74	0.09
		100	82.5	20.6	0.78	0.08
	006	6	100.0	0.0	0.57	0.08
		12	97.5	5.0	0.57	0.06
		25	97.5	5.0	0.68	0.05
		50	100.0	0.0	0.71	0.02
		100	97.5	5.0	0.69	0.06
	008	6	95.0	5.8	0.51	0.05
		12	100.0	0.0	0.59	0.02
		25	100.0	0.0	0.63	0.08
		50	92.5	5.0	0.61	0.07
		100	95.0	5.8	0.56	0.05
	009	6	90.0	20.0	0.66	0.09
		12	25.0	30.0	0.75	0.04
		25	57.5	39.5	0.75	0.07
		50	47.5	27.5	0.85	0.06
		100	15.0	17.3	1.03	0.38
	010	6	100.0	0.0	0.62	0.06
		12	100.0	0.0	0.68	0.09
		25	100.0	0.0	0.63	0.03
		50	90.0	14.1	0.71	0.04
		100	90.0	11.6	0.69	0.10
November 1994	Control	100	95.0	5.8	0.57	0.09
	009	6	100.0	0.0	0.62	0.08
		12	75.0	43.6	0.71	0.17
		25	80.0	21.6	0.63	0.08
		50	30.0	25.8	0.77	0.19
		100	67.5	18.9	0.67	0.12

Table B.2. Results of *Ceriodaphnia* toxicity tests of continuously flowing effluents at the Paducah Gaseous Diffusion Plant
Tests conducted October 1991–November 1994

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
October 1991	Control	100	100	19.90	9.89
	001	6	90	28.00	8.25
		12	100	21.60	11.06
		25	90	34.33	5.10
		50	90	25.33	13.16
		100	80	29.63	9.98
	004	6	100	34.90	5.95
		12	70	33.43	8.83
		25	70	29.43	11.75
		50	90	25.22	9.24
		100	80	30.38	10.14
	006	6	90	31.11	4.94
		12	80	22.75	11.66
		25	90	25.78	12.72
		50	70	29.57	14.80
		100	90	29.78	8.70
	008	6	60	14.83	5.91
		12	70	22.86	10.29
		25	100	29.00	8.23
		50	70	27.43	9.32
		100	100	36.90	6.15
	009	6	100	27.20	10.17
		12	80	22.63	7.17
		25	100	27.30	7.27
		50	90	25.11	8.67
		100	100	32.30	5.46
	011	6	100	28.20	10.81
		12	80	22.13	12.37
		25	100	39.70	3.86
		50	100	33.90	7.16
		100	90	38.89	8.55
February 1992	Control	100	90	19.44	2.96
	001	12	70	24.71	6.58
		25	90	29.00	6.63
		50	100	29.90	3.07
		100	100	30.00	5.93

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
	004	12	80	24.38	3.20
		25	80	24.13	3.52
		50	100	18.50	6.40
		100	100	15.00	7.60
	006	12	90	34.00	3.04
		25	100	32.60	6.40
		50	100	35.80	5.65
		100	80	3.50	2.98
	008	12	80	33.13	10.06
		25	70	35.00	5.48
		50	100	32.40	9.11
		100	100	29.00	5.27
	009	12	70	25.86	4.45
		25	90	29.11	9.75
		50	90	27.78	5.83
		100	90	27.89	4.31
	011	12	60	23.33	4.76
		25	90	28.22	6.63
		50	90	31.56	9.46
		100	100	29.10	9.65
May 1992	Control	100	90	31.11	4.70
	001	12	80	31.25	5.65
		25	90	23.56	7.73
		50	100	21.30	6.11
		100	90	19.11	7.25
	004	12	90	31.67	4.44
		25	100	24.90	2.08
		50	100	32.80	8.87
		100	100	31.60	9.18
	006	12	90	29.44	5.22
		25	90	29.44	5.64
		50	100	27.60	10.50
		100	100	30.60	4.86
	008	12	100	30.40	1.71
		25	90	26.67	6.76
		50	100	25.60	7.79
		100	100	29.20	7.94
	009	12	100	33.40	4.99

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
		25	100	33.50	3.03
		50	100	32.20	3.19
		100	100	31.30	3.53
	011	12	100	31.00	3.65
		25	90	33.11	5.69
		50	100	29.60	10.34
		100	100	31.00	6.53
August 1992	Control	100	100	26.00	6.70
	001	12	100	29.90	4.46
		25	100	34.90	4.58
		50	100	32.80	3.82
		100	100	32.40	2.46
	004	12	100	32.20	8.22
		25	100	29.90	6.21
		50	10	14.00	.
		100	0	.	.
	006	12	100	35.00	4.35
		25	100	35.30	4.72
		50	100	36.40	4.01
		100	100	34.30	3.53
	008	12	90	27.00	9.71
		25	90	26.44	5.83
		50	100	21.60	10.13
		100	100	26.30	7.70
	009	12	100	25.50	4.95
		25	90	24.44	5.25
		50	100	28.80	5.45
		100	100	30.80	5.88
	011	12	100	27.60	4.27
		25	100	23.60	8.75
		50	80	28.00	8.38
		100	90	25.56	3.61
October 1992	Control	100	90	26.56	8.26
	001	12	100	28.80	5.25
		25	80	23.00	10.04
		50	100	32.10	6.84
		100	100	25.70	9.90
	004	12	100	29.20	8.59

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	SD
		25	100	28.30	6.07
		50	100	27.40	8.18
		100	90	31.33	5.63
	006	12	100	19.30	7.83
		25	100	31.00	7.66
		50	100	29.30	10.91
		100	100	29.40	8.06
	008	12	100	29.80	5.14
		25	100	21.60	9.51
		50	100	23.50	8.61
		100	100	21.20	9.31
	009	12	100	28.50	8.58
		25	100	30.40	8.00
		50	100	24.90	7.32
		100	100	20.60	13.22
	011	12	100	27.20	6.73
		25	90	34.56	4.30
		50	100	27.60	7.40
		100	100	31.10	7.13
February 1993	Control	100	90	27.67	4.58
	001	6	90	31.11	5.53
		12	90	31.44	3.09
		25	100	36.20	4.34
		50	100	32.90	11.51
		100	100	34.40	4.60
	Control	100	70	26.29	4.54
	006	6	90	27.89	8.46
		12	90	30.22	4.79
		25	70	30.86	5.49
		50	70	26.43	8.58
		100	100	26.20	12.12
	Control	100	100	33.30	4.60
	008	6	100	27.70	9.98
		12	80	30.88	6.92
		25	100	28.30	10.03
		50	100	34.40	3.06
		100	90	31.33	3.67

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	SD
	Control	100	100	31.50	4.55
	009	6	100	28.00	3.06
		12	100	30.20	4.39
		25	100	30.50	6.98
		50	100	29.50	12.00
		100	100	32.40	3.03
	Control	100	100	29.80	3.05
	011	6	100	28.70	4.99
		12	90	25.56	5.68
		25	100	25.20	9.03
		50	80	30.00	5.95
		100	100	29.70	8.79
May 1993	Control	100	100	18.20	3.85
	001	6	90	17.00	9.17
		12	80	14.00	7.50
		25	90	15.56	7.40
		50	70	22.57	5.29
		100	90	20.33	8.85
	Control	100	90	12.78	6.36
	006	6	70	20.86	8.61
		12	90	18.11	11.86
		25	90	17.22	7.92
		50	100	17.10	9.85
		100	100	20.40	8.28
	Control	100	90	13.89	6.35
	008	6	90	11.67	6.96
		12	100	13.00	8.31
		25	100	11.89	9.88
		50	100	15.90	7.98
		100	100	12.20	6.60
	Control	100	90	15.56	6.11
	009	6	90	17.22	6.36
		12	100	19.70	10.01
		25	100	17.70	9.71
		50	80	17.00	9.68
		100	90	15.67	9.97
	Control	100	90	17.00	9.87
	011	6	60	13.83	9.62

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
		12	100	15.50	11.09
		25	100	14.20	9.96
		50	90	13.67	11.09
		100	90	16.22	5.26
June 1993	Control	100	100	17.90	5.93
	006	6	90	20.78	10.17
		12	100	24.90	7.84
		25	100	29.00	5.21
		50	100	27.20	6.09
		100	90	29.11	5.80
	Control	100	100	23.30	7.13
	008	6	90	30.00	10.44
		12	90	26.22	8.57
		25	90	26.00	8.29
		50	90	29.56	5.79
		100	100	28.10	10.45
	Control	100	90	25.00	10.04
	009	6	90	25.89	12.99
		12	100	30.30	5.66
		25	90	29.89	4.81
		50	100	29.80	4.89
		100	100	26.20	4.59
August 1993	Control	100	100	23.10	7.43
	001	6	100	20.80	6.91
		12	100	19.70	8.64
		25	80	21.25	8.81
		50	100	24.20	7.63
		100	70	24.57	7.52
	Control	100	100	24.40	9.50
	006	6	90	27.22	10.45
		12	90	30.22	4.44
		25	100	30.10	10.03
		50	90	28.89	10.73
		100	100	27.20	9.76
	Control	100	80	26.75	3.69
	008	6	100	23.30	8.06
		12	100	27.60	3.20
		25	100	22.90	3.00

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	SD
		50	100	25.10	2.42
		100	100	24.80	4.64
	Control	100	90	18.67	10.76
	009	6	100	19.60	8.38
		12	100	22.80	6.63
		25	80	19.50	9.53
		50	100	19.50	8.00
		100	100	20.60	8.66
	Control	100	80	23.13	7.04
	011	6	100	21.80	8.66
		12	90	21.11	10.12
		25	100	24.90	5.53
		50	100	22.10	10.98
		100	100	23.70	11.47
October 1993	Control	100	90	18.11	3.86
	001	6	100	13.80	3.68
		12	90	22.22	3.96
		25	90	17.89	5.33
		50	100	19.60	8.00
		100	80	14.50	7.86
	Control	100	100	19.80	1.93
	006	6	80	18.38	4.47
		12	100	23.10	7.13
		25	100	21.90	8.23
		50	90	29.33	7.66
		100	100	26.70	4.37
	Control	100	90	23.67	5.41
	008	6	100	20.00	4.42
		12	100	23.40	5.64
		25	90	26.22	3.80
		50	90	24.33	3.84
		100	100	19.90	7.37
	Control	100	90	15.78	4.24
	009	6	100	17.40	5.85
		12	100	19.20	5.05
		25	90	19.78	5.93
		50	100	22.20	9.45
		100	90	22.90	5.65

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	SD
	Control	100	90	23.44	4.69
	011	6	90	23.11	3.66
		12	100	24.90	3.07
		25	100	21.80	5.94
		50	100	22.20	4.64
		100	100	21.10	8.41
March 1994	Control	100	90	23.89	6.77
	001	6	90	29.78	4.02
		12	100	35.30	6.99
		25	100	40.50	7.96
		50	100	49.00	3.06
		100	100	47.00	5.50
	Control	100	100	18.20	3.26
	006	6	100	26.70	6.46
		12	100	33.10	7.89
		25	100	32.30	7.76
		50	100	40.10	10.30
		100	90	37.78	8.76
	Control	100	90	17.78	5.76
	008	6	100	26.10	4.93
		12	100	28.90	5.28
		25	90	31.44	9.77
		50	100	34.90	7.34
		100	100	36.40	5.25
	Control	100	100	20.20	5.57
	009	6	100	20.30	6.48
		12	100	19.60	4.79
		25	100	22.60	3.17
		50	90	20.11	4.51
		100	90	23.89	5.51
	Control	100	90	18.00	2.18
	011	6	90	20.11	4.68
		12	100	20.50	3.95
		25	90	20.33	3.97
		50	100	25.80	2.35
		100	100	28.60	3.41
April 1994	Control	100	100	18.40	3.24
	006	6	100	5.20	4.76

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
		12	90	7.33	4.66
		25	100	12.90	8.41
		50	100	23.40	8.73
		100	100	22.30	3.23
	011	6	100	19.60	6.85
		12	100	22.10	6.64
		25	100	23.40	6.06
		50	80	27.75	2.55
		100	100	27.90	7.55
May 1994	Control	100	80	12.88	3.04
	001	6	80	16.38	4.66
		12	80	15.00	8.05
		25	90	23.56	5.00
		50	90	26.56	4.03
		100	60	23.67	9.67
	Control	100	90	18.44	1.67
	008	6	100	19.60	3.10
		12	100	21.20	3.55
		25	70	23.86	4.53
		50	90	25.44	3.47
		100	100	24.20	3.05
	Control	100	100	19.10	3.28
	009	6	100	22.90	2.33
		12	90	24.78	3.23
		25	100	26.20	4.89
		50	90	31.44	7.58
		100	100	26.00	8.99
August 1994	Control	100	100	21.50	2.01
	001	6	80	24.50	2.07
		12	100	24.00	2.74
		25	90	21.56	1.88
		50	100	19.30	2.16
		100	100	18.20	2.74
	Control	100	100	23.50	1.84
	006	6	100	26.00	3.53
		12	100	25.80	2.20
		25	100	26.70	3.27
		50	100	21.80	2.15

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
		100	100	16.10	2.08
	Control	100	100	21.70	2.21
	008	6	90	26.67	1.80
		12	90	23.22	2.28
		25	100	21.80	6.05
		50	100	25.20	3.43
		100	90	19.11	3.92
	Control	100	100	23.50	1.96
	009	6	100	26.50	1.78
		12	100	28.30	1.34
		25	100	27.40	2.84
		50	100	29.00	2.31
		100	100	23.00	5.81
	Control	100	100	22.00	2.00
	010	6	100	23.40	1.58
		12	100	24.70	2.98
		25	90	24.67	3.97
		50	100	28.10	2.60
		100	100	25.90	2.88
September 1994	Control	100	100	28.90	4.38
	006	6	100	30.30	3.09
		12	90	32.22	11.03
		25	100	32.80	5.90
		50	100	35.60	8.19
		100	100	34.70	7.15
October 1994	Control	100	100	7.30	5.89
	001	6	60	14.00	8.46
		12	100	18.80	7.28
		25	90	14.11	9.23
		50	90	21.11	10.01
		100	90	18.11	5.60
	Control	100	100	22.60	6.13
	006	6	100	19.50	11.02
		12	100	19.90	6.72
		25	100	24.70	7.02
		50	90	24.22	6.55
		100	100	28.20	4.73

Table B.2 (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female Mean	Offspring/surviving female SD
	Control	100	100	21.00	6.46
	008	6	100	24.40	7.07
		12	100	18.80	8.28
		25	90	22.89	4.78
		50	90	28.56	4.39
		100	90	30.00	4.47
	Control	100	100	27.70	6.43
	009	6	100	29.30	5.29
		12	100	33.50	4.40
		25	100	33.20	5.96
		50	100	34.70	6.70
		100	100	32.20	4.98
	Control	100	90	24.56	7.70
	010	6	100	28.90	7.00
		12	100	32.40	6.60
		25	100	35.30	3.33
		50	100	37.90	6.95
		100	100	33.60	8.53
November 1994	Control	100	100	23.70	3.47
	001	6	100	24.60	4.45
		12	100	21.20	7.90
		25	100	20.90	6.21
		50	100	18.10	6.94
		100	100	19.30	6.27

Table B.3. Summary of water chemistry analyses conducted during toxicity tests of continuously flowing effluents at the Paducah Gaseous Diffusion Plant
Analyses conducted October 1991–November 1994

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
pH (S.U.)	October 1991	001	9.18	0.30	8.74	9.54
		004	7.53	0.09	7.42	7.68
		006	9.40	0.07	9.28	9.48
		008	7.51	0.06	7.43	7.61
		009	7.50	0.22	7.34	7.97
		011	7.79	0.10	7.69	7.95
	February 1992	001	7.90	0.18	7.71	8.23
		004	7.67	0.12	7.56	7.91
		006	9.48	0.20	9.19	9.72
		008	7.64	0.12	7.50	7.86
		009	7.96	0.22	7.54	8.25
		011	7.98	0.10	7.79	8.09
	May 1992	001	7.96	0.42	7.40	8.52
		004	7.41	0.09	7.29	7.55
		006	9.11	0.13	8.92	9.31
		008	7.23	0.08	7.11	7.32
		009	7.37	0.17	7.21	7.71
		011	7.69	0.07	7.62	7.79
	August 1992	001	8.24	0.67	7.42	8.82
		004	7.48	0.18	7.26	7.76
		006	8.96	0.18	8.63	9.20
		008	7.44	0.12	7.30	7.62
		009	7.71	0.16	7.49	7.92
		011	7.62	0.09	7.51	7.73
	October 1992	001	8.08	0.18	7.82	8.38
		004	7.50	0.11	7.37	7.68
		006	8.56	0.23	8.29	8.92
		008	7.37	0.14	7.17	7.57
		009	7.81	0.12	7.61	7.96
		011	8.00	0.33	7.72	8.67
	February 1993	001	7.59	0.07	7.46	7.68
		006	8.91	0.08	8.82	9.06
		008	7.40	0.10	7.27	7.54
		009	7.94	0.31	7.65	8.37

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		011	7.67	0.13	7.40	7.82
	May 1993	001	8.57	0.46	7.63	8.96
		006	8.51	0.32	7.87	8.76
		008	7.57	0.13	7.42	7.74
		009	7.73	0.17	7.47	7.94
		011	8.19	0.50	7.70	9.15
	June 1993	006	8.38	0.94	6.80	9.30
		008	7.41	0.46	6.90	8.20
		009	7.51	0.40	7.10	8.18
	August 1993	001	7.80	0.24	7.56	8.13
		006	9.27	0.08	9.14	9.36
		008	7.31	0.13	7.06	7.45
		009	7.61	0.07	7.54	7.76
		011	7.74	0.12	7.63	7.95
	October 1993	001	8.56	0.18	8.25	8.72
		006	8.54	0.21	8.21	8.78
		008	7.46	0.07	7.40	7.62
		009	7.68	0.12	7.54	7.88
		011	7.65	0.04	7.60	7.71
	December 1993	008	7.44	0.15	7.31	7.65
	March 1994	001	8.14	0.21	7.92	8.54
		006	8.74	0.08	8.66	8.88
		008	7.61	0.09	7.48	7.74
		009	8.09	0.36	7.67	8.65
		011	7.88	0.14	7.75	8.16
	March 1994	006	7.89	0.20	7.64	8.11
		011	7.65	0.24	7.39	8.02
	April 1994	006	8.55	0.25	8.17	8.84
		011	7.67	0.15	7.42	7.86
	May 1994	001	9.14	0.17	8.90	9.35
		008	7.35	0.11	7.19	7.50
		009	7.52	0.08	7.39	7.62
	June 1994	008	7.05	0.14	6.86	7.24
		009	7.51	0.10	7.38	7.64
	August 1994	001	9.19	0.08	9.09	9.32
		006	9.12	0.08	8.95	9.22
		008	7.15	0.09	7.01	7.29
		009	7.61	0.06	7.51	7.69
		010	7.52	0.18	7.27	7.84
	September 1994	006	7.85	0.22	7.67	8.19

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		008	7.13	0.25	6.95	7.66
		009	7.48	0.22	7.27	7.90
	October 1994	001	8.74	0.36	7.89	9.00
		006	8.70	0.23	8.34	8.99
		008	7.51	0.16	7.24	7.75
		009	8.22	0.35	7.77	8.83
		010	7.71	0.26	7.51	8.33
	November 1994	001	7.44	0.20	7.12	7.66
		009	7.51	0.15	7.30	7.72
Conductivity (μS/cm)	October 1991	001	1562.71	158.13	1303	1728
		004	355.57	30.34	320	392
		006	273.29	7.02	262	281
		008	313.14	19.14	288	350
		009	193.86	45.84	116	265
		011	258.00	11.86	239	273
	February 1992	001	900.71	104.96	782	1086
		004	286.71	18.20	259	302
		006	195.00	5.72	185	204
		008	247.14	25.75	208	279
		009	225.00	51.78	132	282
		011	228.57	24.79	191	260
	May 1992	001	1168.71	376.44	657	1561
		004	287.43	11.84	273	301
		006	236.43	4.12	228	240
		008	260.43	14.90	244	286
		009	223.00	8.54	210	233
		011	239.71	11.77	225	258
	August 1992	001	1262.29	450.64	586	1668
		004	234.57	17.36	213	257
		006	219.29	19.59	199	250
		008	210.14	19.45	177	233
		009	209.86	19.15	175	232
		011	201.14	18.25	168	222
	October 1992	001	1782.00	95.01	1632	1867
		004	297.29	37.56	266	358
		006	208.14	6.69	198	217
		008	251.43	21.61	235	292
		009	259.43	25.15	219	296
		011	218.57	20.12	190	252
	February 1993	001	970.29	182.19	760	1214

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		006	169.57	5.56	163	178
		008	263.57	88.42	212	461
		009	350.71	299.41	180	1020
		011	227.00	43.99	188	315
	May 1993	001	1470.29	105.25	1246	1545
		006	269.00	3.96	264	274
		008	278.43	19.11	248	298
		009	339.86	124.79	206	578
		011	251.29	18.09	233	285
	June 1993	006	246.50	41.71	167	281
		008	268.50	24.90	239	300
		009	215.00	43.10	151	255
	August 1993	001	854.71	326.92	489	1300
		006	264.43	7.70	250	273
		008	256.29	21.65	234	288
		009	256.86	17.19	238	287
		011	233.29	20.57	200	255
	October 1993	001	1422.57	153.29	1230	1622
		006	321.29	8.01	307	329
		008	306.43	20.98	277	331
		009	221.29	44.94	164	270
		011	301.71	22.54	270	330
	December 1993	008	318.00	40.82	243	361
		001	1026.00	92.43	907	1148
		006	191.43	6.27	178	196
		008	310.43	42.88	262	376
		009	540.71	130.37	447	817
		011	329.29	73.25	263	475
	March 1994	006	191.71	5.09	181	195
		011	340.43	99.26	248	491
	April 1994	006	183.29	2.50	180	187
		011	224.00	32.17	173	269
	May 1994	001	1323.86	51.68	1244	1384
		008	250.29	13.56	233	268
		009	285.14	32.17	257	354
	June 1994	008	218.14	11.88	206	236
		009	210.86	9.49	194	224
	August 1994	001	1251.43	19.90	1215	1271
		006	194.14	3.72	188	199
		008	207.86	15.09	187	229

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		009	187.00	7.96	176	197
		010	224.86	9.17	213	235
	September 1994	006	205.86	5.84	200	216
		008	256.00	7.14	242	265
		009	230.57	9.52	220	244
	October 1994	001	1338.75	83.82	1170	1452
		006	209.14	2.54	206	213
		008	244.25	11.12	229	259
		009	212.63	10.43	204	234
		010	266.63	15.45	243	288
	November 1994	001	1237.67	95.58	1098	1398
		009	211.57	31.32	166	240
Alkalinity ($mg/L\ CaCO_3$)	October 1991	001	32.29	4.07	28	39
		004	42.86	4.74	38	50
		006	39.14	0.69	38	40
		008	36.14	3.80	31	42
		009	43.43	9.03	32	61
		011	42.14	6.44	34	49
	February 1992	001	39.43	4.83	32	46
		004	52.86	4.56	47	59
		006	41.43	7.72	36	58
		008	46.29	9.07	37	63
		009	69.00	21.91	39	110
		011	52.71	5.38	48	62
	May 1992	001	26.43	2.15	25	31
		004	35.00	3.27	31	39
		006	35.43	1.13	33	36
		008	30.29	3.55	26	36
		009	40.43	2.23	37	43
		011	31.43	2.30	30	36
	August 1992	001	29.71	1.98	27	33
		004	31.00	1.63	28	33
		006	35.14	2.12	33	38
		008	26.00	2.08	23	29
		009	42.43	2.30	38	45
		011	27.71	3.73	23	34
	October 1992	001	24.00	1.00	23	26
		004	36.86	2.97	33	41
		006	35.86	2.61	31	39
		008	27.43	2.07	24	29

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		009	56.57	12.07	39	68
		011	30.29	1.50	28	32
	February 1993	001	40.43	5.68	30	47
		006	44.14	1.57	41	46
		008	37.43	5.88	31	45
		009	54.57	14.20	37	73
		011	45.00	8.56	35	60
	May 1993	001	38.00	11.59	30	64
		006	69.29	5.19	59	76
		008	35.00	4.04	30	41
		009	99.57	69.40	45	233
		011	42.29	2.87	40	48
	June 1993	006	53.33	12.06	30	62
		008	42.33	11.33	30	62
		009	47.83	6.85	41	56
	August 1993	001	26.14	2.12	23	29
		006	46.57	1.27	45	49
		008	25.57	2.30	23	29
		009	47.00	11.45	37	70
		011	26.57	1.81	25	30
	October 1993	001	51.86	14.67	45	85
		006	86.00	1.41	84	88
		008	40.57	5.56	33	48
		009	45.29	3.35	40	49
		011	36.43	3.69	31	43
	December 1993	008	54.50	4.68	50	61
	March 1994	001	48.71	6.26	40	57
		006	61.86	2.34	57	64
		008	59.14	5.21	50	65
		009	79.57	21.85	41	102
		011	66.57	7.46	56	77
	March 1994	006	63.00	3.42	57	67
		011	55.00	12.68	43	72
	April 1994	006	58.86	1.86	57	62
		011	47.83	9.41	37	58
	May 1994	001	29.29	1.11	28	31
		008	28.57	3.60	25	33
		009	61.57	18.43	42	97
	June 1994	008	24.57	2.15	22	28
		009	41.14	1.95	38	43

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
	August 1994	001	29.71	1.98	27	33
		006	48.00	1.00	47	50
		008	21.43	2.64	18	25
		009	31.57	0.53	31	32
		010	22.14	1.07	21	23
	September 1994	006	47.43	1.13	46	49
		008	24.29	3.04	20	28
		009	35.14	3.76	31	41
	October 1994	001	32.25	1.83	31	36
		006	40.14	2.54	36	44
		008	29.38	2.13	26	33
		009	34.50	3.46	30	42
		010	27.13	1.73	25	30
	November 1994	001	34.50	5.82	26	43
		009	41.86	7.60	32	53
Hardness (mg/L $CaCO_3$)	October 1991	001	444.71	42.21	364	487
		004	86.29	13.92	70	106
		006	75.43	7.55	68	88
		008	77.14	10.70	64	96
		009	63.71	14.07	44	90
		011	76.86	9.08	62	86
	February 1992	001	297.14	40.30	240	370
		004	81.14	7.01	74	96
		006	62.86	16.04	50	96
		008	74.57	13.60	60	102
		009	87.43	11.47	74	102
		011	82.00	11.14	74	104
	May 1992	001	416.57	166.14	188	660
		004	112.57	82.35	72	298
		006	72.86	2.54	70	76
		008	66.86	6.82	58	80
		009	73.43	5.00	68	82
		011	73.71	7.52	68	88
	August 1992	001	379.43	149.02	168	506
		004	64.00	5.89	56	70
		006	64.57	6.60	58	76
		008	57.71	7.87	50	68
		009	68.29	7.06	56	76
		011	58.86	7.73	52	70
	October 1992	001	552.00	70.20	424	632

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		004	80.29	10.92	64	94
		006	77.71	9.76	60	88
		008	74.00	11.66	56	88
		009	88.00	19.08	66	120
		011	74.57	15.22	58	96
	February 1993	001	328.29	62.13	260	418
		006	73.14	4.14	68	80
		008	73.14	8.55	66	88
		009	82.57	18.82	56	106
		011	82.00	12.44	68	102
	May 1993	001	469.14	68.67	356	578
		006	125.14	35.61	100	204
		008	81.71	8.83	68	96
		009	124.86	44.82	84	210
		011	86.00	13.01	66	98
	June 1993	006	93.67	7.42	86	106
		008	91.33	18.18	64	112
		009	77.50	15.92	57	98
	August 1993	001	241.71	94.91	134	376
		006	86.00	6.73	78	98
		008	69.14	5.15	60	76
		009	78.86	5.76	70	86
		011	70.00	4.76	62	76
	October 1993	001	494.00	90.06	406	680
		006	134.29	11.34	116	148
		008	93.14	12.69	72	110
		009	93.43	14.55	74	116
		011	99.71	9.48	82	110
	December 1993	008	87.67	10.07	76	104
	March 1994	001	328.86	25.22	286	358
		006	97.14	9.15	84	110
		008	96.00	12.70	78	110
		009	127.71	23.25	98	166
		011	123.43	27.95	86	158
	March 1994	006	76.00	5.66	70	84
		011	100.57	27.61	74	142
	April 1994	006	79.14	7.90	70	90
		011	80.33	18.82	64	114
	May 1994	001	435.43	59.44	380	556
		008	72.57	9.78	60	90

Table B.3 (continued)

Water quality parameter	Date	Outfall	Mean	SD	Min	Max
		009	93.43	18.57	74	130
	June 1994	008	63.43	9.00	54	80
		009	71.71	4.68	64	78
	August 1994	001	428.57	34.69	400	480
		006	85.43	19.96	68	124
		008	60.29	17.49	44	84
		009	72.86	24.13	54	120
		010	74.29	17.90	54	108
	September 1994	006	83.43	8.38	76	96
		008	75.71	16.43	44	98
		009	84.57	7.18	72	92
	October 1994	001	426.75	23.00	394	464
		006	76.86	13.61	60	92
		008	72.00	13.56	56	96
		009	70.25	8.91	60	84
		010	89.75	22.15	70	140
	November 1994	001	384.33	37.00	344	438
		009	79.86	13.52	56	94

Table B.4. Results of Fathead minnow toxicity tests of intermittently flowing effluents at the Paducah Gaseous Diffusion Plant
Tests conducted December 1991–November 1994

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
December 1991	Control	100	97.5	5.0	0.60	0.04
	013	12	95.0	5.8	0.65	0.06
		25	92.5	15.0	0.57	0.08
		50	95.0	10.0	0.60	0.09
		100	97.5	5.0	0.61	0.04
	015	12	95.0	5.8	0.66	0.03
		25	97.5	5.0	0.66	0.11
		50	95.0	5.8	0.60	0.05
		100	95.0	5.8	0.67	0.03
	016	12	97.5	5.0	0.57	0.02
		25	92.5	5.0	0.63	0.08
		50	100.0	0.0	0.63	0.05
		100	95.0	5.8	0.68	0.05
	017	12	87.5	12.6	0.64	0.03
		25	97.5	5.0	0.64	0.04
		50	97.5	5.0	0.65	0.07
		100	80.0	18.3	0.67	0.14
	018	12	97.5	5.0	0.55	0.06
		25	100.0	0.0	0.57	0.05
		50	97.5	5.0	0.58	0.02
		100	100.0	0.0	0.68	0.08
March 1992	Control	100	100.0	0.0	0.30	0.04
	013	12	100.0	0.0	0.25	0.02
		25	82.5	9.6	0.24	0.02
		50	65.0	44.4	0.26	0.03
		100	37.5	33.0	0.35	0.12
	015	12	95.0	5.8	0.25	0.04
		25	20.0	33.7	0.51	0.13
		50	67.5	45.7	0.29	0.03
		100	25.0	30.0	0.45	0.07
	016	12	97.5	5.0	0.30	0.03
		25	87.5	15.0	0.32	0.03
		50	95.0	5.8	0.26	0.03
		100	67.5	32.0	0.26	0.03
	017	12	87.5	9.6	0.33	0.06
		25	87.5	9.6	0.25	0.04
		50	57.5	40.3	0.23	0.08
		100	20.0	18.3	0.53	0.05

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	018	12	92.5	15.0	0.35	0.03
		25	45.0	35.1	0.50	0.06
		50	7.5	9.6	0.61	0.34
		100	5.0	5.8	0.22	0.32
June 1992	Control	100	97.5	5.0	0.47	0.03
	013	12	95.0	10.0	0.43	0.02
		25	97.5	5.0	0.47	0.02
		50	82.5	23.6	0.46	0.04
		100	82.5	17.1	0.44	0.03
	015	12	100.0	0.0	0.42	0.01
		25	100.0	0.0	0.47	0.05
		50	100.0	0.0	0.42	0.03
		100	97.5	5.0	0.47	0.05
	017	12	97.5	5.0	0.45	0.03
		25	87.5	15.0	0.48	0.05
		50	95.0	10.0	0.50	0.05
		100	72.5	15.0	0.53	0.03
	018	12	97.5	5.0	0.52	0.02
		25	95.0	10.0	0.51	0.03
		50	92.5	9.6	0.47	0.03
		100	97.5	5.0	0.49	0.08
September 1992	Control	100	95.0	5.8	0.49	0.04
	013	12	95.0	5.8	0.34	0.06
		25	97.5	5.0	0.40	0.02
		50	92.5	5.0	0.44	0.04
		100	87.5	5.0	0.49	0.05
	015	12	95.0	5.8	0.51	0.07
		25	90.0	20.0	0.48	0.08
		50	90.0	8.2	0.44	0.02
		100	87.5	15.0	0.48	0.09
	016	12	90.0	8.2	0.42	0.02
		25	97.5	5.0	0.44	0.05
		50	72.5	5.0	0.45	0.03
		100	92.5	9.6	0.54	0.09
	017	12	72.5	35.9	0.58	0.09
		25	62.5	32.0	0.60	0.09
		50	57.5	15.0	0.61	0.04
		100	55.0	12.9	0.53	0.13
	018	12	90.0	8.2	0.58	0.07
		25	92.5	5.0	0.54	0.02

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	90.0	14.1	0.46	0.05
		100	92.5	5.0	0.54	0.05
November 1992	Control	100	95.0	5.8	0.40	0.04
	013	12	82.5	15.0	0.53	0.08
		25	90.0	0.0	0.44	0.05
		50	77.5	33.0	0.45	0.12
		100	42.5	26.3	0.42	0.25
	015	12	95.0	5.8	0.40	0.06
		25	90.0	8.2	0.43	0.06
		50	100.0	0.0	0.43	0.11
		100	92.5	5.0	0.36	0.04
	016	12	97.5	5.0	0.43	0.01
		25	82.5	17.1	0.42	0.10
		50	95.0	10.0	0.43	0.06
		100	75.0	20.8	0.37	0.04
	017	12	97.5	5.0	0.39	0.12
		25	87.5	12.6	0.54	0.05
		50	92.5	9.6	0.49	0.09
		100	85.0	12.9	0.49	0.03
	018	12	97.5	5.0	0.45	0.06
		25	100.0	0.0	0.39	0.05
		50	100.0	0.0	0.36	0.07
		100	72.5	22.2	0.34	0.08
January 1993	Control	100	97.5	5.0	0.57	0.09
	013	6	90.0	8.2	0.57	0.08
		12	92.5	5.0	0.67	0.03
		25	90.0	0.0	0.63	0.04
		50	85.0	17.3	0.57	0.09
		100	95.0	5.8	0.62	0.08
	015	6	95.0	5.8	0.50	0.06
		12	72.5	35.9	0.56	0.17
		25	100.0	0.0	0.58	0.08
		50	77.5	12.6	0.60	0.08
		100	75.0	10.0	0.55	0.19
	016	6	85.0	17.3	0.60	0.06
		12	95.0	5.8	0.61	0.08
		25	82.5	12.6	0.62	0.09
		50	80.0	14.1	0.52	0.10
		100	75.0	12.9	0.61	0.11

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	017	6	90.0	8.2	0.45	0.07
		12	95.0	10.0	0.46	0.05
		25	95.0	10.0	0.50	0.05
		50	95.0	10.0	0.57	0.04
		100	87.5	9.6	0.55	0.08
	018	6	100.0	0.0	0.52	0.06
		12	87.5	5.0	0.47	0.07
		25	90.0	8.2	0.48	0.05
		50	77.5	12.6	0.56	0.06
		100	92.5	5.0	0.48	0.02
May 1993	Control	100	100.0	0.0	0.37	0.08
	013	6	85.0	17.3	0.42	0.04
		12	77.5	26.3	0.45	0.08
		25	82.5	20.6	0.40	0.03
		50	87.5	9.6	0.45	0.05
		100	60.0	24.5	0.43	0.11
	015	6	72.5	28.7	0.40	0.04
		12	87.5	9.6	0.39	0.14
		25	85.0	5.8	0.34	0.09
		50	65.0	12.9	0.41	0.02
		100	65.0	23.8	0.35	0.05
	016	6	100.0	0.0	0.33	0.03
		12	82.5	9.6	0.55	0.14
		25	92.5	5.0	0.22	0.08
		50	90.0	8.2	0.46	0.03
		100	80.0	16.3	0.45	0.03
	017	6	60.0	27.1	0.37	0.05
		12	60.0	14.1	0.37	0.10
		25	60.0	8.2	0.49	0.05
		50	55.0	12.9	0.45	0.08
		100	82.5	12.6	0.41	0.05
	018	6	72.5	22.2	0.37	0.08
		12	55.0	17.3	0.39	0.12
		25	70.0	35.6	0.35	0.06
		50	67.5	20.6	0.34	0.10
		100	70.0	14.1	0.35	0.07
September 1993	Control	100	95.0	10.0	0.33	0.03
	013	6	92.5	15.0	0.40	0.11
		12	100.0	0.0	0.34	0.02
		25	82.5	22.2	0.42	0.05

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	70.0	16.3	0.44	0.04
		100	70.0	28.3	0.36	0.08
	015	6	90.0	14.1	0.37	0.07
		12	92.5	9.6	0.38	0.07
		25	92.5	9.6	0.36	0.05
		50	90.0	11.6	0.36	0.06
		100	87.5	15.0	0.38	0.03
	016	6	95.0	5.8	0.46	0.07
		12	95.0	10.0	0.48	0.06
		25	100.0	0.0	0.46	0.10
		50	97.5	5.0	0.51	0.10
		100	90.0	14.1	0.53	0.04
	017	6	100.0	0.0	0.55	0.04
		12	100.0	0.0	0.60	0.04
		25	92.5	15.0	0.59	0.05
		50	97.5	5.0	0.60	0.06
		100	90.0	14.1	0.61	0.06
	018	6	97.5	5.0	0.60	0.05
		12	95.0	5.8	0.59	0.08
		25	100.0	0.0	0.62	0.02
		50	95.0	10.0	0.55	0.03
		100	100.0	0.0	0.59	0.03
November 1993	Control	100	87.5	15.0	0.39	0.05
	013	6	70.0	40.8	0.50	0.10
		12	75.0	12.9	0.46	0.06
		25	80.0	14.1	0.55	0.11
		50	65.0	12.9	0.46	0.05
		100	85.0	12.9	0.49	0.02
	015	6	95.0	5.8	0.51	0.03
		12	90.0	14.1	0.49	0.04
		25	92.5	5.0	0.51	0.06
		50	87.5	5.0	0.55	0.08
		100	95.0	5.8	0.54	0.05
	016	6	92.5	9.6	0.62	0.08
		12	75.0	20.8	0.56	0.05
		25	65.0	12.9	0.48	0.08
		50	77.5	20.6	0.48	0.04
		100	87.5	5.0	0.49	0.12
	017	6	60.0	45.5	0.59	0.04
		12	90.0	0.0	0.55	0.03

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		25	35.0	45.1	0.54	0.11
		50	95.0	10.0	0.64	0.08
		100	85.0	12.9	0.61	0.08
	018	6	95.0	5.8	0.57	0.06
		12	87.5	9.6	0.58	0.07
		25	97.5	5.0	0.59	0.03
		50	87.5	12.6	0.51	0.02
		100	72.5	23.6	0.58	0.06
February 1994	Control	100	100.0	0.0	0.47	0.04
	013	6	100.0	0.0	0.44	0.06
		12	55.0	33.2	0.42	0.02
		25	67.5	45.0	0.46	0.13
		50	62.5	42.7	0.46	0.06
		100	57.5	37.8	0.48	0.12
	015	6	97.5	5.0	0.45	0.06
		12	100.0	0.0	0.45	0.04
		25	90.0	8.2	0.48	0.05
		50	72.5	15.0	0.50	0.06
		100	72.5	32.0	0.57	0.12
	016	6	97.5	5.0	0.39	0.05
		12	95.0	5.8	0.41	0.03
		25	92.5	5.0	0.41	0.04
		50	97.5	5.0	0.42	0.04
		100	95.0	5.8	0.48	0.06
	017	6	97.5	5.0	0.43	0.04
		12	95.0	5.8	0.41	0.03
		25	92.5	9.6	0.40	0.05
		50	75.0	50.0	0.42	0.12
		100	80.0	20.0	0.49	0.06
	018	6	97.5	5.0	0.44	0.05
		12	95.0	5.8	0.43	0.05
		25	92.5	15.0	0.48	0.07
		50	100.0	0.0	0.45	0.02
		100	95.0	5.8	0.45	0.04
April 1994	Control	100	92.5	5.0	0.36	0.01
	013	6	97.5	5.0	0.36	0.01
		12	92.5	9.6	0.36	0.03
		25	90.0	14.1	0.38	0.02
		50	97.5	5.0	0.37	0.03
		100	87.5	12.6	0.38	0.07

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
	015	6	87.5	15.0	0.44	0.14
		12	35.0	12.9	0.35	0.19
		25	65.0	31.1	0.36	0.07
		50	65.0	33.2	0.46	0.05
		100	42.5	35.9	0.40	0.09
	016	6	85.0	19.2	0.32	0.07
		12	95.0	5.8	0.34	0.02
		25	80.0	18.3	0.39	0.06
		50	82.5	23.6	0.44	0.04
		100	97.5	5.0	0.34	0.06
	017	6	97.5	5.0	0.40	0.05
		12	92.5	9.6	0.41	0.08
		25	90.0	14.1	0.37	0.07
		50	85.0	23.8	0.38	0.08
		100	32.5	22.2	0.51	0.16
	018	6	87.5	5.0	0.36	0.08
		12	85.0	12.9	0.39	0.04
		25	95.0	10.0	0.40	0.02
		50	92.5	5.0	0.42	0.03
		100	42.5	32.0	0.41	0.24
September 1994	Control	100	92.6	9.5	6.76	12.83
	013	12	100.0	0.0	0.34	0.03
		25	92.5	9.6	0.41	0.01
		50	90.0	14.1	0.40	0.02
	015	12	100.0	0.0	0.36	0.07
		25	95.0	5.8	0.40	0.02
		50	97.5	5.0	0.45	0.02
		100	92.5	5.0	0.39	0.01
	016	12	100.0	0.0	0.48	0.03
		25	97.5	5.0	0.47	0.06
		50	97.5	5.0	0.49	0.08
		100	87.5	9.6	0.52	0.06
	017	6	87.5	9.6	0.38	0.07
		12	97.5	5.0	0.44	0.04
		25	87.5	15.0	0.42	0.04
		50	90.0	8.2	0.39	0.07
		100	95.0	5.8	0.37	0.06
	018	6	92.5	9.6	0.39	0.03
		12	95.0	5.8	0.40	0.02
		25	95.0	10.0	0.44	0.03

Table B.4 (continued)

Date	Outfall	Conc.	Survival (%)		Growth (mg/larvae)	
			Mean	SD	Mean	SD
		50	90.0	8.2	0.44	0.03
		100	85.0	5.8	0.40	0.08
November 1994	Control	100	97.5	5.0	0.47	0.07
	013	6	67.5	22.2	0.51	0.05
		12	57.5	42.7	0.57	0.13
		25	70.0	38.3	0.70	0.14
		50	55.0	34.2	0.58	0.10
		100	80.0	8.2	0.58	0.08
	015	6	72.5	27.5	0.49	0.06
		12	50.0	35.6	0.56	0.07
		25	67.5	9.6	0.53	0.05
		50	72.5	31.0	0.63	0.07
		100	40.0	21.6	0.65	0.09
	016	6	60.0	18.3	0.57	0.07
		12	47.5	37.8	0.66	0.31
		25	47.5	9.6	0.56	0.13
		50	52.5	22.2	0.57	0.10
		100	45.0	23.8	0.60	0.09
	017	6	5.0	5.8	0.70	0.04
		12	2.5	5.0	0.49	.
		25	10.0	8.2	0.38	0.17
		50	7.5	9.6	0.32	0.02
		100	5.0	5.8	0.33	0.09
	018	6	85.0	10.0	0.53	0.06
		12	82.5	5.0	0.59	0.07
		25	95.0	10.0	0.52	0.02
		50	82.5	23.6	0.59	0.07
		100	80.0	14.1	0.64	0.05

Table B.5. Results of *Ceriodaphnia* toxicity tests of intermittently flowing effluents at the Paducah Gaseous Diffusion Plant
Tests conducted December 1991–November 1994

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
December 1991	Control	100	90	28.33	9.67
	013	12	90	36.00	3.61
		25	100	36.10	4.09
		50	100	34.80	3.39
		100	100	36.00	4.76
	015	12	90	34.22	5.85
		25	60	37.33	3.08
		50	90	33.67	5.24
		100	100	34.70	5.33
	016	12	70	36.14	4.10
		25	80	36.00	5.81
		50	100	33.30	6.45
		100	100	33.50	3.41
	017	12	90	28.56	4.64
		25	90	32.22	3.49
		50	70	33.00	5.16
		100	100	33.20	4.89
	018	12	90	34.44	5.73
		25	90	33.11	4.14
		50	100	31.40	2.63
		100	90	32.67	3.32
March 1992	Control	100	100	23.40	2.07
	013	12	100	27.89	6.39
		25	90	20.13	9.46
		50	90	26.44	5.22
		100	80	26.25	5.34
	015	12	70	25.57	8.34
		25	70	24.71	5.31
		50	100	22.60	5.58
		100	100	25.20	3.36
	016	12	90	23.78	1.48
		25	100	25.60	2.76
		50	100	24.80	5.25
		100	100	25.30	3.77
	017	12	100	22.30	5.68
		25	90	24.11	4.26
		50	100	21.80	8.77

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
		100	80	27.63	3.34
	018	12	100	23.30	9.89
		25	90	22.44	3.43
		50	100	24.40	3.72
		100	100	20.10	2.69
June 1992	Control	100	80	31.88	3.72
	013	12	80	36.88	2.30
		25	100	31.70	7.42
		50	100	32.60	6.82
		100	100	34.10	7.95
	015	12	90	32.44	6.54
		25	90	31.22	3.19
		50	100	31.10	11.33
		100	90	28.33	6.71
	017	12	100	28.60	7.53
		25	100	27.50	8.66
		50	100	27.40	8.49
		100	100	28.50	6.64
	018	12	100	33.30	5.95
		25	100	32.60	3.78
		50	100	32.60	6.24
		100	90	37.44	8.00
November 1992	Control	100	100	31.60	5.72
	013	12	90	30.89	5.58
		25	100	30.70	7.20
		50	100	35.40	5.21
		100	100	34.70	6.57
	Control	100	100	26.90	4.15
	015	12	100	30.80	4.57
		25	100	31.10	4.38
		50	100	32.50	4.01
		100	100	32.70	5.58
	Control	100	100	31.50	3.69
	016	12	100	32.80	6.36
		25	100	34.89	3.55
		50	100	35.70	4.08
	016	100	90	31.56	5.85
	Control	100	100	33.60	6.45
	017	12	100	31.10	6.37

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
		25	100	33.30	6.98
		50	80	32.13	5.14
		100	100	33.80	2.62
	Control	100	80	34.38	2.50
	018	12	90	33.89	5.60
		25	90	31.89	6.35
		50	90	31.33	5.81
		100	100	34.30	5.03
January 1993	Control	100	100	27.70	7.90
	013	6	70	24.50	4.04
		12	100	24.20	6.48
		25	100	22.13	5.72
		50	100	22.67	3.97
		100	100	21.00	6.04
	Control	100	100	23.00	10.00
	015	6	100	27.00	5.94
		12	100	31.30	3.53
		25	100	32.00	3.40
		50	100	30.40	5.87
		100	100	30.90	3.28
	Control	100	80	26.38	2.62
	016	6	100	22.40	3.47
		12	100	26.40	2.76
		25	100	23.40	3.50
		50	100	25.20	3.79
		100	100	23.60	3.75
	Control	100	100	27.90	6.28
	017	6	90	25.67	1.80
		12	90	24.89	4.70
		25	100	25.50	3.54
		50	100	22.90	3.28
		100	90	23.11	3.92
	Control	100	100	29.80	4.96
	018	6	90	29.33	11.16
		12	100	30.90	10.79
		25	100	28.60	8.85
		50	100	30.70	7.72
		100	100	33.10	4.46

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
May 1993	Control	100	90	32.67	6.50
	013	6	100	33.80	3.88
		12	100	32.50	5.32
		25	100	30.80	3.26
		50	90	30.00	4.61
		100	100	26.30	3.50
	Control	100	100	28.00	4.11
	015	6	80	33.50	4.41
		12	100	33.60	3.27
		25	100	30.10	6.12
		50	100	29.20	5.75
		100	100	32.10	4.48
	Control	100	100	37.50	3.17
	016	6	80	36.88	5.06
		12	90	37.44	6.60
		25	90	38.00	4.77
		50	100	40.80	5.22
		100	100	38.60	11.46
	Control	100	100	36.80	4.66
	017	6	100	35.90	4.68
		12	100	40.70	4.50
		25	100	35.60	7.55
		50	100	34.80	4.54
		100	100	34.80	7.41
	Control	100	100	35.30	5.06
	018	6	100	30.50	5.17
		12	100	30.00	3.46
		25	100	28.80	4.44
		50	100	32.50	6.85
		100	100	29.60	3.75
September 1993	Control	100	100	32.00	2.98
	013	6	90	33.00	1.87
		12	100	30.10	4.38
		25	100	27.90	6.95
		50	100	30.00	5.75
		100	100	34.40	2.12
	Control	100	90	27.80	4.05
	015	6	90	30.80	3.16
		12	100	28.30	5.54

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
		25	100	31.70	3.77
		50	100	30.60	4.86
		100	100	30.60	5.10
	Control	100	80	29.25	3.69
	016	6	100	31.40	1.84
		12	80	31.63	5.32
		25	100	32.20	3.36
		50	100	31.50	4.38
		100	100	30.00	4.27
	Control	100	80	27.38	2.92
	017	6	100	25.80	9.43
		12	90	27.00	3.74
		25	100	28.80	4.02
		50	100	28.90	4.38
		100	100	28.30	5.42
	Control	100	100	32.00	2.62
	018	6	100	29.70	2.79
		12	100	32.30	2.11
		25	100	29.50	4.53
		50	90	33.44	3.71
		100	100	35.10	3.25
November 1993	Control	100	100	21.20	3.55
	013	6	100	27.60	2.88
		12	90	25.00	6.67
		25	100	25.20	3.01
		50	100	25.10	4.63
		100	90	24.11	5.80
	Control	100	100	24.90	3.45
	015	6	100	24.10	7.95
		12	100	28.60	2.84
		25	100	28.80	4.64
		50	100	29.40	3.27
		100	100	27.00	1.83
	Control	100	100	25.80	2.04
	016	6	100	25.00	3.09
		12	100	25.30	2.26
		25	100	24.40	5.40
		50	100	28.60	3.17
		100	100	28.20	2.97

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
	Control	100	100	23.80	2.04
	017	6	100	25.40	2.80
		12	100	25.40	2.07
		25	100	26.40	3.03
		50	100	25.00	1.49
		100	100	23.50	2.59
	Control	100	100	20.30	6.52
	018	6	100	26.50	3.14
		12	100	25.70	3.65
		25	100	27.40	2.27
		50	100	24.40	5.21
		100	80	23.00	4.57
February 1994	Control	100	100	25.10	3.81
	013	6	100	23.60	5.02
		12	100	25.90	4.23
		25	100	20.90	7.28
		50	100	22.50	5.62
		100	100	18.60	7.03
	Control	100	100	27.00	3.62
	015	6	100	25.30	2.54
		12	100	25.30	4.16
		25	100	28.90	2.42
		50	100	24.90	4.20
		100	100	24.10	7.13
	Control	100	90	26.56	4.88
	016	6	90	30.11	8.12
		12	100	28.30	7.56
		25	100	30.90	6.05
		50	100	30.50	5.56
		100	100	26.60	3.89
	Control	100	100	24.60	3.95
	017	6	100	25.20	4.16
		12	100	25.40	4.86
		25	100	28.90	6.56
		50	100	19.70	7.02
		100	100	21.60	7.14
	Control	100	100	17.90	4.61
	018	6	100	18.70	4.55
		12	100	18.20	3.29

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
		25	100	18.60	3.60
		50	100	22.00	3.09
		100	100	21.30	7.07
April 1994	Control	100	100	24.70	4.08
	013	6	90	24.20	2.90
		12	100	24.20	3.58
		25	100	23.80	3.12
		50	100	23.90	6.74
		100	100	24.30	4.83
	015	6	100	25.80	10.63
		12	100	27.20	3.49
		25	100	28.00	3.57
		50	90	26.89	4.73
		100	100	26.40	5.34
	016	6	100	22.90	6.01
		12	100	24.50	2.88
		25	100	22.90	3.63
		50	90	25.11	3.30
		100	100	19.60	7.96
	017	6	100	17.89	4.51
		12	100	18.60	1.96
		25	100	22.67	10.75
		50	100	19.40	1.96
		100	100	22.50	8.06
	018	6	90	22.67	2.18
		12	100	20.90	4.15
		25	100	22.80	5.53
		50	100	25.60	7.44
		100	90	24.22	5.02
September 1994	Control	100	100	21.90	3.75
	013	6	100	15.10	5.40
		12	100	22.20	3.71
		25	90	20.89	3.95
		50	90	22.67	3.67
		100	80	21.25	4.65
	Control	100	100	20.70	1.64
	015	6	90	21.56	5.83
		12	100	22.40	3.92
		25	90	22.78	2.86

Table B.5. (continued)

Date	Outfall	Conc.	Survival (%)	Offspring/surviving female	
				Mean	SD
		50	100	24.90	2.08
		100	100	24.40	2.95
	Control	100	100	22.50	3.47
	016	6	100	20.30	10.00
		12	100	22.10	8.52
		25	100	28.40	4.45
		50	100	26.40	4.38
		100	100	25.10	7.06
	Control	100	100	20.30	5.29
	017	6	100	7.80	4.78
		12	100	18.70	6.80
		25	100	14.70	4.16
		50	90	19.33	4.64
		100	80	23.63	2.77
	Control	100	100	20.50	2.22
	018	6	100	21.40	7.52
		12	90	22.22	9.43
		25	10	22.00	.
		50	0	.	.
		100	0	.	.
November 1994	Control	100	100	19.10	6.95
	013	6	100	19.30	4.19
		12	100	21.20	2.62
		25	100	20.30	6.18
		50	100	23.20	4.13
		100	90	19.56	10.53
	Control	100	100	20.30	5.91
	015	6	100	21.70	2.26
		12	100	21.70	5.08
		25	90	23.44	2.83
		50	100	23.80	3.19
		100	90	22.56	2.51
	Control	100	90	20.33	3.61
	016	6	100	20.00	1.94
		12	90	23.00	3.28
		25	100	20.30	5.60
		50	100	22.10	2.88
		100	100	17.90	3.98
	Control	100	100	20.80	2.90

Appendix C

CONCENTRATIONS OF CONTAMINANTS IN INDIVIDUAL FISH AND QUALITY ASSURANCE SUMMARY

QUALITY ASSURANCE SUMMARY

Matrix spike recoveries averaged (± SD) 90 ± 18% (n = 10). Spike recoveries in both the April 1994 and October 1993 samples averaged 90%. Recoveries of decachlorobiphenyl (DCBP) internal recovery standards, added to each sample prior to extraction, were similar to PCB spikes, averaging 85 ± 11 % (n = 87). The mean absolute difference between duplicate samples was 0.26 ± 0.50 µg/g (n = 12). Mean coefficient of variation among duplicates was 43%. PCBs were not found in fish from uncontaminated reference sites (mean concentration <0.10 µg/g, n = 13).

Overall, the PCB concentrations in fish at PGDP display a pattern expected from previous studies at Big Bayou and Little Bayou creeks and would not lead to any conclusions different from those made previously. Variability remains higher than desired but not atypical of PCB analyses of biological samples.

Analyses of standard reference mercury contaminated fish yielded results about 10% higher than the published true value of 2.52 µg/g, averaging 2.77 ± 0.03 µg/g (n = 3). Mean absolute difference between duplicate samples was small, 0.03 ± 0.04 µg/g (n = 5), with a mean coefficient of variation of 8%. Analyses of reference site samples averaged 0.10 ± 0.06 (n = 4), a value similar to the long-term average at the Hinds Creek reference site (0.09 µg/g). In screening analyses, recoveries of matrix spike additions of metals to reference site fish ranged from a low of 78 % for nickel and chromium to a high of 103% for uranium, with an overall average (± SD) for all metals of 90 ± 8%.

Table C.1. Concentrations of mercury and PCBs in individual fish collected from Big Bayou Creek and Little Bayou Creek near PGDP

Site[a]	Date	Spp.[b]	Sex[c]	Tag[d]	Wgt.[e]	Lgth.[f]	Hg[g]	ΣPCB[h]	1248[i]	1254[j]	1260[k]	Lipids[l]
BBK12.5	10/13/93	LNGEAR	M	4980	52.3	14.5	.	<0.08	<0.04	<0.08	<0.08	0.07
BBK12.5	10/13/93	LNGEAR	M	4981	57.9	13.4	.	<0.08	<0.04	<0.08	<0.08	0.05
BBK12.5	10/13/93	LNGEAR	M	4982	45.0	13.5	.	<0.09	<0.04	<0.09	<0.09	0.11
BBK12.5	10/13/93	LNGEAR	M	4983	36.0	12.6	.	<0.09	<0.04	<0.09	<0.09	0.05
BBK12.5	10/13/93	LNGEAR	M	4984	42.5	13.7	.	<0.08	<0.04	<0.08	<0.08	0.05
BBK12.5	10/13/93	LNGEAR	M	4985	46.7	13.9	.	<0.07	<0.03	<0.07	<0.07	0.18
BBK12.5	10/13/93	LNGEAR	M	4986	48.2	13.7	.	<0.08	<0.04	<0.08	<0.08	0.17
BBK12.5	10/13/93	LNGEAR	M	4987	43.4	13.4	.	<0.08	<0.04	<0.08	<0.08	0.07
BBK10.0	10/13/93	LNGEAR	M	4610	45.9	13.3	.	0.07	<0.04	0.05	0.02	0.20
BBK10.0	10/13/93	LNGEAR	M	4611	48.2	13.8	.	<0.07	<0.03	<0.07	<0.07	0.06
BBK10.0	10/13/93	LNGEAR	M	4612	43.4	13.0	.	0.07	<0.07	0.04	0.03	0.16
BBK10.0	10/13/93	LNGEAR	M	4613	55.3	13.4	.	0.02	<0.03	<0.06	0.02	0.25
BBK10.0	10/13/93	LNGEAR	M	4614	41.1	12.7	.	0.08	0.02	0.04	0.02	0.19
BBK10.0	10/13/93	LNGEAR	M	4615	45.4	13.2	.	0.12	0.03	0.06	0.03	0.30
BBK10.0	10/13/93	LNGEAR	M	4616	52.5	13.8	.	<0.06	<0.03	<0.06	<0.06	0.10
BBK10.0	10/13/93	LNGEAR	M	4617	42.4	13.1	.	<0.10	<0.05	<0.10	<0.10	0.06
BBK9.1	10/14/93	LNGEAR	M	4970	46.1	13.6	.	0.06	0.01	0.01	0.04	0.10
BBK9.1	10/14/93	LNGEAR	M	4971	54.9	13.9	.	0.31	0.07	0.13	0.11	0.30
BBK9.1	10/14/93	LNGEAR	M	4972	52.7	13.6	.	0.04	<0.05	0.03	0.01	0.00
BBK9.1	10/14/93	LNGEAR	M	4973	54.4	13.8	.	0.26	0.06	0.08	0.12	0.25
BBK9.1	10/14/93	LNGEAR	M	4974	48.1	13.1	.	0.34	0.12	0.13	0.09	0.49
BBK9.1	10/14/93	LNGEAR	M	4975	45.1	13.6	.	0.09	0.04	0.03	0.02	0.09
BBK9.1	10/14/93	LNGEAR	M	4976	51.9	14.0	.	0.09	0.03	0.04	0.02	0.11
BBK9.1	10/14/93	LNGEAR	M	4977	54.7	13.6	.	0.08	0.03	0.03	0.02	0.10
BBK9.1	10/14/93	SPBASS	F	4720	405	31.0	0.95	0.15	0.02	0.05	0.08	0.10
BBK9.1	10/14/93	SPBASS	F	4721	493	34.2	0.58	0.18	0.03	0.07	0.08	0.14
BBK9.1	10/14/93	SPBASS	M	4722	559	32.8	0.60	0.10	0.01	0.04	0.05	0.10
BBK9.1	10/14/93	SPBASS	M	4723	349	29.1	0.69	0.44	0.06	0.18	0.20	0.19
BBK9.1	10/14/93	SPBASS	M	4724	349	30.2	0.44	0.28	0.05	0.12	0.11	0.20
BBK9.1	10/14/93	SPBASS	F	4725	587	34.1	0.59	0.12	0.02	0.05	0.05	0.21
BBK9.1	10/14/93	SPBASS	F	4726	348	29.5	0.45	0.23	0.04	0.10	0.09	0.24
BBK9.1	10/14/93	SPBASS	F	4727	480	32.6	0.60	0.35	0.04	0.10	0.11	0.11
BBK2.8	10/13/93	LNGEAR	M	4770	58.7	14.4	.	<0.06	<0.03	<0.06	<0.06	0.06
BBK2.8	10/13/93	LNGEAR	F	4771	37.4	12.3	.	<0.12	<0.06	<0.12	<0.12	0.15
BBK2.8	10/13/93	LNGEAR	M	4772	40.8	12.8	.	<0.09	<0.05	<0.09	<0.09	0.29
BBK2.8	10/13/93	LNGEAR	M	4773	41.6	13.0	.	<0.09	<0.05	<0.09	<0.09	0.08
BBK2.8	10/13/93	LNGEAR	M	4774	63.2	15.2	.	<0.06	<0.03	<0.06	<0.06	0.17
BBK2.8	10/13/93	LNGEAR	M	4775	68.6	15.0	.	<0.06	<0.03	<0.06	<0.06	0.09
BBK2.8	10/13/93	LNGEAR	M	4776	49.0	13.8	.	<0.08	<0.04	<0.08	<0.08	0.13
BBK2.8	10/13/93	LNGEAR	M	4777	36.6	12.6	.	<0.10	<0.05	<0.10	<0.10	0.31
LUK9.0	10/14/93	LNGEAR	M	4800	57.7	14.0	.	0.63	0.19	0.25	0.19	0.06
LUK9.0	10/14/93	LNGEAR	M	4801	29.6	11.7	.	0.82	0.12	0.33	0.37	0.00
LUK9.0	10/14/93	LNGEAR	M	4802	24.9	11.5	.	0.39	<0.04	<0.09	0.39	0.00
LUK9.0	10/14/93	LNGEAR	M	4803	28.1	11.5	.	0.24	<0.07	<0.14	0.24	0.00
LUK9.0	10/14/93	LNGEAR	M	4804	28.6	11.7	.	1.23	0.28	<0.05	0.95	0.05

Table C.1 (continued)

Site[a]	Date	Spp.[b]	Sex[c]	Tag[d]	Wgt.[e]	Lgth.[f]	Hg[g]	ΣPCB[h]	1248[i]	1254[j]	1260[k]	Lipids[l]
LUK9.0	10/14/93	LNGEAR	M	4805	27.8	11.4	.	1.67	0.84	0.83	<0.05	0.37
LUK9.0	10/14/93	LNGEAR	M	4806	27.8	11.6	.	0.65	0.10	<0.06	0.55	0.04
LUK9.0	10/14/93	LNGEAR	M	4807	26.1	11.6	.	0.33	0.04	<0.07	0.29	0.04
LUK7.2	10/14/93	SPBASS	F	4849	146	22.5	.	0.36	0.11	0.16	0.19	0.08
LUK4.3	10/14/93	SPBASS	M	4850	385	30.9	.	0.21	0.03	0.08	0.10	0.09
LUK4.3	10/14/93	SPBASS	F	4851	571	33.6	.	0.03	<0.01	0.01	0.02	0.03
LUK4.3	10/14/93	SPBASS	M	4852	679	35.8	.	0.48	0.03	0.16	0.29	0.27
LUK4.3	10/14/93	SPBASS	M	4853	187	23.9	.	0.58	0.12	0.22	0.24	0.24
LUK4.3	10/14/93	SPBASS	F	4854	217	25.2	.	0.95	0.24	0.39	0.32	0.60
LUK4.3	10/14/93	LNGEAR	M	4870	37.3	13.0	.	0.04	<0.05	0.03	0.01	0.04
LUK4.3	10/14/93	LNGEAR	M	4871	42.7	12.9	.	0.13	<0.04	0.07	0.06	0.52
LUK4.3	10/14/93	LNGEAR	M	4872	38.9	13.1	.	0.29	0.04	0.16	0.09	0.02
LUK4.3	10/14/93	LNGEAR	M	4873	38.4	13.7	.	0.18	<0.05	0.13	0.05	0.06
LUK4.3	10/14/93	LNGEAR	M	4874	38.3	12.3	.	0.26	0.03	0.16	0.07	0.64
LUK4.3	10/14/93	LNGEAR	M	4875	38.5	12.9	.	0.05	<0.05	0.02	0.03	0.06
LUK4.3	10/14/93	LNGEAR	F	4876	40.5	12.5	.	<0.08	<0.04	<0.08	<0.08	0.09
LUK4.3	10/14/93	LNGEAR	M	4877	36.4	12.6	.	0.12	<0.05	0.05	0.07	0.14
HINDSCR	12/16/93	REDBRE	M	8065	65.5	16.1	.	<0.12	<0.06	<0.12	<0.12	0.00
HINDSCR	12/16/93	REDBRE	F	8066	51.3	14.8	.	<0.09	<0.05	<0.09	<0.09	0.06
HINDSCR	12/16/93	REDBRE	M	8067	39.2	13.7	.	<0.13	<0.06	<0.13	<0.13	0.08
HINDSCR	12/16/93	REDBRE	F	8068	36.2	12.7	.	<0.12	<0.06	<0.12	<0.12	0.05
HINDSCR	12/16/93	REDBRE	F	8070	47.3	14.0	.	<0.09	<0.05	<0.09	<0.09	0.08
HINDSCR	12/16/93	REDBRE	M	8071	41.2	13.4	.	<0.10	<0.05	<0.10	<0.10	0.07
BBK12.5	5/2/94	LNGEAR	M	8310	84.9	15.0	0.08	<0.06	<0.03	<0.06	<0.06	0.73
BBK12.5	5/2/94	LNGEAR	M	8311	54.7	12.5	0.07	<0.08	<0.04	<0.08	<0.08	0.91
BBK12.5	5/2/94	LNGEAR	M	8312	49.8	12.8	0.08	<0.07	<0.03	<0.07	<0.07	1.40
BBK12.5	5/2/94	LNGEAR	M	8313	87.4	14.8	0.09	<0.05	<0.03	<0.05	<0.05	0.83
BBK12.5	5/2/94	LNGEAR	M	8314	52.6	13.1	0.10	<0.12	<0.06	<0.12	<0.12	1.10
BBK12.5	5/2/94	LNGEAR	M	8315	37.7	11.8	0.07	<0.16	<0.08	<0.16	<0.16	1.00
BBK12.5	5/2/94	LNGEAR	M	8316	67.6	14.2	0.09	<0.11	<0.05	<0.11	<0.11	0.44
BBK12.5	5/2/94	LNGEAR	M	8317	41.5	11.5	0.07	<0.17	<0.08	<0.17	<0.17	0.42
BBK10.0	5/3/94	LNGEAR	M	8330	57.4	13.5	0.35	0.11	<0.05	<0.11	0.11	0.27
BBK10.0	5/3/94	LNGEAR	M	8331	55.9	13.6	0.33	0.07	<0.05	<0.10	0.07	0.42
BBK10.0	5/3/94	LNGEAR	M	8332	68.8	14.6	0.18	0.22	<0.05	<0.11	0.22	0.44
BBK10.0	5/3/94	LNGEAR	M	8333	62.4	13.8	0.12	0.04	<0.05	0.04	<0.11	0.37
BBK10.0	5/3/94	LNGEAR	M	8334	45.3	12.4	0.16	0.05	<0.06	0.05	<0.12	0.41
BBK10.0	5/3/94	LNGEAR	M	8335	47.1	12.5	0.11	0.33	<0.08	0.13	0.20	1.00
BBK10.0	5/3/94	LNGEAR	M	8336	70.5	14.2	0.13	0.16	0.04	0.05	0.07	0.55
BBK10.0	5/3/94	LNGEAR	M	8337	54.4	13.6	0.53	0.17	<0.10	0.05	0.12	0.44
BBK9.1	5/3/94	LNGEAR	M	8350	77.7	14.8	0.19	0.27	0.03	0.12	0.12	1.00
BBK9.1	5/3/94	LNGEAR	M	8351	60.9	13.5	0.16	0.03	<0.05	0.03	<0.10	0.12
BBK9.1	5/3/94	LNGEAR	M	8352	80.5	15.0	0.27	0.17	<0.04	0.09	0.08	0.43
BBK9.1	5/3/94	LNGEAR	M	8353	53.4	13.7	0.29	0.10	<0.04	<0.07	0.10	0.09
BBK9.1	5/3/94	LNGEAR	M	8354	47.3	12.8	0.15	0.17	<0.04	0.08	0.09	0.11
BBK9.1	5/3/94	LNGEAR	M	8355	86.4	15.1	0.16	0.03	<0.03	0.03	<0.07	0.59

Table C.1 (continued)

Site[a]	Date	Spp.[b]	Sex[c]	Tag[d]	Wgt.[e]	Lgth.[f]	Hg[g]	ΣPCB[h]	1248[i]	1254[j]	1260[k]	Lipids[l]
BBK9.1	5/3/94	LNGEAR	M	8356	48.0	13.0	0.26	0.50	<0.04	0.19	0.32	0.86
BBK9.1	5/3/94	LNGEAR	M	8357	51.8	13.5	0.22	0.21	<0.05	0.09	0.13	0.19
LUK9.0	5/3/94	LNGEAR	M	8340	36.1	12.2	.	3.42	<0.05	1.36	2.06	0.22
LUK9.0	5/3/94	LNGEAR	M	8341	32.6	11.3	.	2.16	0.26	0.77	1.13	0.25
LUK9.0	5/3/94	LNGEAR	M	8342	24.3	10.2	.	2.65	0.56	1.26	0.83	0.60
LUK9.0	5/3/94	LNGEAR	F	8343	32.3	11.0	.	0.94	0.35	0.32	0.27	0.14
LUK9.0	5/3/94	LNGEAR	M	8344	37.4	11.6	.	0.50	0.16	0.17	0.16	0.00
LUK9.0	5/3/94	LNGEAR	M	8345	29.1	11.9	.	0.76	<0.07	0.13	0.63	0.00
LUK9.0	5/3/94	LNGEAR	F	8346	33.7	11.6	.	0.08	0.04	0.02	0.02	0.03
LUK9.0	5/3/94	LNGEAR	M	8347	22.9	9.9	.	0.75	0.10	0.29	0.36	0.16
LUK7.2	5/2/94	LNGEAR	M	4835	56.7	12.8	0.10	<0.13	<0.06	<0.13	<0.13	0.05
LUK7.2	5/2/94	LNGEAR	M	4836	52.2	13.4	0.09	0.51	0.06	0.20	0.25	0.05
LUK7.2	5/2/94	LNGEAR	M	4837	48.3	13.2	0.08	0.62	0.12	0.29	0.21	0.07
LUK7.2	5/2/94	LNGEAR	M	4838	45.6	12.6	0.09	0.29	<0.09	0.13	0.17	0.04
LUK4.3	5/2/94	LNGEAR	M	8300	41.0	12.1	.	0.03	<0.05	0.02	0.01	0.14
LUK4.3	5/2/94	LNGEAR	M	8301	57.7	13.1	.	0.14	0.04	0.08	0.02	0.43
LUK4.3	5/2/94	LNGEAR	M	8302	79.9	14.2	.	0.23	0.03	0.07	0.13	1.59
LUK4.3	5/2/94	LNGEAR	M	8303	71.9	14.1	.	0.30	0.05	0.08	0.17	0.94
LUK4.3	5/2/94	LNGEAR	M	8304	36.9	11.8	.	0.19	<0.05	0.06	0.13	0.14
LUK4.3	5/2/94	LNGEAR	F	8305	34.0	11.3	.	0.07	<0.07	0.02	0.04	0.79
LUK4.3	5/2/94	LNGEAR	F	8306	30.5	11.0	.	0.13	<0.07	0.04	0.09	0.41
LUK4.3	5/2/94	LNGEAR	M	8307	35.1	11.1	.	0.61	0.08	0.19	0.33	1.03
MASSAC	5/3/94	LNGEAR	M	8320	32.6	11.5	0.07	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8321	74.9	15.4	0.18	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8322	71.5	13.9	0.14	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8323	43.2	12.1	0.17	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8324	32.4	11.4	0.12	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8325	70.5	14.2	0.11	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8326	30.2	10.9	0.12	.	.	.	.	.
MASSAC	5/3/94	LNGEAR	M	8327	35.4	11.4	0.11	.	.	.	.	.
HINDSCR	5/18/94	REDBRE	M	8493	42.2	14.5	0.13	.	.	.	.	.
HINDSCR	5/18/94	REDBRE	F	8480	30.6	11.3	0.05	.	.	.	.	.
HINDSCR	5/18/94	REDBRE	M	8490	108.7	17.6	0.05	<0.10	<0.05	<0.10	<0.10	0.42
HINDSCR	5/18/94	REDBRE	F	8487	83.3	16.4	0.18	<0.12	<0.06	<0.12	<0.12	0.61
HINDSCR	5/18/94	REDBRE	F	8489	101.5	16.8	.	<0.07	<0.03	<0.07	<0.07	0.41
HINDSCR	5/18/94	REDBRE	M	8492	54.1	14.0	.	<0.12	<0.06	<0.12	<0.12	0.50
HINDSCR	5/18/94	REDBRE	F	8488	104.9	16.4	.	<0.08	<0.04	<0.08	<0.08	0.13

Table C.1 (continued)

[a]BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; MAK = Massac Creek kilometer; HINDSCR = Hinds Creek.

[b]Spp = species, LNGEAR = Longear sunfish, *Lepomis megalotus*; REDBRE = redbreast sunfish, *Lepomis auritus*.

[c]Sex: M = male; F = female.

[d]Tag = fish identification tag number.

[e]Weight in grams.

[f]Length = total length, in centimeters.

[g]Hg = total mercury concentration, micrograms per gram wet wt.

[h]ΣPCB = sum of PCBs quantified as specific Aroclor mixtures, micrograms per gram wet wt

[i]1248 = PCBs quantified as similar to Aroclor 1248, micrograms per gram wet wt.

[j]1254 = PCBs quantified as similar to Aroclor 1254, micrograms per gram wet wt.

[k]1260 = PCBs quantified as similar to Aroclor 1260, micrograms per gram wet wt.

[l]Lipid = Lipid content of fish fillet, percentage wet weight.

Appendix D

SPECIES CHARACTERISTICS, DENSITY, AND BIOMASS FOR FISH COMMUNITY DATA COLLECTED FROM BIG BAYOU CREEK, LITTLE BAYOU CREEK, AND MASSAC CREEK DURING MARCH AND SEPTEMBER 1994

Table D.1. Tolerance, feeding guilds and lithophilic spawners for species found in and near the drainages of Big Bayou Creek, Little Bayou Creek, and Massac Creek

Species	Tolerance[a]	Feeding guild[b]	Lithophilic spawner[c]
Gizzard shad (*Dorosoma cepedianum*)	TOL	GEN	
Goldfish (*Carassius auratus*)	TOL	GEN	
Red shiner (*Cyprinella lutrensis*)	TOL		
Spotfin shiner (*Cyprinella spiloptera*)	TOL		
Steelcolor shiner (*Cyprinella whipplei*)	INTOL		
Common carp (*Cyprinus carpio*)	TOL	GEN	
Ribbon shiner (*Lythrurus fumeus*)	INTOL		
Emerald shiner (*Notropis atherinoides*)			LITH
River shiner (*Notropis blennius*)			LITH
Sand shiner (*Notropis stramineus*)	INTOL		
Mimic shiner (*Notropis volucellus*)	INTOL		
Suckermouth minnow (*Phenacobius mirabilis*)		BIN	LITH
Fathead minnow (*Pimephales promelas*)	TOL	GEN	
Creek chub (*Semotilus atromaculatus*)	TOL	GEN	
White sucker (*Catostomus commersoni*)	TOL	GEN	LITH
Creek chubsucker (*Erimyzon oblongus*)		BIN	
Spotted sucker (*Minytrema melanops*)	INTOL	GEN	LITH
Black redhorse (*Moxostoma duquesnei*)	INTOL	BIN	LITH
Golden redhorse (*Moxostoma erythrurum*)	INTOL	BIN	LITH
Black bullhead (*Ameiurus melas*)	TOL	GEN	
Yellow bullhead (*Ameiurus natalis*)	TOL	GEN	
Tadpole madtom (*Noturus gyrinus*)	INTOL	BIN	
Freckled madtom (*Noturus nocturnus*)	INTOL	BIN	
Grass pickerel (*Esox americanus vermiculatus*)		PIS	
Pirate perch (*Aphredoderus sayanus*)		BIN	
Green sunfish (*Lepomis cyanellus*)	TOL		
Warmouth (*Lepomis gulosus*)		GEN	
Bluegill (*Lepomis macrochirus*)		GEN	
Longear sunfish (*Lepomis megalotis*)		GEN	
Spotted bass (*Micropterus punctulatus*)		PIS	
Largemouth bass (*Micropterus salmoides*)		PIS	
Mud darter (*Etheostoma asprigene*)		BIN	LITH
Bluntnose darter (*Etheostoma chlorosomum*)	INTOL	BIN	
Slough darter (*Etheostoma gracile*)		BIN	
Logperch (*Percina caprodes*)	INTOL	BIN	LITH
Blackside darter (*Percina maculata*)	INTOL	BIN	LITH

[a]Tolerant (TOL) and sensitive (INTOL) species were tentatively identified for the Paducah area using collection records and text discussions in Becker (1983), Burr and Warren (1986), Cross and Collins (1975), Etnier and Starnes (1993), Karr et al. (1986), Lee et al. (1980), Ohio EPA (1987, 1988), Plfieger (1975), Robison and Buchanan (1988), Smith (1979), and Trautman (1981). Complete citations for references listed in this table may be found in Section 6 of this report.

[b]Feeding guilds are assigned to categories of interest in assessing impacts. Guilds include species that are primarily *generalists* (GEN), fish that feed on many types of food items and from many areas of the stream; *benthic insectivores* (BIN), those that eat macroinvertebrates associated with bottom substrates; and *piscivores* (PIS), fish that eat other fish.

[c]Lithophilic spawners (LITH) are species that release eggs randomly or without parental care in or onto gravel substrates. These species are especially vulnerable to siltation or low dissolved oxygen conditions.

Table D.2. Fish densities (number/m^2) in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, March 1994

	Sites[a]				
Species[b]	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Stoneroller	0.32	1.18	1.67	0.21	0.60
Red shiner	-	0.01	-	0.18	-
Steelcolor shiner[c]	<0.01	-	-	-	0.01
Ribbon shiner	-	-	-	0.07	0.01
Redfin shiner[c]	-	<0.01	-	0.11	0.06
Golden shiner	-	-	-	<0.01	-
Suckermouth minnow	-	<0.01	0.01	0.16	-
Bluntnose minnow	-	<0.01	0.05	1.61	0.07
Creek chub	-	<0.01	0.25	0.21	0.03
White sucker	<0.01	-	<0.01	-	0.01
Creek chubsucker	<0.01	0.01	0.05	0.01	0.01
Spotted sucker	<0.01	-	-	-	-
Yellow bullhead	0.01	-	0.14	0.03	0.03
Pirate perch	-	-	-	0.07	0.01
Blackspotted topminnow	0.04	0.01	0.15	0.49	0.12
Western mosquitofish	-	-	-	0.02	-
Green sunfish	0.06	0.01	0.10	0.12	0.04
Warmouth	<0.01	-	-	0.02	-
Bluegill	0.01	-	0.03	<0.01	0.01
Longear sunfish	0.50	0.13	0.62	0.27	0.43
Hybrid sunfish	0.01	<0.01	0.01	-	-
Spotted bass	0.01	-	0.01	<0.01	0.01
Largemouth bass	<0.01	-	-	-	-
Bluntnose darter	-	-	-	0.08	-
Slough darter	-	-	-	0.16	-
Logperch	-	-	-	-	0.01
Blackside darter	-	-	-	-	0.03
Total density	0.97	1.36	3.09	3.82	1.49

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

[b]Common and scientific names according to the American Fisheries Society (Robbins et al. 1991).

[c]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Table D.3. Fish biomass (g fish/m²) in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, March 1994

	Sites[a]				
Species[b]	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Stoneroller	0.79	6.39	6.84	0.31	1.25
Red shiner	-	0.01	-	0.13	-
Steelcolor shiner[c]	<0.01	-	-	-	0.04
Ribbon shiner	-	-	-	0.05	<0.01
Redfin shiner[c]	-	<0.01	-	0.11	0.08
Golden shiner	-	-	-	0.01	-
Suckermouth minnow	-	0.01	0.07	0.48	-
Bluntnose minnow	-	<0.01	0.11	2.34	0.17
Creek chub	-	<0.01	1.09	0.47	0.10
White sucker	1.55	-	0.13	-	0.56
Creek chubsucker	0.20	0.01	0.33	0.14	0.15
Spotted sucker	0.09	-	-	-	-
Yellow bullhead	0.46	-	2.20	0.16	0.75
Pirate perch	-	-	-	0.53	0.06
Blackspotted topminnow	0.06	0.02	0.21	0.70	0.16
Western mosquitofish	-	-	-	0.01	-
Green sunfish	0.77	0.13	1.14	0.63	0.22
Warmouth	0.09	-	-	0.24	-
Bluegill	0.58	-	0.23	<0.01	0.01
Longear sunfish	9.67	1.07	3.66	0.44	2.83
Hybrid sunfish	0.44	0.17	0.51	-	-
Spotted bass	2.11	-	0.05	0.01	0.27
Largemouth bass	0.12	-	-	-	-
Bluntnose darter	-	-	-	0.07	-
Slough darter	-	-	-	0.15	-
Logperch	-	-	-	-	0.09
Blackside darter	-	-	-	-	0.09
Total biomass	16.93	7.81	16.57	6.98	6.83

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

[b]Common and scientific names according to the American Fisheries Society (Robbins et al. 1991).

[c]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Table D.4. Fish densities (number/m^2) in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, September 1994

	Sites[a]				
Species[b]	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Stoneroller	0.56	4.43	1.53	0.67	1.93
Red shiner	-	-	0.06	0.63	<0.01
Steelcolor shiner[c]	-	-	-	-	0.02
Miss. silvery minnow	-	-	-	-	0.17
Ribbon shiner	0.01	-	-	-	<0.01
Redfin shiner[c]	0.06	-	0.05	-	0.08
Golden shiner	-	-	-	-	<0.01
Suckermouth minnow	-	-	-	0.01	-
Bluntnose minnow	-	0.01	0.13	0.88	0.12
Creek chub	-	0.01	0.35	1.34	0.38
White sucker	<0.01	-	<0.01	-	0.02
Creek chubsucker	0.01	0.01	0.04	-	0.30
Bigmouth buffalo	<0.01	-	-	-	-
Spotted sucker	<0.01	-	-	-	0.01
Golden redhorse	-	-	-	-	0.08
Black bullhead	<0.01	-	-	-	-
Yellow bullhead	0.01	0.03	0.05	0.09	0.07
Pirate perch	-	-	-	-	0.01
Blackspotted topminnow	0.10	0.38	0.90	0.12	0.60
Western mosquitofish	0.01	0.01	-	0.02	0.28
Green sunfish	0.06	0.01	0.10	-	0.24
Warmouth	-	-	<0.01	-	<0.01
Bluegill	0.08	0.03	0.04	-	0.19
Longear sunfish	0.27	0.61	0.96	-	1.20
Hybrid sunfish		-	-	-	0.01
Spotted bass	0.01	0.04	0.05	-	0.02
Largemouth bass	0.01	<0.01	<0.01	-	-
Slough darter	-	-	-	-	<0.01
Logperch	-	-	-	-	<0.01
Blackside darter	-	-	-	-	0.01
Total density	1.19	5.57	4.26	3.76	5.74

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

[b]Common and scientific names according to the American Fisheries Society (Robbins et al. 1991).

[c]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Table D.5. Fish biomass (g fish/m^2) in Big Bayou Creek, Little Bayou Creek, and a reference stream, Massac Creek, September 1994

Species[b]	Sites[a]				
	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Stoneroller	1.26	8.61	3.20	1.02	2.95
Red shiner	-	-	0.08	0.20	<0.01
Steelcolor shiner[c]	-	-	-	-	0.01
Miss. silvery minnow	-	-	-	-	0.46
Ribbon shiner	<0.01	-	-	-	<0.01
Redfin shiner[c]	0.05	-	0.03	-	0.07
Golden shiner	-	-	-	-	0.03
Suckermouth minnow	-	-	-	0.02	-
Bluntnose minnow	-	0.01	0.15	0.64	0.15
Creek chub	-	0.03	0.39	3.48	0.99
White sucker	0.27	-	0.09	-	0.77
Creek chubsucker	0.35	0.04	0.42	-	1.65
Bigmouth buffalo	1.28	-	-	-	-
Spotted sucker	1.22	-	-	-	0.35
Golden redhorse	-	-	-	-	1.70
Black bullhead	0.17	-	-	-	0.37
Yellow bullhead	0.33	0.09	0.58	0.46	
Pirate perch	-	-	-	-	0.06
Blackspotted topminnow	0.13	0.30	0.80	0.03	0.68
Western mosquitofish	<0.01	<0.01	-	0.01	0.07
Green sunfish	1.46	0.18	0.81	-	1.07
Warmouth	-	-	0.10	-	0.06
Bluegill	2.84	0.32	0.40	-	0.93
Longear sunfish	3.64	4.89	2.15	-	4.50
Hybrid sunfish	-	-	-	-	0.23
Spotted bass	0.91	0.60	0.32	-	0.58
Largemouth bass	0.54	0.03	0.70	-	-
Slough darter	-	-	-	-	<0.01
Logperch	-	-	-	-	0.04
Blackside darter	-	-	-	-	0.03
Total biomass	14.45	15.10	10.22	5.86	17.75

[a]BBK = Big Bayou Creek kilometer, LUK = Little Bayou Creek kilometer, MAK = Massac Creek kilometer.

[b]Common and scientific names according to the American Fisheries Society (Robbins et al. 1991).

[c]Species identification confirmed by Dr. David A. Etnier, Department of Zoology, University of Tennessee.

Appendix E

CHECKLIST OF BENTHIC MACROINVERTEBRATE TAXA COLLECTED FROM BIG BAYOU CREEK, LITTLE BAYOU CREEK, AND MASSAC CREEK IN PADUCAH, KENTUCKY, SEPTEMBER 1991 TO MARCH 1994

Table E.1. Checklist of benthic macroinvertebrate taxa collected from Big Bayou Creek, Little Bayou Creek, and Massac Creek in Paducah, Kentucky, September 1991–June 1994

Taxon	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
	Site[a,b]				
Coelenterata					
Hydrozoa	-	2	-	-	-
Hydridae					
Hydra	1	1	2	-	-
Turbellaria					
Planariidae	1,2,3	1,2,3	1,2,3	1	-
Nemertea		1,3	1,2,3	1,2,3	1,2,31,3
Nematoda		1	1	1	1,21,2
Annelida					
Hirudinea		-	-	3	--
Glossiphoniidae					
Helobdella	-	2,3	-	-	-
Oligochaeta	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Branchiura sowerbyi	2,3	-	-	1	-
Crustacea					
Amphipoda					
Talitridae					
Hyalella azteca	1	1,2	-	-	-
Decapoda		-	-	-	-1
Hydrachnida	1	1	-	-	-
Hydrachnidae	-	-	1	1,3	1,3
Hygrobatidae					
Atractides	1	-	1	-	1,3
Hygrobates	1,2,3	1,2,3	1	1	-
Lebertiidae					
Lebertia	-	-	-	3	1
Limnesiidae					
Limnesia	-	2	-	-	-
Pionidae					
Piona	1	-	-	-	-
Torrenticolidae					
Torrenticola	1,3	1,2,3	3	1,2,3	1,2,3

Table E.1 (continued)

Taxon	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
	Site[a,b]				
Insecta					
Ephemeroptera	-	-	-	3	-
Baetidae	1,2	1,2	1	1,3	1,2,3
Baetis	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Pseudocloeon	-	-	1	-	-
Caenidae					
Caenis	1,2,3	1,2,3	1,2,3	1,2	1,2,3
Heptageniidae	1	1,2,3	1	1	1
Stenacron	-	2	3	-	-
Stenonema	1,2,3	1,2,3	1,3	-	1,2
Oligoneuriidae					
Isonychia	1,3	1	-	-	-
Tricorythidae					
Tricorythodes	1,2,3	1,2,3	3	-	-
Odonata		-	1,2	2	--
Anisoptera					
Gomphidae	-	-	-	3	-
Dromogomphus	1	-	-	-	-
Progomphus	-	-	-	1,3	1
Libellulidae					
Erythemis simplicicollis	-	1	-	-	-
Libellula	-	1	-	-	-
Miathyria					
Macromiidae					
Macromia	-	1	-	3	-
Zygoptera	1	1	-	-	-
Calopterygidae					
Calopteryx	-	-	1	1	1
Hetaerina	-	1	-	1	-
Coenagrionidae	-	1	-	-	-
Argia	1,3	1,2	-	3	2
Enallagma	-	1	-	-	-
Ischnura	-	1	1	-	-

Table E.1 (continued)

Taxon	Site[a,b]				
	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Plecoptera	1	1	1,3	1,2	1
Capniidae	-	3	1,3	1	1,3
Allocapnia	-	3	2	-	3
Leuctridae	-	-	3	-	-
Nemouridae	3	-	2	-	3
Amphinemura	-	-	1	1	1
Perlodidae					
Isoperla	-	-	1	-	-
Megaloptera					
Corydalidae					
Corydalus cornutus	3	1,3	1,3	1,2,3	-
Trichoptera	1	1,2,3	1,2,3	1	1,2,3
Hydropsychidae	1,2,3	1,2,3	3	1,2,3	1,2,3
Cheumatopsyche	1,2,3	1,2,3	1,3	1,2,3	1,2,3
Hydropsyche	1,2	-	1,2,3	1,2,3	1,3
Hydroptilidae	-	-	2	-	-
Hydroptila	1	1	1,2	1,3	-
Leptoceridae					
Oecetis	1	1	1	1,3	1
Philopotamidae	3	-	-	-	-
Chimarra	1,2,3	1,2,3	1,2,3	1	1,3
Polycentropodidae	3	-	-	-	-
Polycentropus	-	-	1	-	-
Coleoptera					
Elmidae	1	-	-	-	-
Dubiraphia	1	-	1,2	1,2,3	-
Optioservus	-	-	-	-	1
Stenelmis	1,2,3	1,3	1,3	1,2,3	1,3
Gyrinidae					
Dineutus	-	-	-	1	1
Haliplidae					
Peltodytes	-	1	-	-	-
Hydrophilidae	-	2	-	-	-
Berosus	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Enochrus	-	1	-	-	-
Hydrobius	-	-	-	1	-

Table E.1 (continued)

Taxon	BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
	Site[a,b]				
Diptera		-	-	3	11
Ceratopogonidae	1	-	1	-	-
Atrichopogon	-	1,2	1,2	-	-
Bezzia	1	1	1,2	1	1,2,3
Culicoides	1	1	1	1,3	-
Monohelea	1	1	-	-	-
Palpomyia	-	-	1	-	1
Probezzia	1	-	-	1	-
Chironomidae	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Chironomini	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Orthocladiinae	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Tanypodinae	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Tanytarsini	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Empididae					
Chelifera	1	1	1	-	-
Hemerodromia	1,2	1,2,3	1,2	1,2	3
Simuliidae	1	-	2,3	2	-
Simulium	1,2,3	1	1,2	1,2	1,2,3
Stegopterna	-	-	2	-	-
Tabanidae					
Tabanus	1	1	-	1	-
Tipulidae	-	1,2	2	-	3
Erioptera	-	1	-	-	1
Helius	-	1	-	-	-
Limonia	-	-	-	2	-
Tipula	-	2	1,2	1	-
Mollusca					
Gastropoda					
Ancylidae	-	-	-	1,3	3
Ferrissia fragilis	1	1	1	1,3	3
Hydrobiidae	-	-	-	1	-
Lymnaeidae	-	-	-	1	-
Fossaria	-	-	-	1	-
Pseudosuccinea columella	-	-	-	3	1
Physidae					
Physella	-	1,3	-	1	1,2

Table E.1 (continued)

Taxon	Site[a,b] BBK 9.1	BBK 10.0	BBK 12.5	LUK 7.2	MAK 13.8
Gastropoda (continued)					
Planorbidae	-	1,3	-	-	-
Gyraulus deflectus	1	-	-	-	-
Gyraulus parvus	1	3	-	-	-
Micromenetus dilatatus	1,3	1,3	-	1	1
Micromenetus	-	-	-	1	-
Bivalvia					
Corbiculidae					
Corbicula fluminea	1,2,3	-	-	-	-
Sphaeriidae	2	-	-	2,3	-
Musculium	1	-	-	3	-
Pisidium	-	-	-	1,3	3
Sphaerium	1	-	-	-	-

[a]BBK = Big Bayou Creek kilometer; LUK = Little Bayou Creek kilometer; MAK = Massac Creek kilometer.

[b]The numbers associated with each taxon and site indicate the sampling years (i.e., the one year cycle beginning with the first collection date) that the taxon was collected at least once, with 1 = September 1991–June 1992, 2 = September 1992 and March 1993, and 3 = September 1993 and March 1994. A blank indicates that a lower level of classification (e.g., family, genus, or species) was possible at one or more sites, and a dash (-) indicates that the taxon was not collected or that the taxon was not identified to a lower level at one or more sites.

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