UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

MEMORANDUM

DATE: September 2, 2014

SUBJECT: Dioxin/Furans: LCP Chemicals Superfund Site, Brunswick, Glynn County, GA

FROM: Galo Jackson, Remedial Project Manager

TO: Pam Scully, Acting Section Chief
U.S. Environmental Protection Agency, Region 4
Superfund Remedial Branch, Superfund Division

The attached memorandum consolidates and updates all the currently available dioxin/furans data available for the LCP Chemicals marsh. Additional dioxin/furans data was collected in 2011 in areas of the Uplands. This data is not contained in this memorandum.

Attachments

I. Introduction: Purpose

Polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) are persistent chemicals in the environment. They tend to be very insoluble in water, adsorb strongly onto soils, sediments, and airborne particulates, are persistent in the environment, and bioaccumulate in biological tissues. These substances have been associated with a wide variety of toxic effects in animals. The association of PCDDs/PCDFs with the LCP Chemicals Site is due to the use of graphite electrodes in the former chlor-alkali plant.

The purpose of this memorandum is to consolidate the PCDD/PCDF analytical data available for the LCP Chemicals National Priorities List Site, Brunswick, GA. In addition, this memorandum will evaluate the adequacy of the available PCDD/PCDF data for the purposes of concluding the remedial investigation at the Site and remedy selection for the LCP Chemicals marsh.

Results of 45 sediment, three surface soil, six surface water and various biota tissue are presented below. The general conclusion from this consolidation of PCDD/PCDF data is that there exists a strong correlation between Aroclor-1268 and PCDD/PCDF concentrations.

II. Sources of Data

A. Ecological Assessment Ecological Risk Evaluation of the Salt Marsh and Adjacent Areas at the LCP Superfund Site, Brunswick, GA: 1997

The initial sediment PCDD/PCDF analytical data collection by the EPA took place in 1995, during the LCP Chemical marsh investigation conducted by the EPA's Environmental Response Team (ERT). Seven sediment samples from the creeks and Domain 1 were analyzed for PCDD/PCDF (Table 1 and Figure 1a). In addition to the seven sediment samples analyzed for PCDD/PCDF, two surface soil samples were collected from the Uplands, motivated by the need for contaminated soil for a treatability study conducted by ERT. Three of the seven 1995 sediment samples were collected in the former facility disposal area (FFDA) located in the marsh, adjacent to the Uplands. The remaining sediment samples were collected in either the LCP Ditch or the Eastern Creek. The following year, an additional 13 sediment samples were collected and analyzed for PCDD/PCDF, primarily in Purvis Creek and the Turtle River (Table 1 and Figure 1b). Two of the sediment samples collected in 1996 were from the Western Creek Complex and the LCP Ditch. Table 1 presents the WHO (2005) toxicity equivalence concentration (TEC[1]) totals for each of the 1995 and 1996 PCDD/PCDF analyses, as well as the Aroclor-1268 results. Attachment 1 contains the results of the WHO (2005) TEC calculations for all the 1995 and 1996 dioxin data presented in the April 1997 Ecological Assessment Ecological Risk Evaluation (ERE) of the Salt Marsh and Adjacent Areas at the LCP Superfund Site, Brunswick, GA. Note that the 13 acres of the FFDA and over 2,650 linear feet of the channel sediment were removed in the late 1990s.

Prior to the late 1990s removal, the sediment TEC totals ranged from 2.7 to 12,761 nanograms/kilogram (ng/kg) or parts per trillion (ppt) (Table 1). The post-removal sediment TEC range is between 6.6 and 2,768 ng/kg. It is anticipated that under Alternative 6, the

[1] TEQ is an analogous acronym found in the literature

sediment sampling stations with TEC totals ranging between 2.7 and 22.5 ng kg will remain in-place.

A review of the dioxin TEC data in Attachment 1indicates that many of the individual congeners at many stations were not detected. The TEC calculation assumed that each congener was present at one-half its detection limit. This results in substantial overestimation of dioxin TEC sediment concentrations compared to the actual measured (detected) results. In addition, the majority of detected concentrations are furans rather than dioxins.

B. Brunswick Community Study Sediment Data - 1995

During November and December 1995, 14 river sediment samples were sampled and analyzed for PCDDs PCDFs and Aroclor-1268, among other parameters (Figure 2). The river sediment sampling stations covered areas of the Turtle River, St. Simons Sound and tidal tributaries along the eastern boarder of the Brunswick Peninsula. Most of the Brunswick Community Study (BCS) sediment samples were collected outside the boundaries of Operable Unit 1 (the LCP Chemicals marsh). Attachment 2 contains the Toxic Equivalency Factor (TEF) calculation spreadsheets for the 14 BCS river sediment samples.

Table 2 shows that the TEC totals ranged from 11.4 to 20.4 ng kg. It is also apparent in Attachment 2 that the detection limits in the Brunswick Community Study were elevated, relative to those reported in the 1997 ERE. The detection limits in the BCS were generally ten times higher than those achieved in the 1997 ERE. As a consequence, even with the re-calculation of all the 1995 dioxin TECs using the WHO TEF of 2005, the total TECs calculated from the BCS reflect artifact of using one half the detection limit for the dioxin congeners not detected.

C. Kannan, et al (1998): 1996 Data

In early 1996, investigators from Michigan State University sampled and analyzed soil and sediment composites from three locations at the LCP Chemicals Site. The three samples were collected from: a) excavated soil from the Uplands-located brine impoundments, b) marsh sediment (removed during the late 1990s removal), and c) creek sediment from the LCP Ditch, which was partially removed also in the late1990s. The findings were published in Toxicological and Environmental Chemistry (Kannan, et al. 1998). Table 3 presents the Aroclor-1268 and PCDD PCDF results published by Kannan. Figure 3 shows the locations of the Kannan's 1996 soil and sediment samples collected by Kannan and others. Attachment 3 contains the TEF calculation spreadsheets for the three Kannan samples.

Kannan's results raged from 1.271 ng kg TEC in the removed former Brine Impoundments to 56 ng kg in the LCP Ditch, which is proposed for removal (Table 3).

D. ATSDR Turtle River Dioxin Health Consultation Fish Data - October 1997

The October 1997 Turtle River Agency for Toxic Substances and Disease Registry (ATSDR) Health Consultation presented dioxin fish data from 1989 through 1994. The fish data presented in the report were acquired by Georgia-Pacific staff from two Turtle River stations, one immediately above the confluence of Purvis Creek with the Turtle River and the second near the confluence of the East River with the Turtle River. Fish tissue dioxin data for the Chattahoochee and Oconee Rivers, and the Sapelo Sound are also presented in the report for the sake of comparison. The Health Consultation concluded that fish dioxin concentrations were higher in the Turtle River than in comparison areas; however, the dioxin levels found were well below the Food and Drug Administration tolerance levels for dioxin in fish. Attachment 4 contains the ATSDR Turtle River Dioxin Contamination Health Consultation.

E. U.S. Fish and Wildlife 1998 Fish Dioxin Data

In May and June1998, the U.S. Fish and Wildlife Service collected killifish (*Fundus heteroclitus*) tissue from mid-way along the LCP Ditch. Along with other parameters, the whole body tissue was analyzed for dioxins furans. Attachment 5 contains documentation of the 1998 U.S. fish and Wildlife killifish sampling, as well as the TEF calculation spreadsheets for the two whole fish tissue killifish samples collected in 1998.

Note that almost all dioxin furan congeners were found to be below detection limits. Consequently, because the calculated TECs assume each congener is present at one-half the detection limit, the results are an overestimation of actual tissue levels. In addition, the concentrations of dioxin furan in the whole fish tissue samples were taken from killifish collected from the LCP Ditch during the marsh removal which also represent worst case conditions. The TEC mammal concentration in samples KF0513MD and KF071MD are 6.5 and 7.1 ng kg, respectively, also assuming one half the detection limit for the non-detected dioxin furan congeners. The TEC fish concentration in samples KF0513MD and KF071MD are is 8.1 and 8.2 ng kg. The one half detection limit concentration predicts no NOAEL-level or LOAEL-level risk to the river otter. Overall, the concentrations of dioxin furans measured in the fish collected from the Site are low and do not appear to present unacceptable risk to the environment.

F. Honeywell Years 2000 and 2011 Sediment and Surface Water Data:

Five sediment and six surface water samples were collected and analyzed in 2000, during the development of the baseline ecological risk assessment. Two of the year 2000 sediment and surface water samples were collected at background stations, located in Troup Creek (TC) and the Crescent River (CR). During the summer of 2011, four sediment samples were collected along the length of the former Altamaha Canal, south of the Site.

Tables 4a and 4b present the WHO (2005) TEC totals for each of the 2000 and 2011 dioxin furan analyses conducted by Honeywell, as well as the Aroclor-1268 results. Figure 4 shows the locations of the year 2000 and 2011 Honeywell sampling stations. Attachment 6 contains the TEF calculation spreadsheets for the nine sediment and six surface water samples collected during the 2000 and 2011investigations.

Table 4a shows that PCDDs PCDFs were more elevated in both Eastern Creek samples. Whereas the samples collected in the LCP Chemicals marsh contained an overwhelming proportion of PCDFs, those collected south of the Site, in the former Altamaha Canal, contained an even proportion of PCDDs and PCDFs. Both reference stations did not have detectable Aroclor-1268 but did contain low concentrations of PCDDs PCDFs. Surface water PCDD PCDF concentrations at the LCP Chemicals marsh were not very different from those found at the two reference stations (Troup Creek and Crescent River).

III. Relationship Between Dioxin/Furans and Chlor-Alkali Sites

A. Relationship at Time of Generation

Until the late 1970s, chlorine gas produced by electrolysis of brine consisted of the use of mercury cells containing graphite electrodes. Elevated levels of PCDFs have been found in several samples of graphite electrode sludge from similar facilities in Europe. PCDFs predominate in these sludges, and the heavier, more chlorinated congeners account for a large fraction of the respective congener totals. During the 1980s, titanium metal anodes were developed to replace graphite electrodes.

Although the origin of PCDFs in graphite electrode sludge is uncertain, chlorination of the cyclic aromatic hydrocarbons (such as dibenzofuran) present in the coal tar used as a binding agent in the graphite electrodes has been proposed as the primary source. A review of the data in Attachments 1 and 2 indicate that PCDFs are more prevalent in the LCP chemicals marsh sediments than dioxins. At the LCP Chemical Site, use of the highly chlorinated Aroclor-1268 to extend the life of the graphite anodes may also have contributed to the creation of PCDFs in the graphite electrode sludge.

B. Dioxin TEC Gradients

As noted in the 1997 ERE, sediment dioxin TECs declined from an average of about 6,768 ng kg [range 2,640 to 12,761 ng kg] in the vicinity of the removed FFDA to 138 ng kg at dioxin station 111, located over half way down the LCP Ditch, at the confluence of the Eastern Creek with the LCP Ditch, to a TEC of 6.9 ng kg at dioxin sampling station 117, where the LCP Ditch enters Purvis Creek, (Figure 1). This represents a 1,000 fold reduction of TECs from the removed source area (the former facility disposal area) to Purvis Creek.

With exception of dioxin station 100, the Purvis Creek sediment dioxin TECs remain at single digit parts per trillion downstream of where the LCP Ditch enters Purvis Creek, until the confluence of Purvis Creek with the Turtle River. All the Turtle River sediment TECs remained in the single digit part per trillion range (Table 1).

IV. Co-location and Dioxin Distribution and Remedial Alternatives

The PCDD PCDF and Aroclor-1268 sediment data presented in Tables 1 through 3 show a strong relationship between Aroclor-1268 concentration and PCDD PCDF concentration. A similar relationship was found at the Onondaga Lake and Ninemile Creek Superfund sites in upstate New York.
At the Onondaga Lake Site, while PCDD PCDFs were determined to be both human health and ecological risk drivers as a result of fish consumption in Onondaga Lake, they were not found to

be widespread in lake sediments. The New York State Department of Environmental Conservation (NYSDEC) sediment screening criteria for protection of wildlife and humans from bioaccumulation were used as comparison values for PCDD/PCDFs. The areas where PCDD/PCDFs are elevated were found to be generally co-located with areas that exceed the lake cleanup criteria, so these areas are being addressed under the lake remedy.

There was a similar situation with the Ninemile Creek Site and a similar approach was used. PCDD/PCDFs were also among the risk drivers there but they exceeded the NYSDEC bioaccumulation screening criteria at only three of the 194 creek sample locations. These locations would be remediated based on concentrations of other detected contaminants (*e.g.*, mercury). Therefore, Site preliminary remediation goals in sediments were not developed.

V. Estimation of Dioxin Protective Levels in Sediment for the LCP Chemicals Site

A. Human Health Risk

The Human Health Risk Assessment (HHRA) for the LCP Chemicals marsh, assumed a six days per year reasonable maximum exposure intake frequency for direct human contact to the sediment. Using this site-specific exposure frequency, the dioxin-TEC protective for the human child is calculated as follows:

$$50 \text{ ng/kg} \times \frac{350 \text{ d/y}}{6 \text{ d/y}} = 2{,}900 \text{ ng/kg (for dioxin TEC in sediment)}$$

Based on the dioxin TECs in Tables 1-4, all areas above this concentration of 2,900 ng/kg will be removed, thereby suggesting no risk to the children from direct contact to sediment.

For fish consumption, using the EPA Office of Water Fish Advisory Guidance (with an ingestion rate higher than OU1 HHRA injection rate for all receptors), the calculated screening level is 3 ng/kg (for dioxin TEC in fish fillets). The fish filet data associated with the 1997 Turtle River Health Consultation Report (Attachment 4) led ATSDR to the conclusion that the TEC levels were not of significant concern.

These sediment and fish fillet values are both based on a non-carcinogenic hazard quotient of one (HQ = 1) for the sensitive young child receptor, using the EPA IRIS Reference Dose. They are also within the carcinogenic risk range using the provisional slope factor from CalEPA. Kannan et al. (1999) analyzed organ and muscle tissue from clapper rail, mottled duck, boat-tailed grackle, red-winged blackbird, stripped mullet, yellow tail, sea trout, Atlantic croaker and blue crab for TCDD/TCDF. All were found to be uniformly below the detection limits of 10 ng/kg.

B. Ecological Risk

Attachment 7 contains the method used to estimate the sediment dioxin TEC protective levels based on assumptions and calculations associated primarily with the 2,3,7,8-TCDD congener. This method resulted in an estimated sediment concentration of 260 ng kg TEC as a preliminary remediation goal (PRG) for the omnivorous mammal, such as the river otter. Similarly, the calculated sediment PRG for fish is 32 ng kg TEC (protective of 95 % of species). The PRG for PCDD PCDF in fish tissue is 0.909 ng g lipid. These PRGs are considered very conservative because they are based largely on 2,3,7,8-TCDD data from literature, whereas bioaccumulation and toxicity data are generally not available for the other congeners. In addition, it is likely that the heavier chlorinated furans, that are more prevalent in the LCP Chemicals marsh than dioxins, partition from sediment to a lesser degree than 2,3,7,8-TCDD and thus would be less bioavailable as well as less toxic. Furthermore, application of these sediment PRGs must take into account the numerous congeners that are not detected but conservatively assumed to be present at one half their detection limit.

VI. Comparison of Protective Levels to In-Place Remaining Sediment Concentrations

Tables 1 through 4 identify those PCDD PCDF sampling stations which either have already been removed or will be removed. The range of sediment concentration to remaining in-place after the proposed remedy is between 2.7 and 53.6 ng kg dioxin TEC. The maximum concentration is well below the dioxin-TEC concentration protective of the child, below the protective level for protection of the omnivorous mammal and below the protective level for protection of 90% of fish species. The maximum concentration is moderately above the highly conservative PRG protective of 95% of fish species.

Due to the uncertainty related to limited sediment samples analyzed for dioxin furans, it is recognized that additional PCDD PCDF sampling will be required to confirm the dioxin furans conceptual Site model, i.e. that Aroclor 1268 and dioxin furans are co-located and that remediating the former will reduce dioxin furans concentrations to acceptable levels. The additional sampling of the areas not proposed for either removal or covering should take place during the remedial design.

VII. References

Kannan, K., Maruya, K.A., Tanabe, S. Environ. Sci. and Technol. 1997, 31, 1483-1488.
Kannan, K., Watanabe, I., Giesy, J., Toxicol. and Environ. Chem., 1998, 67, 135-146.
Kannan, K., Kawano, M., Kashima, Y. Matsui, M., Giesy, J. Environ. Sci. and Technol. 1999, 33, 1004-1008.
Sprenger M. Finley N. Huston M. 1997. Ecological assessment - ecological risk evaluation of the salt marsh and adjacent areas at the LCP Superfund Site, Brunswick, Georgia. Final report. Vol. 1 and 2. April, 1997. EPA, Edison, NJ.

TABLES

TABLE 1: EPA/ERT 1995 and 1996 DIOXIN TEC and AROCLOR-1268 SEDIMENT AND SURFACE SOIL DATA

Location	Year	Lat, Degrees	Lat, minutes	Long,degree	Long, minutes	TEC Dioxin Total, ng/kg	Aroclor-1268, ug/kg	Aroclor-1268, mg/kg	Description
17/18	1995	31	11.21921N	81	30.72342W	213.7	56000	56	LCP ditch- to be removed
36	1995	31	11.21900N	81	30.68083W	393.2	55000	55	LCP Ditch- to be removed
61	1995	31	11.07234N	81	30.80849W	2768.3	1300000	1300	Eastern Cr. - to be removed
68	1995	31	11.19943N	81	30.78956W	762.4	330000	330	Eastern Cr. - to be removed
E3	1995	31	11.16236N	81	30.71258W	4905.4	3800000	3800	FFDA - already removed
Grid Marsh	1995		11.15579N		30.74037W	119.4	6100	6.1	FFDA - already removed
H1	1995	31	11.11987N	81	30.68218W	12760.7	4000000	4000	FFDA - already removed
Cell Bldg.	1995					244.6	53000	53	Uplands soil
Process S.	1995					764.1	450000	450	Uplands soil
100	1996	31	11.27086N	81	30.98613W	22.5	1100	1.1	Purvis Cr. - likely not remediated
101	1996	31	11.27086N	81	30.98633W	6.6	85	0.085	Purvis Cr. - will not be remediated
102	1996	31	11.27087N	81	30.98652W	7.4	130	0.13	Purvis Cr. - will not be remediated
105	1996	31	11.27087N	81	30.98709W	8.7	990	0.99	Turtle River
106	1996	31	11.27087N	81	30.98729W	5.1	160	0.16	Turtle River
107	1996	31	11.27087N	81	30.98748W	4.3	580	0.58	Turtle River
108	1996	31	11.06902N	81	31.39046W	3.1	600	0.6	Turtle River
110	1996	31	10.96355N	81	31.24823W	2.7	250	0.25	Purvis Cr. - will not be remediated
111	1996	31	11.14556N	81	30.80434W	137.6	6100	6.1	LCP Ditch - to be removed
117	1996	31	11.26151N	81	30.96241W	6.9	11000	11	Purvis Cr. - will not be remediated
118	1996	31	11.25511N	81	30.93770W	9.4	10000	10	WCC -will not be remediated
F2 (surf.)	1996	31	11.14990N	81	30.69494W	2639.8	1100000	1100	FFDA - already removed
F2 (subsurf.	1996	31	11.14990N	81	30.69494W	1326.1	88000	88	FFDA - already removed

Conversion used WHO TEF (2005) factor

FFLF: Former facility landfill

WCC: Western creek complex

Note: Coordinates taken from Sprenger Report Figure 6.

Shaded cells denote removed.

Red denotes TEC concentations greater than the 260 ng 2,3,7,8-TCDD/ kg sed PRG for protection of the omnivoroud mammal

Green denotes TEC concentations greater than the 32 ng 2,3,7,8-TCDD/kg sed PRG for protection of 95% of fish species

TABLE 2: BRUNSWICK COMMUNITY STUDY TEC DIOXIN and AROCLOR-1268 SEDIMENT DATA: DECEMBER 1995

Location	Year	Lat, Degrees	Lat, minutes	Lat, seconds	Long,degree	Long, minutes	Long, seconds	TEQ Dioxin Total, ng/kg	Aroclor-1268, ug/kg
BR000	1995							11.4	N/A
BR003	1995	31	13	10.6932N	81	33	45.0108W	15.1	10JN
BR008	1995	31	10	34.05N	81	31	46.7508W	13.4	590
BR010	1995	31	9	47.2572N	81	31	33.87W	15.1	90U
BR022	1995	31	15	29.4373N	81	24	8.2764W	15.2	94U
BR028	1995	31	11	22.9632N	81	32	9.6828W	15.1	500U
BR030	1995	31	10	14.6388N	81	27	3.696W	15.4	110J
BR032	1995	31	9	3.582N	81	30	32.958W	19.7	610
BR041	1995	31	3	41.4792N	81	25	38.19W	11.2	120J
BR048	1995	31	11	52.8252N	81	31	24.5964W	20.4	1400
BR052	1995	31	8	47.2164N	81	25	53.5008W	14.7	200U
BR055	1995	31	8	11.022N	81	32	21.03W	15.1	500U
BR074	1995	31	8	43.1376N	81	31	31.8756W	15.6	86U
BR080	1995	31	5	40.7796N	81	27	12.7764W	14.9	48J

Conversion used WHO TEF (2005) factor

N/A: Not analyzed

U:Not detected

stimated value

N: Presumptive evidence.

TABLE 3: KANNAN 1996 DIOXIN TEC AND AROCLOR-1268 SEDIMENT AND SOIL DATA

Sample ID	Year	TEC Dioxin, Total, ng/kg	Aroclor-1268, mg/kg
ES	1996	1,271.30	567
MS	1996	614.2	481/276
CS	1996	56	9.6

Note: MS Aroclor-1268 results are for the MSL and MSR transects. Only one PCDD/PCDF MS result was reported in the subsequent 1998 Kannan PCDD/PCDF paper.

TABLE 4a: HONEYWELL 2000 AND 2011 DIOXIN TEC AND AROCLOR-1268 SEDIMENT DATA

Location	Year	Lat, Degrees	Lat, minutes	Lat, sec	Long,degree	Long, minutes	Long, sec	Dioxin Total, ng/kg	Aroclor-1268, ug/kg	Description
C-6	2000	31	11	2.96N	81	30	47.626W	1877.8	7580	Eastern Cr. - will be removed
C-8	2000	31	11	8.873N	81	30	50.146W	123.3	2200	Eastern Cr. - will be removed
C-15	2000	31	11	9.681N	81	31	0.569W	53.6	99	mouth of WCC - will not be remediated
TC-C	2000	31	13	40.072N	81	26	42.38W	6.9	0.089U	Troup Cr. reference sta.
CR-C	2000	31	30	26.989N	81	21	43.581W	13.1	0.045U	Crescent River- reference sta.
AL-J1-83	2011	31	10	24.766N	81	30	35.827W	125.5	41	Altamaha canal south of Site
AL-D1-12	2011	31	10	43.212N	81	30	43.01W	61.9	22	Altamaha canal south of Site
AL-M1-1	2011	31	10	19.005N	81	30	31.437W	68.0	43	Altamaha canal south of Site
AL-S1-32	2011	31	10	12.289N	81	30	24.978W	20.3	34	Altamaha canal south of Site

Conversion used WHO TEF (2005) factor

BERA Event 2000

Altamaha Canal Event 2011

C-6: 1268: average of 7 analyses (range 110U-20,000)

Red denotes TEC concentrations greater than the 260 ng 2,3,7,8-TCDD/ kg sed PRG for protection of the omnivorous mammal

Green denotes TEC concentrations greater than the 32 ng 2,3,7,8-TCDD/kg sed PRG for protection of 95% of fish species

U: Below detection limit

TABLE 4b: HONEYWELL 2000 AND 2011 DIOXIN TEC AND AROCLOR-1268 SURFACE WATER DATA

Location	Year	Lat, Degrees	Lat, minutes	Lat, sec	Long,degree	Long, minutes	Long, sec	Dioxin Total, pg/L	Aroclor-1268, ug/L	Description
C-6	2000	31	11	2.96N	81	30	47.626W	1.69	1U	Eastern Cr.
C-8	2000	31	11	8.873N	81	30	50.146W	3.72	1U	Eastern Cr.
C-15	2000	31	11	9.681N	81	31	0.569W	2.74	1U	mouth of WCC
C-15 (duplicate)	2000	31	11	9.681N	81	31	0.569W	4.64	NA	mouth of WCC
TC-C	2000	31	13	40.072N	81	26	42.38W	1.91	1U	Troup Cr. reference sta.
CR-C	2000	31	30	26.989N	81	21	43.581W	2.85	0.33J	Crescent River- reference sta.

Conversion used WHO TEF (2005) factor

NA: not anlayzed

pg/L: picogram per liter

U: Below detection limit

FIGURES

Figure 1a: Locations of 1995 and 1996 Sediment Location Analyzed for PCDDs/PCFDs and Aroclor 1268

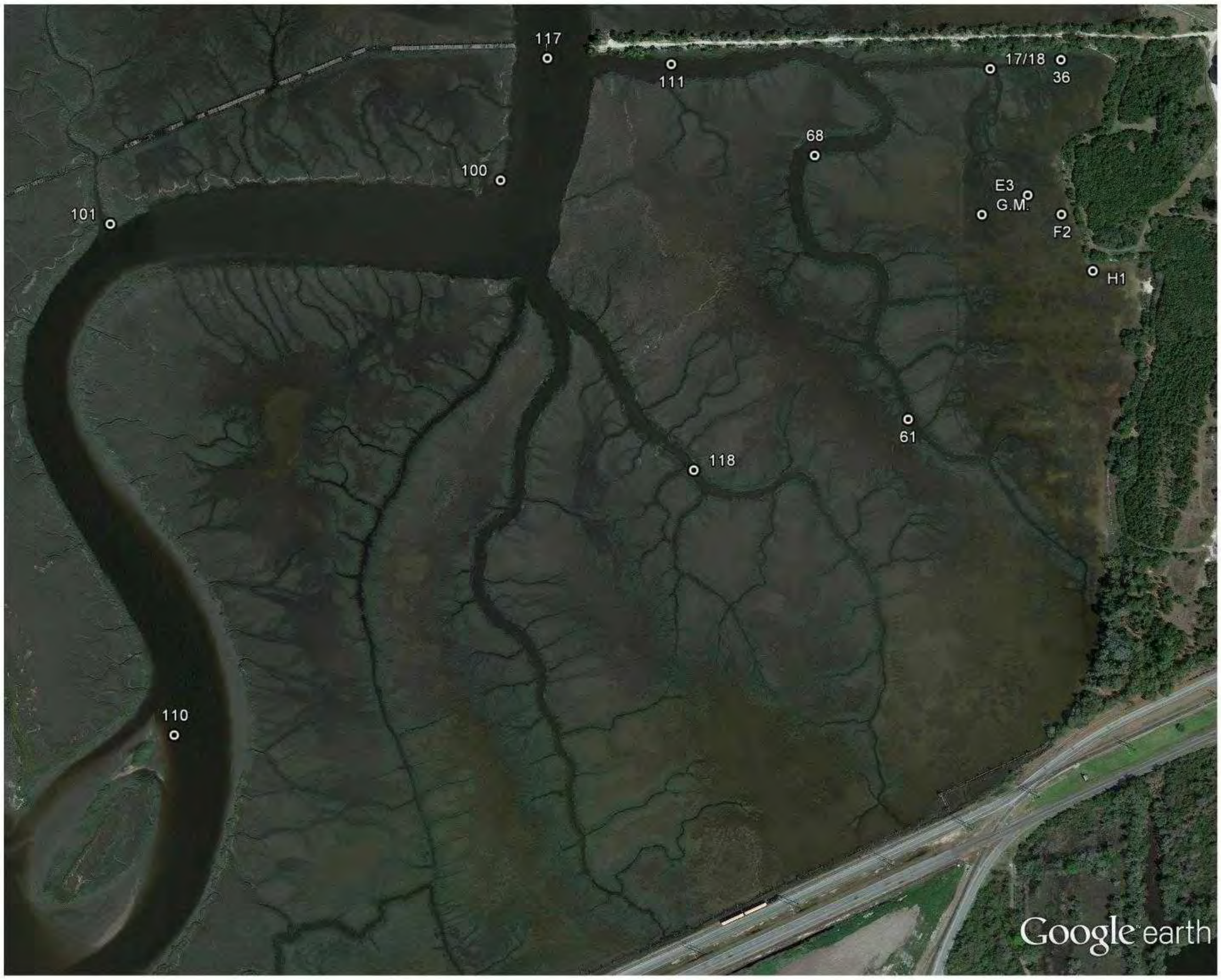

Figure1b: Locations of OU1 1995 and 1996 Sediment Location Analyzed for PCDDs/PCFDs and Aroclor 1268

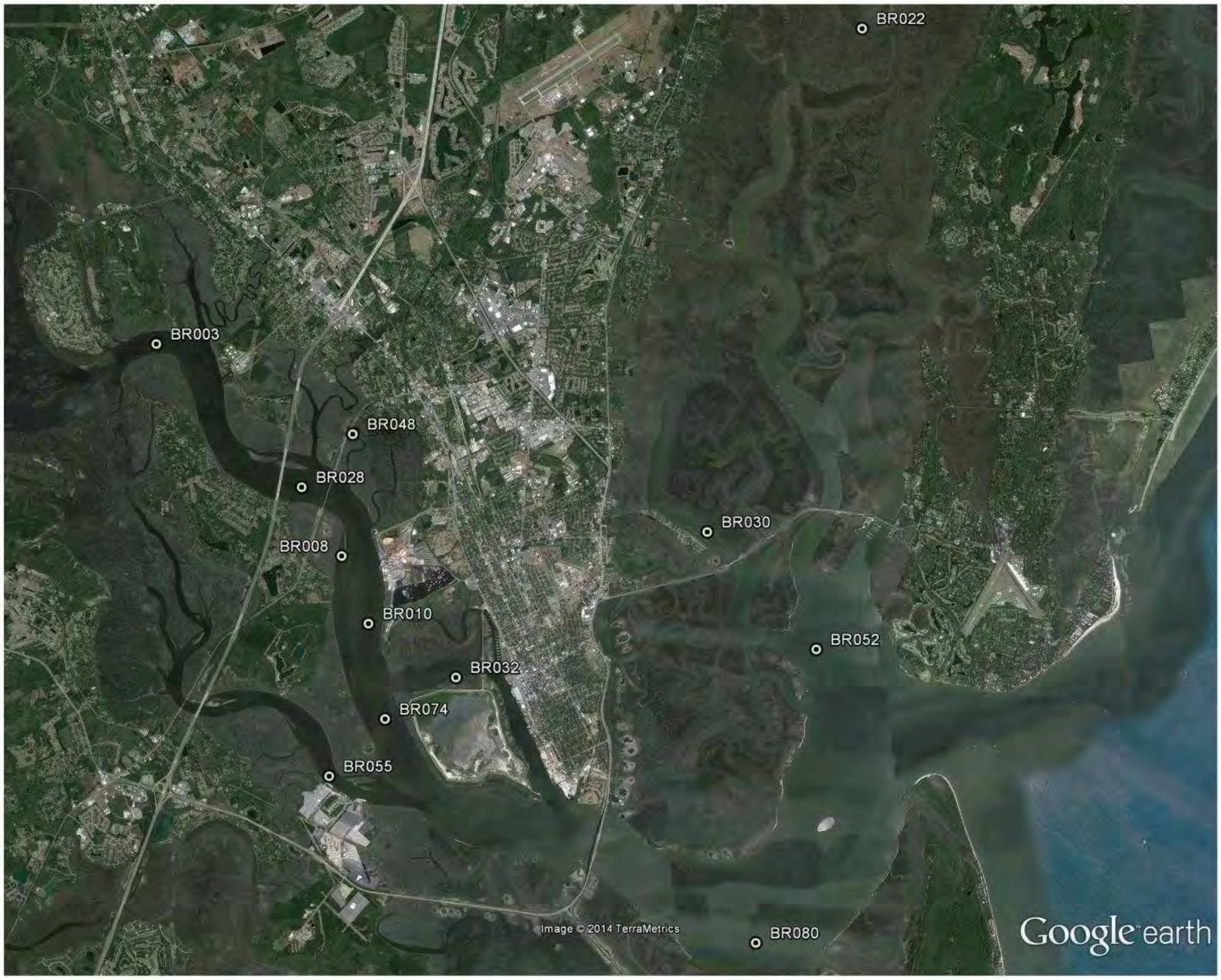

Figure 2: Locations of 1995 River Stations Analyzed for TCDD/TCDF and Aroclor 1268 During Brunswick Community Study

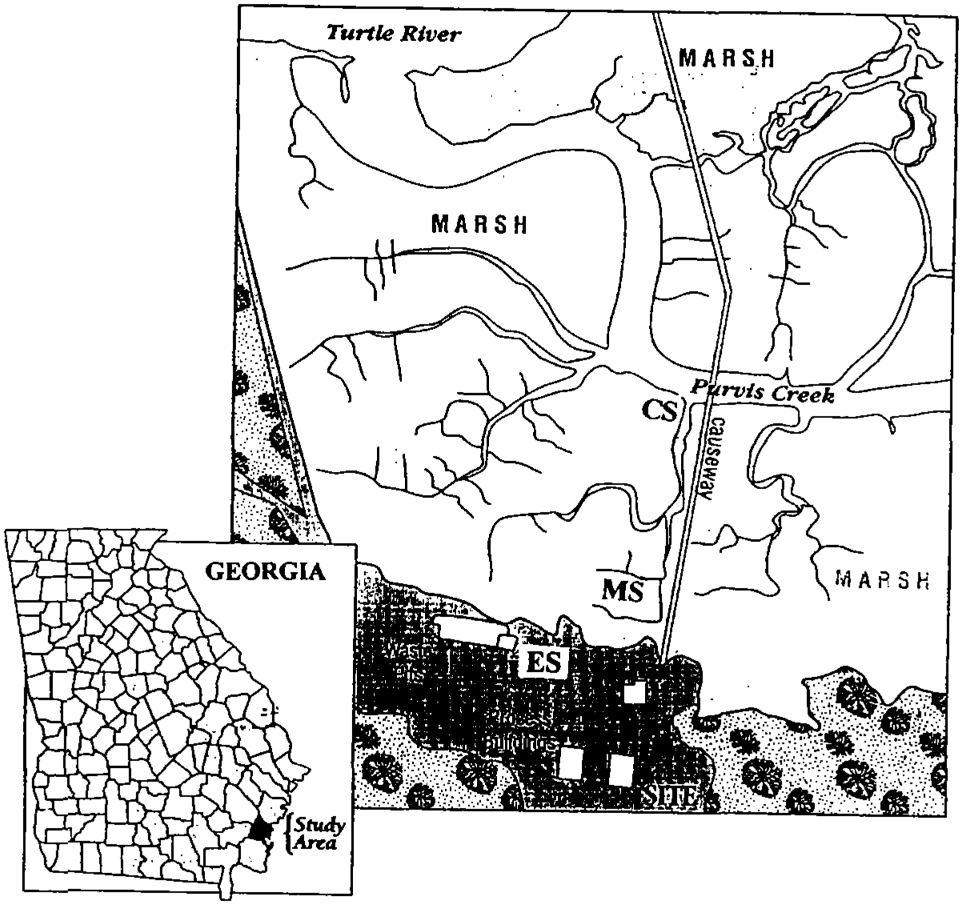

FIGURE I Map of the LCP Chemicals Superfund Site in Glynn County near the city of Brunswick, Georgia, showing soil and sediment sampling locations. (ES — Excavation soil, MS — Marsh sediment, CS — Creek sediment).

Figure 3: Kannan and others Sediment Sampling Locations

Figure 4: Locations Honeywell Year 2000 and 2011 Sediment and surface Water Samples Analyzed for TCDDDD/TCDF and Aroclor 1268

ATTACHMENT 1

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 17-18

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	7.83		1	7.83
1,2,3,7,8-PeCDD	4.93		1	4.93
1,2,3,4,7,8-HxCDD	41.4		0.1	4.14
1,2,3,6,7,8-HxCDD	13.4		0.1	1.34
1,2,3,7,8,9-HxCDD	30		0.1	3
1,2,3,4,6,7,8-HpCDD	796		0.01	7.96
OCDD	5770		0.0003	1.731
2,3,7,8-TCDF	250		0.1	25
1,2,3,7,8-PeCDF	293		0.03	8.79
2,3,4,7,8-PeCDF	106		0.3	31.8
1,2,3,4,7,8-HxCDF	700		0.1	70
1,2,3,6,7,8-HxCDF	192		0.1	19.2
1,2,3,7,8,9-HxCDF	15.9		0.1	1.59
2,3,4,6,7,8-HxCDF	120		0.1	12
1,2,3,4,6,7,8-HpCDF	1210		0.01	12.1
1,2,3,4,7,8,9-HpCDF	187		0.01	1.87
OCDF	1560		0.0003	0.468
Total (ng/kg)				**213.7**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 36

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	15.9		1	15.9
1,2,3,7,8-PeCDD	4.88		1	4.88
1,2,3,4,7,8-HxCDD	12.8		0.1	1.28
1,2,3,6,7,8-HxCDD	92.7		0.1	9.27
1,2,3,7,8,9-HxCDD	49.8		0.1	4.98
1,2,3,4,6,7,8-HpCDD	1130		0.01	11.3
OCDD	6850		0.0003	2.055
2,3,7,8-TCDF	359		0.1	35.9
1,2,3,7,8-PeCDF	676		0.03	20.28
2,3,4,7,8-PeCDF	209		0.3	62.7
1,2,3,4,7,8-HxCDF	1370		0.1	137
1,2,3,6,7,8-HxCDF	413		0.1	41.3
1,2,3,7,8,9-HxCDF	33		0.1	3.3
2,3,4,6,7,8-HxCDF	185		0.1	18.5
1,2,3,4,6,7,8-HpCDF	2000		0.01	20
1,2,3,4,7,8,9-HpCDF	372		0.01	3.72
OCDF	2870		0.0003	0.861
Total (ng/kg)				**393.2**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 61

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	29.3		1	29.3
1,2,3,7,8-PeCDD	8.6		1	8.6
1,2,3,4,7,8-HxCDD	42.6		0.1	4.26
1,2,3,6,7,8-HxCDD	57.3		0.1	5.73
1,2,3,7,8,9-HxCDD	38.9		0.1	3.89
1,2,3,4,6,7,8-HpCDD	2140		0.01	21.4
OCDD	13100		0.0003	3.93
2,3,7,8-TCDF	2300		0.1	230
1,2,3,7,8-PeCDF	5050		0.03	151.5
2,3,4,7,8-PeCDF	1670		0.3	501
1,2,3,4,7,8-HxCDF	11900		0.1	1190
1,2,3,6,7,8-HxCDF	2770		0.1	277
1,2,3,7,8,9-HxCDF	270		0.1	27
2,3,4,6,7,8-HxCDF	600		0.1	60
1,2,3,4,6,7,8-HpCDF	21000		0.01	210
1,2,3,4,7,8,9-HpCDF	3800		0.01	38
OCDF	22200		0.0003	6.66
Total (ng/kg)				**2768.3**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 68

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	20.6		1	20.6
1,2,3,7,8-PeCDD	7.74		1	7.74
1,2,3,4,7,8-HxCDD	24.3		0.1	2.43
1,2,3,6,7,8-HxCDD	48.7		0.1	4.87
1,2,3,7,8,9-HxCDD	48.2		0.1	4.82
1,2,3,4,6,7,8-HpCDD	2140		0.01	21.4
OCDD	14800		0.0003	4.44
2,3,7,8-TCDF	682		0.1	68.2
1,2,3,7,8-PeCDF	1240		0.03	37.2
2,3,4,7,8-PeCDF	401		0.3	120.3
1,2,3,4,7,8-HxCDF	2640		0.1	264
1,2,3,6,7,8-HxCDF	734		0.1	73.4
1,2,3,7,8,9-HxCDF	387		0.1	38.7
2,3,4,6,7,8-HxCDF	384		0.1	38.4
1,2,3,4,6,7,8-HpCDF	4860		0.01	48.6
1,2,3,4,7,8,9-HpCDF	608		0.01	6.08
OCDF	3960		0.0003	1.188
Total (ng/kg)				**762.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. E-3

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	14.6		1	14.6
1,2,3,7,8-PeCDD	12.81		1	12.81
1,2,3,4,7,8-HxCDD	48.8		0.1	4.88
1,2,3,6,7,8-HxCDD	52.5		0.1	5.25
1,2,3,7,8,9-HxCDD	50.6		0.1	5.06
1,2,3,4,6,7,8-HpCDD	2410		0.01	24.1
OCDD	14000		0.0003	4.2
2,3,7,8-TCDF	3510		0.1	351
1,2,3,7,8-PeCDF	7280		0.03	218.4
2,3,4,7,8-PeCDF	2590		0.3	777
1,2,3,4,7,8-HxCDF	20800		0.1	2080
1,2,3,6,7,8-HxCDF	5640		0.1	564
1,2,3,7,8,9-HxCDF	349		0.1	34.9
2,3,4,6,7,8-HxCDF	3020		0.1	302
1,2,3,4,6,7,8-HpCDF	43500		0.01	435
1,2,3,4,7,8,9-HpCDF	6050		0.01	60.5
OCDF	39110		0.0003	11.733
Total (ng/kg)				**4905.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Grid Marsh

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	7.4		1	7.4
1,2,3,7,8-PeCDD	1.6	U	1	0.8
1,2,3,4,7,8-HxCDD	4		0.1	0.4
1,2,3,6,7,8-HxCDD	8.9		0.1	0.89
1,2,3,7,8,9-HxCDD	8.2		0.1	0.82
1,2,3,4,6,7,8-HpCDD	170		0.01	1.7
OCDD	1600		0.0003	0.48
2,3,7,8-TCDF	220		0.1	22
1,2,3,7,8-PeCDF	170		0.03	5.1
2,3,4,7,8-PeCDF	120		0.3	36
1,2,3,4,7,8-HxCDF	240		0.1	24
1,2,3,6,7,8-HxCDF	61		0.1	6.1
1,2,3,7,8,9-HxCDF	52		0.1	5.2
2,3,4,6,7,8-HxCDF	53		0.1	5.3
1,2,3,4,6,7,8-HpCDF	260		0.01	2.6
1,2,3,4,7,8,9-HpCDF	50		0.01	0.5
OCDF	390		0.0003	0.117
Total (ng/kg)				**119.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. H-1

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	7.32		1	7.32
1,2,3,7,8-PeCDD	15.4		1	15.4
1,2,3,4,7,8-HxCDD	61.1		0.1	6.11
1,2,3,6,7,8-HxCDD	91.6		0.1	9.16
1,2,3,7,8,9-HxCDD	54.4		0.1	5.44
1,2,3,4,6,7,8-HpCDD	3480		0.01	34.8
OCDD	22000		0.0003	6.6
2,3,7,8-TCDF	9660		0.1	966
1,2,3,7,8-PeCDF	28100		0.03	843
2,3,4,7,8-PeCDF	8100		0.3	2430
1,2,3,4,7,8-HxCDF	49300		0.1	4930
1,2,3,6,7,8-HxCDF	15700		0.1	1570
1,2,3,7,8,9-HxCDF	561		0.1	56.1
2,3,4,6,7,8-HxCDF	7790		0.1	779
1,2,3,4,6,7,8-HpCDF	92200		0.01	922
1,2,3,4,7,8,9-HpCDF	15700		0.01	157
OCDF	75900		0.0003	22.77
Total (ng/kg)				12760.7

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Cell Bldg

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2.2		1	2.2
1,2,3,7,8-PeCDD	0.8	U	1	0.4
1,2,3,4,7,8-HxCDD	5		0.1	0.5
1,2,3,6,7,8-HxCDD	5.2		0.1	0.52
1,2,3,7,8,9-HxCDD	1.8		0.1	0.18
1,2,3,4,6,7,8-HpCDD	56		0.01	0.56
OCDD	380		0.0003	0.114
2,3,7,8-TCDF	99		0.1	9.9
1,2,3,7,8-PeCDF	190		0.03	5.7
2,3,4,7,8-PeCDF	110		0.3	33
1,2,3,4,7,8-HxCDF	1200		0.1	120
1,2,3,6,7,8-HxCDF	280		0.1	28
1,2,3,7,8,9-HxCDF	120		0.1	12
2,3,4,6,7,8-HxCDF	99		0.1	9.9
1,2,3,4,6,7,8-HpCDF	1700		0.01	17
1,2,3,4,7,8,9-HpCDF	340		0.01	3.4
OCDF	4100		0.0003	1.23
Total (ng/kg)				**244.6**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Process South

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.5		1	1.5
1,2,3,7,8-PeCDD	2.8	U	1	1.4
1,2,3,4,7,8-HxCDD	13		0.1	1.3
1,2,3,6,7,8-HxCDD	6.8		0.1	0.68
1,2,3,7,8,9-HxCDD	5		0.1	0.5
1,2,3,4,6,7,8-HpCDD	110		0.01	1.1
OCDD	370		0.0003	0.111
2,3,7,8-TCDF	53		0.1	5.3
1,2,3,7,8-PeCDF	130		0.03	3.9
2,3,4,7,8-PeCDF	340		0.3	102
1,2,3,4,7,8-HxCDF	3400		0.1	340
1,2,3,6,7,8-HxCDF	440		0.1	44
1,2,3,7,8,9-HxCDF	1300		0.1	130
2,3,4,6,7,8-HxCDF	71		0.1	7.1
1,2,3,4,6,7,8-HpCDF	12000		0.01	120
1,2,3,4,7,8,9-HpCDF	340		0.01	3.4
OCDF	5900		0.0003	1.77
Total (ng/kg)				**764.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. 100

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.75	U	1	0.375
1,2,3,7,8-PeCDD	1.1	U	1	0.55
1,2,3,4,7,8-HxCDD	2.4	U	0.1	0.12
1,2,3,6,7,8-HxCDD	1.5	U	0.1	0.075
1,2,3,7,8,9-HxCDD	1.8	U	0.1	0.09
1,2,3,4,6,7,8-HpCDD	170		0.01	1.7
OCDD	1700		0.0003	0.51
2,3,7,8-TCDF	6.5		0.1	0.65
1,2,3,7,8-PeCDF	24		0.03	0.72
2,3,4,7,8-PeCDF	6.8		0.3	2.04
1,2,3,4,7,8-HxCDF	110		0.1	11
1,2,3,6,7,8-HxCDF	17		0.1	1.7
1,2,3,7,8,9-HxCDF	7.3	U	0.1	0.365
2,3,4,6,7,8-HxCDF	9.3		0.1	0.93
1,2,3,4,6,7,8-HpCDF	140		0.01	1.4
1,2,3,4,7,8,9-HpCDF	24		0.01	0.24
OCDF	200		0.0003	0.06
Total (ng/kg)				22.5

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreac
for Sample No. 101

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.548	U	1	0.774
1,2,3,7,8-PeCDD	1.947	U	1	0.9735
1,2,3,4,7,8-HxCDD	4.565	U	0.1	0.22825
1,2,3,6,7,8-HxCDD	2.86	U	0.1	0.143
1,2,3,7,8,9-HxCDD	3.319	U	0.1	0.16595
1,2,3,4,6,7,8-HpCDD	125.164		0.01	1.25164
OCDD	1386.664		0.0003	0.4159992
2,3,7,8-TCDF	1.719	U	0.1	0.08595
1,2,3,7,8-PeCDF	1.382	U	0.03	0.02073
2,3,4,7,8-PeCDF	1.388	U	0.3	0.2082
1,2,3,4,7,8-HxCDF	11.803		0.1	1.1803
1,2,3,6,7,8-HxCDF	3.936	U	0.1	0.1968
1,2,3,7,8,9-HxCDF	6.064	U	0.1	0.3032
2,3,4,6,7,8-HxCDF	5.915	U	0.1	0.29575
1,2,3,4,6,7,8-HpCDF	29.673		0.01	0.29673
1,2,3,4,7,8,9-HpCDF	2.954	U	0.01	0.01477
OCDF	38.506		0.0003	0.0115518
Total (ng/kg)				**6.6**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 102

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.428	U	1	0.214
1,2,3,7,8-PeCDD	0.994	U	1	0.497
1,2,3,4,7,8-HxCDD	1.654	U	0.1	0.0827
1,2,3,6,7,8-HxCDD	5.668		0.1	0.5668
1,2,3,7,8,9-HxCDD	9.924		0.1	0.9924
1,2,3,4,6,7,8-HpCDD	175.898		0.01	1.75898
OCDD	1795.379		0.0003	0.5386137
2,3,7,8-TCDF	2.816		0.1	0.2816
1,2,3,7,8-PeCDF	0.829	U	0.03	0.012435
2,3,4,7,8-PeCDF	0.845	U	0.3	0.12675
1,2,3,4,7,8-HxCDF	12.058		0.1	1.2058
1,2,3,6,7,8-HxCDF	2.257	U	0.1	0.11285
1,2,3,7,8,9-HxCDF	3.956	U	0.1	0.1978
2,3,4,6,7,8-HxCDF	3.89		0.1	0.389
1,2,3,4,6,7,8-HpCDF	36.542		0.01	0.36542
1,2,3,4,7,8,9-HpCDF	6.907		0.01	0.06907
OCDF	28.627		0.0003	0.0085881
Total (ng/kg)				**7.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 105

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2		1	2
1,2,3,7,8-PeCDD	1.2	U	1	0.6
1,2,3,4,7,8-HxCDD	1.2	U	0.1	0.06
1,2,3,6,7,8-HxCDD	7.5		0.1	0.75
1,2,3,7,8,9-HxCDD	8.2		0.1	0.82
1,2,3,4,6,7,8-HpCDD	170		0.01	1.7
OCDD	1700		0.0003	0.51
2,3,7,8-TCDF	3.9		0.1	0.39
1,2,3,7,8-PeCDF	1	U	0.03	0.015
2,3,4,7,8-PeCDF	1.1	U	0.3	0.165
1,2,3,4,7,8-HxCDF	9.7		0.1	0.97
1,2,3,6,7,8-HxCDF	1.7		0.1	0.17
1,2,3,7,8,9-HxCDF	1.2	U	0.1	0.06
2,3,4,6,7,8-HxCDF	1	U	0.1	0.1
1,2,3,4,6,7,8-HpCDF	34		0.01	0.34
1,2,3,4,7,8,9-HpCDF	0.61	U	0.01	0.00305
OCDF	20		0.0003	0.006
Total (ng/kg)				**8.7**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 106

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.26	U	1	0.13
1,2,3,7,8-PeCDD	0.88	U	1	0.44
1,2,3,4,7,8-HxCDD	0.98	U	0.1	0.049
1,2,3,6,7,8-HxCDD	4		0.1	0.4
1,2,3,7,8,9-HxCDD	8.7		0.1	0.87
1,2,3,4,6,7,8-HpCDD	150		0.01	1.5
OCDD	1700		0.0003	0.51
2,3,7,8-TCDF	1.9		0.1	0.19
1,2,3,7,8-PeCDF	0.4	U	0.03	0.006
2,3,4,7,8-PeCDF	0.4	U	0.3	0.06
1,2,3,4,7,8-HxCDF	5.7		0.1	0.57
1,2,3,6,7,8-HxCDF	0.65	U	0.1	0.0325
1,2,3,7,8,9-HxCDF	1.1	U	0.1	0.055
2,3,4,6,7,8-HxCDF	1	U	0.1	0.05
1,2,3,4,6,7,8-HpCDF	21		0.01	0.21
1,2,3,4,7,8,9-HpCDF	0.69	U	0.01	0.00345
OCDF	18		0.0003	0.0054
Total (ng/kg)				**5.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 107

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.5	U	1	0.75
1,2,3,7,8-PeCDD	3.8	U	1	1.9
1,2,3,4,7,8-HxCDD	3	U	0.1	0.15
1,2,3,6,7,8-HxCDD	1.8	U	0.1	0.09
1,2,3,7,8,9-HxCDD	2.2	U	0.1	0.11
1,2,3,4,6,7,8-HpCDD	44		0.01	0.44
OCDD	450		0.0003	0.135
2,3,7,8-TCDF	1.1	U	0.1	0.055
1,2,3,7,8-PeCDF	2.5	U	0.03	0.0375
2,3,4,7,8-PeCDF	2.5	U	0.3	0.375
1,2,3,4,7,8-HxCDF	1.3	U	0.1	0.065
1,2,3,6,7,8-HxCDF	0.8	U	0.1	0.04
1,2,3,7,8,9-HxCDF	1.4	U	0.1	0.07
2,3,4,6,7,8-HxCDF	1.2	U	0.1	0.06
1,2,3,4,6,7,8-HpCDF	1.1	U	0.01	0.0055
1,2,3,6,7,8,9-HpCDF	1.6	U	0.01	0.008
OCDF	1.8	U	0.0003	0.00027
Total (ng/kg)				4.3

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 108

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.35	U	1	0.175
1,2,3,7,8-PeCDD	0.86	U	1	0.43
1,2,3,4,7,8-HxCDD	2.7		0.1	0.27
1,2,3,6,7,8-HxCDD	2.5		0.1	0.25
1,2,3,7,8,9-HxCDD	6.8		0.1	0.68
1,2,3,4,6,7,8-HpCDD	76		0.01	0.76
OCDD	710		0.0003	0.213
2,3,7,8-TCDF	0.27	U	0.1	0.0135
1,2,3,7,8-PeCDF	0.49	U	0.03	0.00735
2,3,4,7,8-PeCDF	0.5	U	0.3	0.075
1,2,3,4,7,8-HxCDF	1.3		0.1	0.13
1,2,3,6,7,8-HxCDF	0.36	U	0.1	0.018
1,2,3,7,8,9-HxCDF	0.63	U	0.1	0.0315
2,3,4,6,7,8-HxCDF	0.56	U	0.1	0.028
1,2,3,4,6,7,8-HpCDF	3.5		0.01	0.035
1,2,3,4,7,8,9-HpCDF	1.1	U	0.01	0.0055
OCDF	3		0.0003	0.0009
Total (ng/kg)				**3.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. 110

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.33	U	1	0.165
1,2,3,7,8-PeCDD	0.88	U	1	0.44
1,2,3,4,7,8-HxCDD	0.91	U	0.1	0.0455
1,2,3,6,7,8-HxCDD	0.54	U	0.1	0.027
1,2,3,7,8,9-HxCDD	0.66	U	0.1	0.033
1,2,3,4,6,7,8-HpCDD	55		0.01	0.55
OCDD	690		0.0003	0.207
2,3,7,8-TCDF	0.74	U	0.1	0.037
1,2,3,7,8-PeCDF	0.7	U	0.03	0.0105
2,3,4,7,8-PeCDF	0.71	U	0.3	0.1065
1,2,3,4,7,8-HxCDF	8		0.1	0.8
1,2,3,6,7,8-HxCDF	0.4	U	0.1	0.02
1,2,3,7,8,9-HxCDF	0.71	U	0.1	0.0355
2,3,4,6,7,8-HxCDF	0.62	U	0.1	0.031
1,2,3,4,6,7,8-HpCDF	21		0.01	0.21
1,2,3,~~6~~,7,8,9-HpCDF	0.57	U	0.01	0.00285
OCDF	11		0.0003	0.0033
Total (ng/kg)				**2.7**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreads
for Sample No. 111

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2.897	U	1	1.4485
1,2,3,7,8-PeCDD	7.137	U	1	3.5685
1,2,3,4,7,8-HxCDD	23.488	U	0.1	1.1744
1,2,3,6,7,8-HxCDD	14.716	U	0.1	0.7358
1,2,3,7,8,9-HxCDD	17.074	U	0.1	0.8537
1,2,3,4,6,7,8-HpCDD	356.583		0.01	3.56583
OCDD	3285.556		0.0003	0.9856668
2,3,7,8-TCDF	153.512		0.1	15.3512
1,2,3,7,8-PeCDF	170.109		0.03	5.10327
2,3,4,7,8-PeCDF	53.22		0.3	15.966
1,2,3,4,7,8-HxCDF	479.172		0.1	47.9172
1,2,3,6,7,8-HxCDF	139.025		0.1	13.9025
1,2,3,7,8,9-HxCDF	11.07	U	0.1	0.5535
2,3,4,6,7,8-HxCDF	141.403		0.1	14.1403
1,2,3,4,6,7,8-HpCDF	1101.075		0.01	11.01075
1,2,3,~~8~~4,7,8,9-HpCDF	96.82		0.01	0.9682
OCDF	1062.26		0.0003	0.318678
Total (ng/kg)				**137.6**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreac
for Sample No. 117

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.561	U	1	0.7805
1,2,3,7,8-PeCDD	2.943	U	1	1.4715
1,2,3,4,7,8-HxCDD	5.264	U	0.1	0.2632
1,2,3,6,7,8-HxCDD	3.298	U	0.1	0.1649
1,2,3,7,8,9-HxCDD	3.826	U	0.1	0.1913
1,2,3,4,6,7,8-HpCDD	137.753		0.01	1.37753
OCDD	1481.322		0.0003	0.4443966
2,3,7,8-TCDF	1.691	U	0.1	0.08455
1,2,3,7,8-PeCDF	1.504	U	0.03	0.02256
2,3,4,7,8-PeCDF	1.51	U	0.3	0.2265
1,2,3,4,7,8-HxCDF	12.086		0.1	1.2086
1,2,3,6,7,8-HxCDF	1.98	U	0.1	0.099
1,2,3,7,8,9-HxCDF	3.051	U	0.1	0.15255
2,3,4,6,7,8-HxCDF	2.976	U	0.1	0.1488
1,2,3,4,6,7,8-HpCDF	26.13		0.01	0.2613
1,2,3,4,7,8,9-HpCDF	5.426	U	0.01	0.02713
OCDF	34.864		0.0003	0.0104592
Total (ng/kg)				**6.9**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spread
for Sample No. 118

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2.934	U	1	1.467
1,2,3,7,8-PeCDD	4.524	U	1	2.262
1,2,3,4,7,8-HxCDD	5.67	U	0.1	0.2835
1,2,3,6,7,8-HxCDD	3.552	U	0.1	0.1776
1,2,3,7,8,9-HxCDD	4.121	U	0.1	0.20605
1,2,3,4,6,7,8-HpCDD	184.22		0.01	1.8422
OCDD	1803.19		0.0003	0.540957
2,3,7,8-TCDF	3.683	U	0.1	0.18415
1,2,3,7,8-PeCDF	1.68	U	0.03	0.0252
2,3,4,7,8-PeCDF	1.687	U	0.3	0.25305
1,2,3,4,7,8-HxCDF	8.734		0.1	0.8734
1,2,3,6,7,8-HxCDF	4.306	U	0.1	0.2153
1,2,3,7,8,9-HxCDF	6.634	U	0.1	0.3317
2,3,4,6,7,8-HxCDF	6.47	U	0.1	0.3235
1,2,3,4,6,7,8-HpCDF	38.739		0.01	0.38739
1,2,3,~~6~~4,7,8,9-HpCDF	5.102	U	0.01	0.02551
OCDF	46.445		0.0003	0.0139335
Total (ng/kg)				**9.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. F2-Surface

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.2	U	1	0.6
1,2,3,7,8-PeCDD	13	U	1	6.5
1,2,3,4,7,8-HxCDD	48	U	0.1	2.4
1,2,3,6,7,8-HxCDD	410		0.1	41
1,2,3,7,8,9-HxCDD	140		0.1	14
1,2,3,4,6,7,8-HpCDD	1700		0.01	17
OCDD	15000		0.0003	4.5
2,3,7,8-TCDF	700		0.1	70
1,2,3,7,8-PeCDF	3600		0.03	108
2,3,4,7,8-PeCDF	1100		0.3	330
1,2,3,4,7,8-HxCDF	15000		0.1	1500
1,2,3,6,7,8-HxCDF	1800		0.1	180
1,2,3,7,8,9-HxCDF	120		0.1	12
2,3,4,6,7,8-HxCDF	1400		0.1	140
1,2,3,4,6,7,8-HpCDF	19000		0.01	190
1,2,3,6,7,8,9-HpCDF	1900		0.01	19
OCDF	16000		0.0003	4.8
Total (ng/kg)				**2639.8**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. F2- Subsurface

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.63	U	1	0.315
1,2,3,7,8-PeCDD	18	U	1	9
1,2,3,4,7,8-HxCDD	50	U	0.1	2.5
1,2,3,6,7,8-HxCDD	93		0.1	9.3
1,2,3,7,8,9-HxCDD	52		0.1	5.2
1,2,3,4,6,7,8-HpCDD	720		0.01	7.2
OCDD	4700		0.0003	1.41
2,3,7,8-TCDF	600		0.1	60
1,2,3,7,8-PeCDF	1800		0.03	54
2,3,4,7,8-PeCDF	740		0.3	222
1,2,3,4,7,8-HxCDF	6900		0.1	690
1,2,3,6,7,8-HxCDF	1100		0.1	110
1,2,3,7,8,9-HxCDF	84		0.1	8.4
2,3,4,6,7,8-HxCDF	670		0.1	67
1,2,3,4,6,7,8-HpCDF	6700		0.01	67
1,2,3,6,7,8,9-HpCDF	1100		0.01	11
OCDF	5800		0.0003	1.74
Total (ng/kg)				**1326.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

ATTTACHMENT 2

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR00

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	1.3	J	1	1.3
1,2,3,4,7,8-HxCDD	1.6	J	0.1	0.16
1,2,3,6,7,8-HxCDD	4.1	J	0.1	0.41
1,2,3,7,8,9-HxCDD	7.2	J	0.1	0.72
1,2,3,4,6,7,8-HpCDD	120		0.01	1.2
OCDD	1000		0.0003	0.3
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	8.5	J	0.01	0.085
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	15	J	0.0003	0.0045
Total (ng/kg)				**11.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spread
for Sample No. BR003

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDD	20	U	0.01	0.1
OCDD	130	U	0.0003	0.0195
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	2.7	J	0.01	0.027
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	4.8	J	0.0003	0.00144
Total (ng/kg)				**15.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreac
for Sample No. BR008

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	4.000	J	1	4
1,2,3,7,8-PeCDD	1.5	J	1	1.5
1,2,3,4,7,8-HxCDD	2.2	J	0.1	0.22
1,2,3,6,7,8-HxCDD	5.1	J	0.1	0.51
1,2,3,7,8,9-HxCDD	7	J	0.1	0.7
1,2,3,4,6,7,8-HpCDD	160		0.01	1.6
OCDD	1500		0.0003	0.45
2,3,7,8-TCDF	20	U	0.1	1
1,2,3,7,8-PeCDF	5.2	J	0.03	0.156
2,3,4,7,8-PeCDF	2.9	J	0.3	0.87
1,2,3,4,7,8-HxCDF	20	U	0.1	1
1,2,3,6,7,8-HxCDF	3.2	U	0.1	0.16
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	3.5	J	0.1	0.35
1,2,3,4,6,7,8-HpCDF	25		0.01	0.25
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	38		0.0003	0.0114
Total (ng/kg)				**13.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR010

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDD	12	U	0.01	0.06
OCDD	60	U	0.0003	0.009
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	1.7	J	0.01	0.017
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	3.7	J	0.0003	0.00111
Total (ng/kg)				**15.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR022

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDD	20	U	0.01	0.1
OCDD	260	U	0.0003	0.039
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	12	U	0.01	0.06
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	25	U	0.0003	0.00375
Total (ng/kg)				**15.2**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spread
for Sample No. BR028

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDD	12	U	0.01	0.06
OCDD	80	U	0.0003	0.012
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	2	J	0.01	0.02
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	25	U	0.0003	0.00375
Total (ng/kg)				**15.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR030

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.100	J	1	1.1
1,2,3,7,8-PeCDD	3.3	J	1	3.3
1,2,3,4,7,8-HxCDD	5.2	J	0.1	0.52
1,2,3,6,7,8-HxCDD	9.2	J	0.1	0.92
1,2,3,7,8,9-HxCDD	19		0.1	1.9
1,2,3,4,6,7,8-HpCDD	250		0.01	2.5
OCDD	2600		0.0003	0.78
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	1.8	J	0.1	0.18
1,2,3,4,6,7,8-HpCDF	12		0.01	0.12
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	13	J	0.0003	0.0039
Total (ng/kg)				**15.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR032

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	3.800	J	1	3.8
1,2,3,7,8-PeCDD	2.9	J	1	2.9
1,2,3,4,7,8-HxCDD	5.1	J	0.1	0.51
1,2,3,6,7,8-HxCDD	11	J	0.1	1.1
1,2,3,7,8,9-HxCDD	20		0.1	2
1,2,3,4,6,7,8-HpCDD	310		0.01	3.1
OCDD	2700		0.0003	0.81
2,3,7,8-TCDF	20	U	0.1	1
1,2,3,7,8-PeCDF	5.1	J	0.03	0.153
2,3,4,7,8-PeCDF	4	J	0.3	1.2
1,2,3,4,7,8-HxCDF	20	U	0.1	1
1,2,3,6,7,8-HxCDF	3.9	J	0.1	0.39
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	6.7	J	0.1	0.67
1,2,3,4,6,7,8-HpCDF	43		0.01	0.43
1,2,3,4,7,8,9-HpCDF	3	J	0.01	0.03
OCDF	60		0.0003	0.018
Total (ng/kg)				**19.7**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR041

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.100	J	1	1.1
1,2,3,7,8-PeCDD	2.4	J	1	2.4
1,2,3,4,7,8-HxCDD	4.1	J	0.1	0.41
1,2,3,6,7,8-HxCDD	7.7	J	0.1	0.77
1,2,3,7,8,9-HxCDD	15		0.1	1.5
1,2,3,4,6,7,8-HpCDD	190		0.01	1.9
OCDD	1700		0.0003	0.51
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	1.3	J	0.3	0.39
1,2,3,4,7,8-HxCDF	4.4	J	0.1	0.44
1,2,3,6,7,8-HxCDF	2.4	J	0.1	0.24
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	3	J	0.1	0.3
1,2,3,4,6,7,8-HpCDF	15		0.01	0.15
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	16	J	0.0003	0.0048
Total (ng/kg)				**11.2**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR048

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	4.000	J	1	4
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	3.1	J	0.1	0.31
1,2,3,6,7,8-HxCDD	8.1	J	0.1	0.81
1,2,3,7,8,9-HxCDD	11		0.1	1.1
1,2,3,4,6,7,8-HpCDD	190		0.01	1.9
OCDD	1500	J	0.0003	0.45
2,3,7,8-TCDF	20	U	0.1	1
1,2,3,7,8-PeCDF	6.2	J	0.03	0.186
2,3,4,7,8-PeCDF	4.6	J	0.3	1.38
1,2,3,4,7,8-HxCDF	20	U	0.1	1
1,2,3,6,7,8-HxCDF	4.6	J	0.1	0.46
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	7.4	J	0.1	0.74
1,2,3,4,6,7,8-HpCDF	37		0.01	0.37
1,2,3,4,7,8,9-HpCDF	3.4	J	0.01	0.034
OCDF	58		0.0003	0.0174
Total (ng/kg)				**20.4**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR052

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	1.8	J	0.1	0.18
1,2,3,7,8,9-HxCDD	3.6	J	0.1	0.36
1,2,3,4,6,7,8-HpCDD	40	U	0.01	0.2
OCDD	380		0.0003	0.114
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	1.6	J	0.01	0.016
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	25	U	0.0003	0.00375
Total (ng/kg)				**14.7**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR055

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDD	20	U	0.01	0.1
OCDD	160	U	0.0003	0.024
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	2.2	J	0.01	0.022
1,2,3,4,7,8,9-HpCDF	2.2	J	0.01	0.022
OCDF	25	U	0.0003	0.00375
Total (ng/kg)				**15.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR074

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	3.200	J	1	3.2
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	12	U	0.1	0.6
1,2,3,6,7,8-HxCDD	12	U	0.1	0.6
1,2,3,7,8,9-HxCDD	2.4	J	0.1	0.24
1,2,3,4,6,7,8-HpCDD	30	U	0.01	0.15
OCDD	260	U	0.0003	0.039
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	12	U	0.1	0.6
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	12	U	0.01	0.06
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	25	U	0.0003	0.00375
Total (ng/kg)				**15.6**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Sprea
for Sample No. BR080

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.000	U	1	2.5
1,2,3,7,8-PeCDD	12	U	1	6
1,2,3,4,7,8-HxCDD	1.4	J	0.1	0.14
1,2,3,6,7,8-HxCDD	3.1	J	0.1	0.31
1,2,3,7,8,9-HxCDD	6.6	J	0.1	0.66
1,2,3,4,6,7,8-HpCDD	76		0.01	0.76
OCDD	750		0.0003	0.225
2,3,7,8-TCDF	5	U	0.1	0.25
1,2,3,7,8-PeCDF	12	U	0.03	0.18
2,3,4,7,8-PeCDF	12	U	0.3	1.8
1,2,3,4,7,8-HxCDF	2	J	0.1	0.2
1,2,3,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,7,8,9-HxCDF	12	U	0.1	0.6
2,3,4,6,7,8-HxCDF	12	U	0.1	0.6
1,2,3,4,6,7,8-HpCDF	5.9	J	0.01	0.059
1,2,3,4,7,8,9-HpCDF	12	U	0.01	0.06
OCDF	7.8	J	0.0003	0.00234
Total (ng/kg)				**14.9**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

ATTACHMENT 3

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. Kannan Excavation Soil

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	10.000	U	1	5
1,2,3,7,8-PeCDD	10	U	1	5
1,2,3,4,7,8-HxCDD	9		0.1	0.9
1,2,3,6,7,8-HxCDD	50		0.1	5
1,2,3,7,8,9-HxCDD	25		0.1	2.5
1,2,3,4,6,7,8-HpCDD	1290		0.01	12.9
OCDD	8350		0.0003	2.505
2,3,7,8-TCDF	510		0.1	51
1,2,3,7,8-PeCDF	280		0.03	8.4
2,3,4,7,8-PeCDF	210		0.3	63
1,2,3,4,7,8-HxCDF	7580		0.1	758
1,2,3,6,7,8-HxCDF	1360		0.1	136
1,2,3,7,8,9-HxCDF	10	U	0.1	0.5
2,3,4,6,7,8-HxCDF	520		0.1	52
1,2,3,4,6,7,8-HpCDF	13410		0.01	134.1
1,2,3,4,7,8,9-HpCDF	2360		0.01	23.6
OCDF	36280		0.0003	10.884
Total (ng/kg)				**1271.3**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Kannan Marsh Sediment

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	10.000	U	1	5
1,2,3,7,8-PeCDD	10	U	1	5
1,2,3,4,7,8-HxCDD	15		0.1	1.5
1,2,3,6,7,8-HxCDD	55		0.1	5.5
1,2,3,7,8,9-HxCDD	60		0.1	6
1,2,3,4,6,7,8-HpCDD	1460		0.01	14.6
OCDD	13200		0.0003	3.96
2,3,7,8-TCDF	560		0.1	56
1,2,3,7,8-PeCDF	230		0.03	6.9
2,3,4,7,8-PeCDF	180		0.3	54
1,2,3,4,7,8-HxCDF	2700		0.1	270
1,2,3,6,7,8-HxCDF	720		0.1	72
1,2,3,7,8,9-HxCDF	10	U	0.1	0.5
2,3,4,6,7,8-HxCDF	600		0.1	60
1,2,3,4,6,7,8-HpCDF	4640		0.01	46.4
1,2,3,4,7,8,9-HpCDF	400		0.01	4
OCDF	9430		0.0003	2.829
Total (ng/kg)				**614.2**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Kannan Creek Sediment

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	10.000	U	1	5
1,2,3,7,8-PeCDD	10	U	1	5
1,2,3,4,7,8-HxCDD	10		0.1	1
1,2,3,6,7,8-HxCDD	22		0.1	2.2
1,2,3,7,8,9-HxCDD	10		0.1	1
1,2,3,4,6,7,8-HpCDD	380		0.01	3.8
OCDD	4310		0.0003	1.293
2,3,7,8-TCDF	75		0.1	7.5
1,2,3,7,8-PeCDF	16		0.03	0.48
2,3,4,7,8-PeCDF	23		0.3	6.9
1,2,3,4,7,8-HxCDF	132		0.1	13.2
1,2,3,6,7,8-HxCDF	37		0.1	3.7
1,2,3,7,8,9-HxCDF	10	U	0.1	0.5
2,3,4,6,7,8-HxCDF	24		0.1	2.4
1,2,3,4,6,7,8-HpCDF	170		0.01	1.7
1,2,3,4,7,8,9-HpCDF	15		0.01	0.15
OCDF	450		0.0003	0.135
Total (ng/kg)				**56.0**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

ATTACHMENT 4

Health Consultation

TURTLE RIVER DIOXIN CONTAMINATION
(a/k/a GEORGIA PACIFIC PAPER MILL)

BRUNSWICK, GLYNN COUNTY, GEORGIA

OCTOBER 31, 1997

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

TURTLE RIVER DIOXIN CONTAMINATION
(a/k/a GEORGIA PACIFIC PAPER MILL)

BRUNSWICK, GLYNN COUNTY, GEORGIA

Prepared by:

Superfund Site Assessment Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Purpose

The Glynn County Department of Health requested that Agency for Toxic Substances and Disease Registry (ATSDR) health assessors reevaluate the extent of the dioxin contamination in the Turtle River, Glynn County, Georgia. A private citizen first petitioned ATSDR to write a health consultation for the Turtle River Dioxin Contamination Site in May 1995. ATSDR staff prepared a health consultation for the site in 1996 [1]. Since that time, additional effluent data have become available.

Findings

The Turtle River Dioxin Contamination Site poses no apparent public health hazard if people adhere to the State of Georgia 1997 Fish Consumption Guidelines. Dioxins were found in various species of fish caught in the Turtle River near the Georgia-Pacific Brunswick, Georgia, Mill waste water outfalls. Dioxin levels in Turtle River fish are greater than levels in fish from other areas of Georgia. While some dioxins are present, dioxins do not pose a health threat to people who consume Turtle River fish once a week. According to the State of Georgia 1997 Fish Consumption Guidelines, people should consume fish from the area near the Georgia-Pacific Plant no more than once a week.

Bleach plant effluent contained very low levels of dioxin. Effluent from the Georgia-Pacific Plant might have contributed to the elevated Turtle River dioxin levels in the past.

Several potential sources of dioxins exist in Glynn County.

Background

A condition of Georgia-Pacific's National Pollution Discharge Elimination System permit requires that the company collect Turtle River fish and analyze them for dioxins and furans. The State of Georgia Environmental Protection Division (EPD) requires that the plant test for 2 of the 75 dioxin congeners. Those two congeners are 2,3,7,8 tetra-chlorodibenzodioxin (TCDD) and 2,3,7,8 tetra-chlorodibenzofuran (TCDF).

The Georgia-Pacific Brunswick Plant was has been in operation since 1938. The plant is on the Turtle River (Figure 1). Georgia-Pacific has two outfalls along the Turtle River (Figure 2).

Georgia EPD has issued fish consumption advisories for the Turtle River. Unrestricted commercial and recreational fishing took place in the Turtle River until 1992, when fishing was banned because of high levels of mercury and polychlorinated biphenyls detected in fish tissue. The recommended fish consumption rate for the area near Georgia-Pacific (areas D, E, and G on Figure 3) is one 8-ounce meal a week.

Citizens are concerned because they believe Georgia-Pacific is releasing chlorine into the

Turtle River regularly, and because there was an accidental release of 8 to 9 pounds of chlorine [4]. Residents are concerned that chlorine released from the plant may contribute to the formation of dioxins and that dioxins may be bioaccumulating and bioconcentrating in Turtle River fish. A Georgia-Pacific Environmental Service spokesman stated that there have been spills in the past. Fuel, oil, petroleum compounds, and some partially treated waste water have been spilt [4].

Discussion

Fish

The dioxins of concern in the Turtle River are 2,3,7,8 tetra-chlorodibenzodioxin (TCDD) and 2,3,7,8 tetra-chlorodibenzofuran (TCDF). Dioxins are a group of 75 congeners, with TCDD being the most toxic of the dioxin compounds [2]. Dioxin congeners other than TCDD are measured in equivalents of TCDD.

Dioxins are by-products of pesticides such as pentachlorophenol which was formerly used to prevent wood damage; the defoliant Agent Orange; bleached pulp and paper production; burning of fossil fuel; and incineration [2, 3]. Widespread low-level dioxin contamination is a result of industrialization. Present levels of dioxins in the environment are higher than levels before industrialization [2].

Of all food sources, fish have the greatest potential to become contaminated with dioxins. Dioxins readily absorb to aquatic sediment and can bioaccumulate and bioconcentrate in the food chain. The food chain is the series of organisms that are consumed by each other, beginning with single-celled animals and increasing in size to multi-celled animals such as birds and then to man, the highest trophic or predator level. Bioaccumulation is the process by which toxic chemicals, etc., gradually accumulate in living tissue. Bioconcentration is the process by which tissue concentrations of a bioaccumulated chemical increase as the chemical passes through the food chain.

Georgia-Pacific staff have sampled and analyzed bottom-feeding and game fish since 1989. Six year's worth of fish data are available. During 1989, the Chattahoochee and Oconee rivers and the Sapelo Sound were used as reference stations. In subsequent years, Sapelo Sound was the only reference station. The same two Turtle River sampling stations were used from 1989 to 1994. Station 1 is approximately 1 mile upstream of the mill discharge between the Highway 303 bridge and the oil dock (Figure 2). Station 2 is approximately 1 mile downstream of the discharge at the East River confluence.

Fish dioxin levels were higher in the Turtle River than in the reference areas, but low levels of dioxins were detected in fish from the most pristine reference station, Sapelo Sound (Tables 1–6, Appendix B). In 1991, the highest dioxin levels were detected. The levels were 7.96 parts per trillion (ppt) at Station 1 and 9.16 ppt at Station 2. Fish dioxin levels have decreased since 1991 (Appendix B) [5, 6, 7, 8, 9]. All of the Turtle River fish dioxin levels were well below the Food and Drug Administration tolerance level for dioxins in fish, 25 ppt. The Agency for Toxic Substances and Disease Registry (ATSDR) does not have a health comparison value for dioxins in fish tissue. According to the 1997 Georgia Fish Consumption Guidelines, people should consume only one 8-ounce fish meal per week from Turtle river seafood sampling areas D, E, and G (Figure 3). ATSDR has determined that the State of Georgia fish consumption advisory is also protective for dioxin.

Dioxins in Effluent

As part of Georgia-Pacific's effort to assess the environmental status of its Brunswick Operation, the company had process sewer and effluents constituents tested for the presence of TCDD and TCDF for 3 days in 1994 [10]. Routinely, waste water from the plant is first held in an on-site lagoon and aerated before being discharged in the Turtle River. TCDF was detected at less than 0.01 ppt in Bleach Plant Three effluent. No dioxins were detected in Bleach Plant One or Bleach Plant Two effluent. According to a Georgia-Pacific Environmental Service spokesman, they have not detected dioxins or furans in the final treated waste water effluent since November 1991 [4].

As of 1991, it did not appear that the Georgia-Pacific plant was contributing greatly to the dioxins in the river. The only set of effluent data available is from the 1994 study. The plant might have contributed dioxins to the river via effluent water and spills in the past.

Brunswick is an industrial area. Other industries or hazardous waste-handling sites might have contributed to the dioxins in the Turtle River. There are two National Priorities List sites in Glynn County, and there several facilities where hazardous wastes are handled.

Health Effects

Dioxin-like compounds are distributed to organs according to fat content and tend to accumulated in people's fat tissue. Some congeners are metabolically degraded and excreted in feces. The half-life of 2,3,7,8 tetra-chlorodibenzodioxin (TCDD) in humans is very long, about a decade [3]. In the general population, the background level of TCDD in adipose tissue may be as high as 20 parts per trillion [3]. Dioxins are very toxic to some animal species, but the evidence for corresponding toxicity in humans has not been established [3]. There have been no reports of human deaths resulting from systemic dioxin toxicity. Only two health effects of dioxin exposure in people have been confirmed. They are chloracne and elevated liver enzymes.

Conclusions

Fish dioxin concentrations were higher in the Turtle River than in comparison areas. The Turtle River dioxin levels are well below the Food and Drug Administration tolerance level for dioxins in fish, and levels appear to be decreasing. The State of Georgia Environmental Protection Division has issued fish consumption guidelines that are protective of the public's health. In 1994, low levels of 2,3,7,8 tetra-chlorodibenzofuran were found in bleach plant process water. According to a Georgia-Pacific spokesman, final process water has been free of dioxins since 1991. Several potential sources of dioxin exist in Glynn County, Georgia.

Recommendations

People should adhere to the current Turtle River fish consumption guidelines.

References

1. Agency for Toxic Substances and Disease Registry. Health consultation for the Georgia-Pacific Site, Brunswick, Georgia. August 1996.

2. Schecter, Arnold. Dioxins and Health. 1994.

3. Agency for Toxic Substances and Disease Registry. Case study for dioxin toxicity. Atlanta: US Department of Health and Human Services, Public Health Service, 1990.

4. Glynn County Health Department. Environmental health education needs assessment project: dioxin contamination of the Turtle River, Brunswick, Georgia. Prepared for National Association of County and City Health Officials and Agency for Toxic Substances and Disease Registry. March 24 - September 15, 1996.

5. EA Engineering, Science, and Technology, Inc. Dioxin monitoring study of fish tissue from the Turtle River near Georgia-Pacific's Brunswick, Georgia Mill. March 1990.

6. EA Engineering, Science, and Technology, Inc. Dioxin monitoring study of fish tissue from the Turtle River near Georgia-Pacific's Brunswick, Georgia Mill. January 1991.

7. EA Engineering, Science, and Technology, Inc. Dioxin monitoring study of fish tissue from the Turtle River near Georgia-Pacific's Brunswick, Georgia Mill. January 1992.

8. EA Engineering, Science, and Technology, Inc. Dioxin monitoring study of fish tissue from the Turtle River near Georgia-Pacific's Brunswick, Georgia Mill. December 1993.

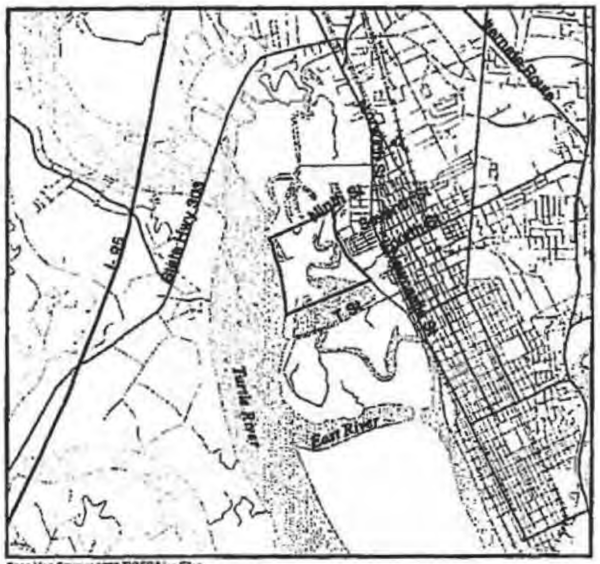
9. EA Engineering, Science, and Technology, Inc. Dioxin monitoring study of fish tissue from the Turtle River near Georgia-Pacific's Brunswick, Georgia Mill. January 1995.

10. Institute of Paper Science and Technology. A three-day study of process sewer and effluent constituents at the Georgia-Pacific Brunswick Facility. July 1994.

Georgia Pacific Corp.

Brunswick, GA

INTRO MAP

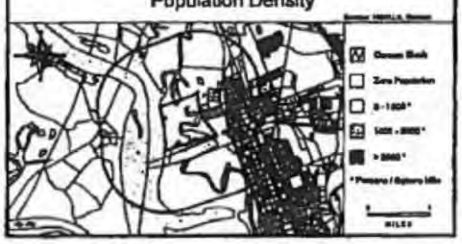


Base Map Source: 1992 TIGER/Line Files

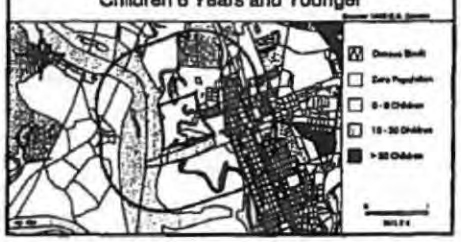
Demographic Statistics Within One Mile of Site*	
Total Population	4,846
White	2,139
Black	2,693
American Indian, Eskimo, Aleut	3
Asian or Pacific Islander	8
Other race	3
Hispanic origin	16
Children Aged 6 and Younger	499
Adults Aged 65 and Older	831
Females Aged 15 - 44	1,057
Total Housing Units	2,025

Demographic Statistics Source: 1990 U.S. Census
*Calculated using an area-proportion spatial analysis technique

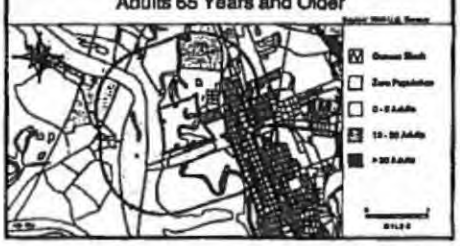
Population Density



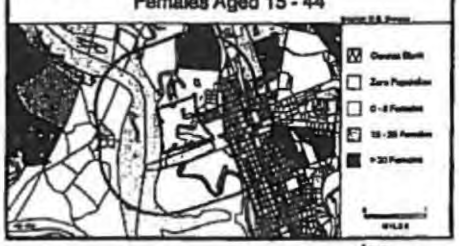
Children 6 Years and Younger



Adults 65 Years and Older



Females Aged 15 - 44



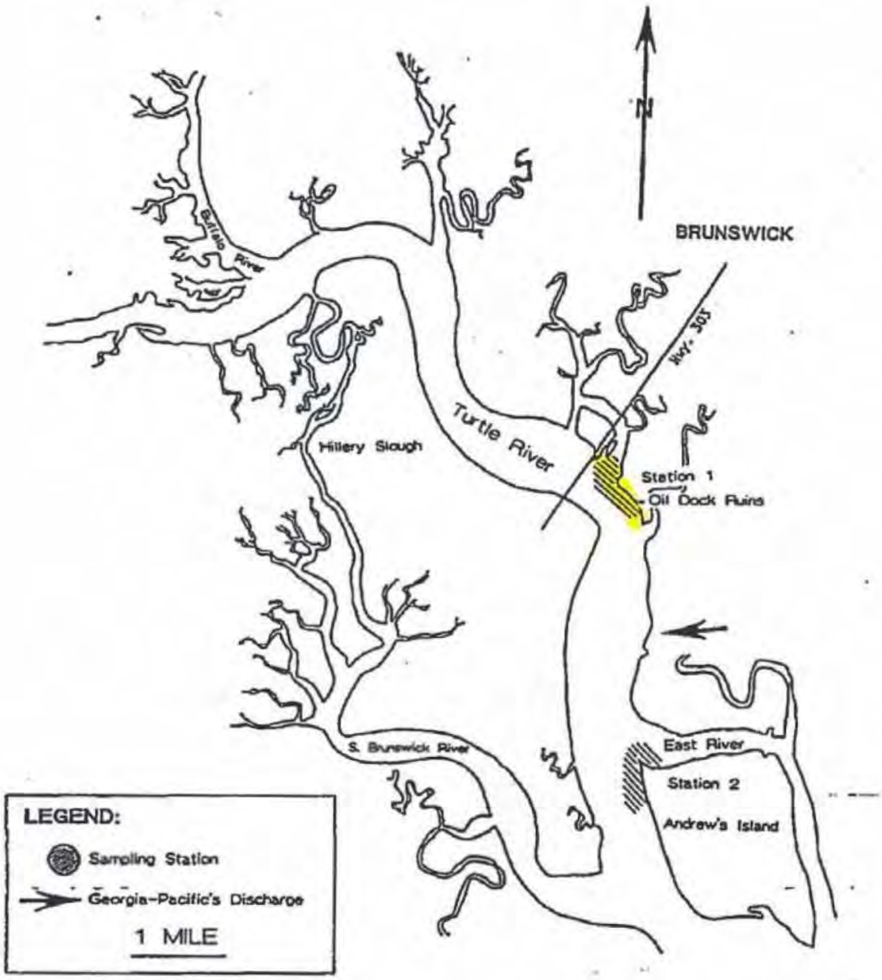

N
BRUNSWICK
Hwy. 303
Buffalo River
Turtle River
Hillery Slough
Station 1
Oil Dock Ruins
S. Brunswick River
East River
Station 2
Andrew's Island
LEGEND:
Sampling Station
Georgia-Pacific's Discharge
1 MILE

Figure 3. Seafood Sampling Areas

Brunswick, Georgia
Seafood Sampling Areas
Glynn County

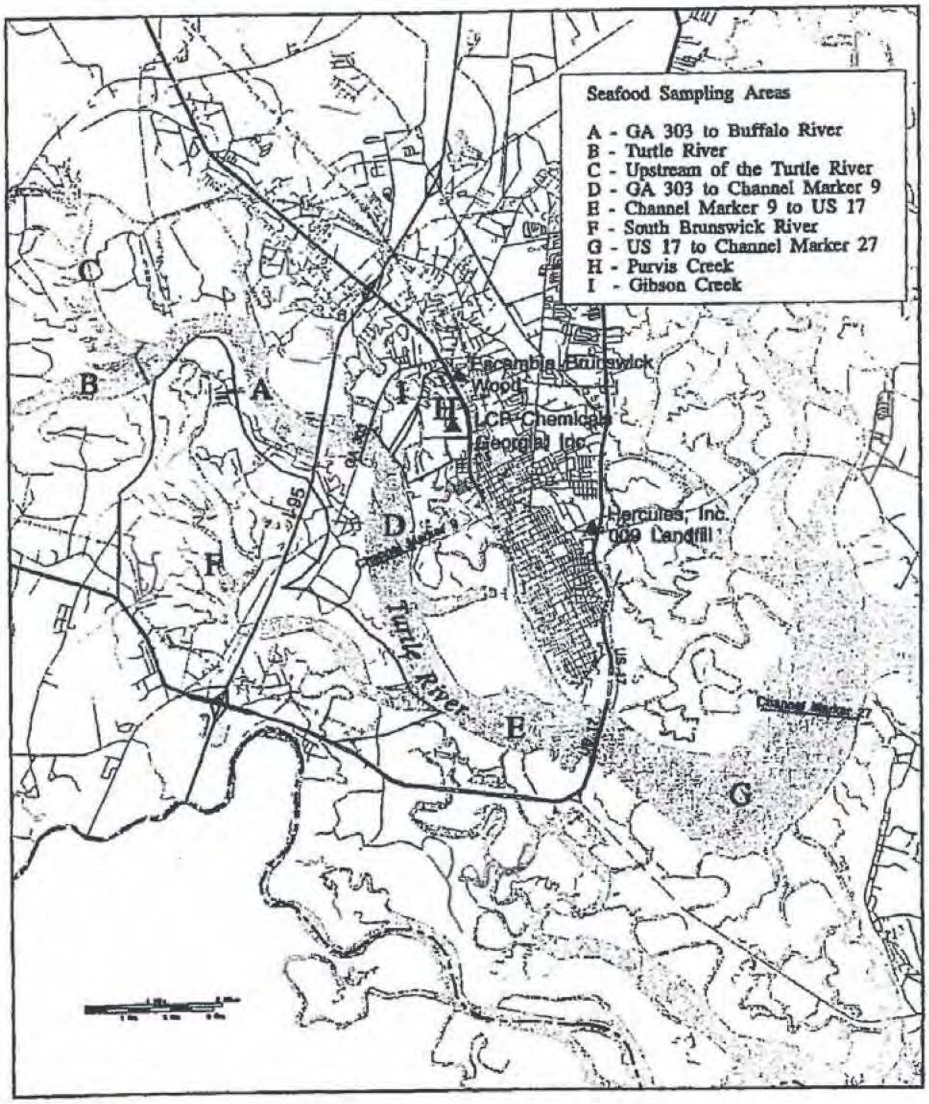


Table 1. Summary of Fish Composite Samples Fall 1989

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Black Drum	Black Drum	Southern Flounder	Southern Flounder	Black Drum	Black Drum
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD	4.5	6.9	.89	2.9	1.8	6.2	.95	2.2
TCDF	3.4	3.9	1.5	7.5	1.3	4.1	1.9	6.1
TEV	4.84	7.29	1.04	3.65	1.93	6.61	1.14	2.81

Location	Chattahoochee River				Oconee River				Sapelo Sound			
Species	Bluegill	Bluegill	Common Carp	Common Carp	Redbreast Sunfish	Redbreast Sunfish	Common Carp	Common Carp	Southern Flounder	Southern Flounder	Hardhead Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Fish	Fillet	Whole Fish
TCDD	ND	.81	3.7	5.3	ND	ND	ND	ND	.17	.32	.33	.42
TCDF	.23	.68	1.8	4.0	0.24	.49	.92	2.1	.24	.46	.36	.52
TEV	0.02	0.88	3.88	5.7	0.02	0.05	0.09	0.21	.02	.05	.04	.05

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + 0.1 TCDF concentration)
ND = Concentration not detected

Table 2. Summary of Fish Composite Samples Fall 1990

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Black Drum	Black Drum	Sheepshead	Sheepshead	Hardhead Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD	ND		ND		ND		5.1	
TCDF	2.4		1		ND		1.1	
TEV	.24	NA	0.1	NA	–	NA	5.21	NA

Location	Sapelo Sound	
Species	Southern Flounder	Hardhead Catfish
Composite Sample	Fillet	Fillet
TCDD	ND	3.10
TCDF	.59	4.6
TEV	0.06	3.56

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + TCDF concentration)
ND = Concentration not detected
NA = not applicable

Table 3. Summary of Fish Composite Samples Fall 1991

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Black Drum	Black Drum	Southern Flounder	Southern Flounder	Black Drum	Black Drum
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD	1.5	2.9	2.0	6.2	2.1	8.3	.09	.392
TCDF	3.8	6.8	6.9	17.6	5.1	8.6	1.1	8.0
TEV	1.88	3.58	2.69	7.96	2.61	9.16	.2	1.39

Location	Sapelo Sound			
Species	Southern Kingfish	Southern Kingfish	Southern Flounder	Southern Flounder
Composite Sample	Fillet	Whole Body	Fillet	Whole Body
TCDD	ND	ND	.13	ND
TCDF	ND	ND	.48	.57
TEV	–	–	.18	.06

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + TCDF concentration)
ND = Concentration not detected

Table 4. Summary of Fish Composite Samples Fall 1992

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Atlantic Croaker	Atlantic Croaker	Southern Flounder	Southern Flounder	Gafftopsail Catfish	Gafftopsail Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD								
TCDF								
TEV	.07	3.09	0.06	0.07	0.19	1.5	0.96	2.75

Location	Sapelo Sound			
Species	Southern Flounder	Southern Flounder	Hardhead Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body
TCDD				
TCDF				
TEV	.01	.03	.21	.2

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + 0.1 TCDF concentration)
ND = Concentration not detected

Table 5. Summary of Fish Composite Samples Fall 1993

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Black Drum	Black Drum	Southern Flounder	Southern Flounder	Gafftopsail Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD	.7	2.0	.2	.54	.36	.94	1.9	3.5
TCDF	2.5	ND	1.6	4.2	1.1	3.1	1.5	5.6
TEV	.95	<2.65	.36	.96	.47	1.25	2.05	4.06

Location	Sapelo Sound			
Species	Southern Flounder	Southern Flounder	Hardhead Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body
TCDD	.11	.14	.26	.77
TCDF	ND	.42	.46	.79
TEV	<0.15	.18	.31	.85

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + TCDF concentration)
ND = Concentration not detected

Table 6. Summary of Fish Composite Samples Fall 1994

Location	Turtle River Station One				Turtle River Station Two			
Species	Southern Flounder	Southern Flounder	Striped Mullet	Striped Mullet	Southern Flounder	Southern Flounder	Striped Mullet	Striped Mullet
Composite Sample	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body	Fillet	Whole Body
TCDD	.18	ND	1.9	.43	ND	.08	.96	.83
TCDF	.67	.77	14.8	3.1	ND	.38	8.2	7.6
TEV	.25	.08	3.38	3.53	–	.12	1.78	1.59

Location	Sapelo Sound			
Species	Southern Flounder	Southern Flounder	Hardhead Catfish	Hardhead Catfish
Composite Sample	Fillet	Whole Body	Fillet	Whole Body
TCDD	ND	ND	.29	.22
TCDF	ND	ND	ND	.36
TEV	–	–	.29	.26

Dioxin values are in parts per trillion.
TCDD = 2,3,7,8 tetra-chlorodibenzodioxin
TCDF = 2,3,7,8 tetra-chlorodibenzofuran
TEV = Total Toxic Equivalent Value (TCDD concentration + 0.1 TCDF concentration)
ND = Concentration not detected

ATTACHMENT 5

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Whole Fish (KF0513MD)

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	0.890	U	1	0.445
1,2,3,7,8-PeCDD	4.44	U	1	2.22
1,2,3,4,7,8-HxCDD	4.44	U	0.5	1.11
1,2,3,6,7,8-HxCDD	4.44	U	0.01	0.0222
1,2,3,7,8,9-HxCDD	4.44	U	0.01	0.0222
1,2,3,4,6,7,8-HpCDD	4.44	U	0.001	0.00222
OCDD	8.87	U	0.0001	0.0004435
2,3,7,8-TCDF	2.8		0.05	0.14
1,2,3,7,8-PeCDF	4.44	U	0.05	0.111
2,3,4,7,8-PeCDF	6.2		0.5	3.1
1,2,3,4,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,6,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,7,8,9-HxCDF	4.44	U	0.1	0.222
2,3,4,6,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,4,6,7,8-HpCDF	4.44	U	0.01	0.0222
1,2,3,4,7,8,9-HpCDF	4.44	U	0.01	0.0222
OCDF	8.87	U	0.0001	0.0004435
Total TEQ fish (ng/kg)				8.1

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Whole Fish (KF0513MD)

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	TEF Mammal	Converted Result
2,3,7,8-TCDD	0.890	U	1	0.445
1,2,3,7,8-PeCDD	4.44	U	1	2.22
1,2,3,4,7,8-HxCDD	4.44	U	0.1	0.222
1,2,3,6,7,8-HxCDD	4.44	U	0.1	0.222
1,2,3,7,8,9-HxCDD	4.44	U	0.1	0.222
1,2,3,4,6,7,8-HpCDD	4.44	U	0.01	0.0222
OCDD	8.87	U	0.0003	0.0013305
2,3,7,8-TCDF	2.8		0.1	0.28
1,2,3,7,8-PeCDF	4.44	U	0.03	0.0666
2,3,4,7,8-PeCDF	6.2		0.3	1.86
1,2,3,4,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,6,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,7,8,9-HxCDF	4.44	U	0.1	0.222
2,3,4,6,7,8-HxCDF	4.44	U	0.1	0.222
1,2,3,4,6,7,8-HpCDF	4.44	U	0.01	0.0222
1,2,3,4,7,8,9-HpCDF	4.44	U	0.01	0.0222
OCDF	8.87	U	0.0003	0.0013305
Total TEQ mammal (ng/kg)				6.5

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Whole Fish (KF0701MD)

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	1.180	U	1	0.59
1,2,3,7,8-PeCDD	5.9	U	1	2.95
1,2,3,4,7,8-HxCDD	5.9	U	0.5	1.475
1,2,3,6,7,8-HxCDD	5.9	U	0.01	0.0295
1,2,3,7,8,9-HxCDD	5.9	U	0.01	0.0295
1,2,3,4,6,7,8-HpCDD	5.9	U	0.001	0.00295
OCDD	12	U	0.0001	0.0006
2,3,7,8-TCDF	4.5		0.05	0.225
1,2,3,7,8-PeCDF	5.9	U	0.05	0.1475
2,3,4,7,8-PeCDF	5.9	U	0.5	1.475
1,2,3,4,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,6,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,7,8,9-HxCDF	5.9	U	0.1	0.295
2,3,4,6,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,4,6,7,8-HpCDF	5.9	U	0.01	0.0295
1,2,3,4,7,8,9-HpCDF	5.9	U	0.01	0.0295
OCDF	12	U	0.0001	0.0006
Total TEQ fish(ng/kg)				**8.2**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. Whole Fish (KF0701MD)

Sample Location:

COMPOUND	Result (ng/kg)	Qualifier	TEF Mammal	Converted Result
2,3,7,8-TCDD	1.180	U	1	0.59
1,2,3,7,8-PeCDD	5.9	U	1	2.95
1,2,3,4,7,8-HxCDD	5.9	U	0.1	0.295
1,2,3,6,7,8-HxCDD	5.9	U	0.1	0.295
1,2,3,7,8,9-HxCDD	5.9	U	0.1	0.295
1,2,3,4,6,7,8-HpCDD	5.9	U	0.01	0.0295
OCDD	12	U	0.0003	0.0018
2,3,7,8-TCDF	4.5		0.1	0.45
1,2,3,7,8-PeCDF	5.9	U	0.03	0.0885
2,3,4,7,8-PeCDF	5.9	U	0.3	0.885
1,2,3,4,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,6,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,7,8,9-HxCDF	5.9	U	0.1	0.295
2,3,4,6,7,8-HxCDF	5.9	U	0.1	0.295
1,2,3,4,6,7,8-HpCDF	5.9	U	0.01	0.0295
1,2,3,4,7,8,9-HpCDF	5.9	U	0.01	0.0295
OCDF	12	U	0.0003	0.0018
Total TEQ mammal (ng/kg)				**7.1**

Prepared in Anticipation of Litigation
FOIA Exempt

KILLIFISH (*Fundulus heteroclitus*) MONITORING
TO PRESERVE BIOLOGICAL EVIDENCE AT THE
LCP SUPERFUND SITE, BRUNSWICK, GEORGIA

Marsh killifish (*Fundulus heteroclitus*) have been collected from six stations in the Purvis Creek system during the US EPA's emergency marsh removal activities. The data generated during this sampling effort will be used to record ecosystem conditions and trends during and immediately following a major disturbance of the contaminant "sink". The information regarding prey contaminant concentrations over time will aid in determining past, present, and future threats to higher trophic level species, including the federally listed wood stork (*Mycteria americana*). The data will also provide a baseline to aid in long-term monitoring of the marsh ecosystem.

Sampling has been conducted monthly beginning in May 1998, and will continue for at least six months following completion of the US EPA's emergency removal activities. The locations of the sampling stations were selected to produce a possible gradient of contaminant levels away from the removal activities (see attached map). A time series for all stations will not be possible because of access limitations in the outfall canal during removal operations.

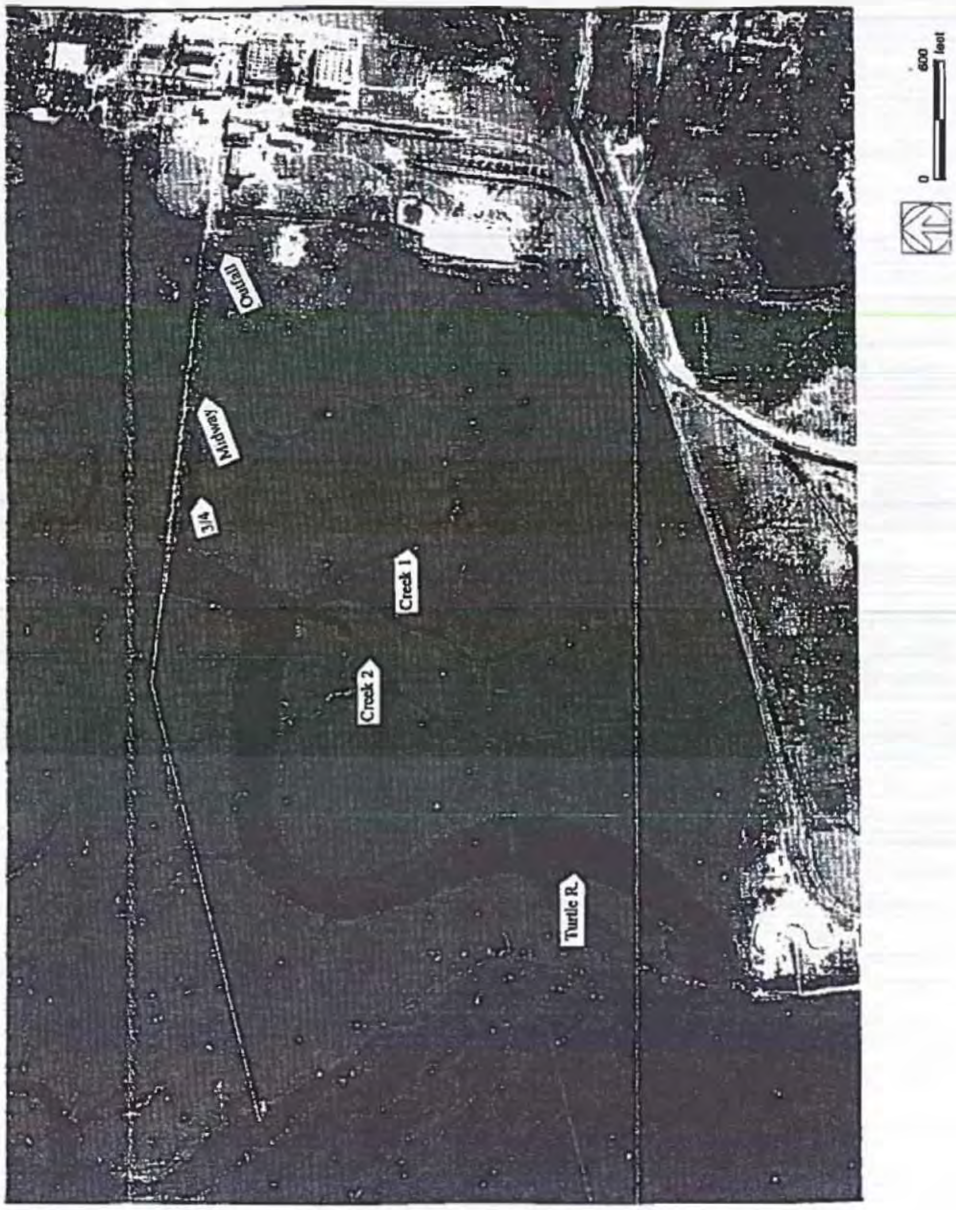
Minnow traps baited with commercial cat food are used to collect killifish. The traps are baited and set during high water because of navigability problems in the outfall canal and smaller creeks. The traps are placed mid-channel at each station and left until high water on the following day (approximately 24hrs). The traps are checked daily and reset for up to three days to help insure that a sufficient number (sample volume) of fish are collected. When checking the traps, all live killifish captured at a particular station are placed in an individual plastic tub containing water collected offsite in the Turtle River. The fish are transported directly to the laboratory for further processing.

At the laboratory, the fish from each station are separated by sex and maintained for at least 24 hrs in water from the Turtle River to depurate any food eaten. The fish are then counted, weighed (total weight by sex), and placed in pre-cleaned I-Chem jars and frozen at -20°C. An individual sample consists of all of the male or female fish caught at a particular station during the monthly sampling effort (up to three days).

SAMPLE #'s
FOR KILLI'S

SEX
KF 0121 TR
(M) DATE LOCATION

USFWS
12/21/98


Outfall
Midway
3/4
Creek 1
Creek 2
Turtle R.
0
600
feet

ATTACHMENT 6

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. C-6

Sample Location: C-6

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	53.7		1	53.7
1,2,3,7,8-PeCDD	6.2		1	6.2
1,2,3,4,7,8-HxCDD	11.4		0.1	1.14
1,2,3,6,7,8-HxCDD	24.2		0.1	2.42
1,2,3,7,8,9-HxCDD	40.9		0.1	4.09
1,2,3,4,6,7,8-HpCDD	891		0.01	8.91
OCDD	8810	E	0.0003	2.643
2,3,7,8-TCDF	4120	E	0.1	412
1,2,3,7,8-PeCDF	6660	E	0.03	199.8
2,3,4,7,8-PeCDF	1020		0.3	306
1,2,3,4,7,8-HxCDF	5860	E	0.1	586
1,2,3,6,7,8-HxCDF	1650		0.1	165
1,2,3,7,8,9-HxCDF	328		0.1	32.8
2,3,4,6,7,8-HxCDF	731		0.1	73.1
1,2,3,4,6,7,8-HpCDF	1520		0.01	15.2
1,2,3,4,7,8,9-HpCDF	799		0.01	7.99
OCDF	2570		0.0003	0.771
Total (ng/kg)				**1877.8**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. C-8

Sample Location: C-8

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	13.4		1	13.4
1,2,3,7,8-PeCDD	8.7	B	1	8.7
1,2,3,4,7,8-HxCDD	2.3	U	0.1	0.115
1,2,3,6,7,8-HxCDD	320		0.1	32
1,2,3,7,8,9-HxCDD	53		0.1	5.3
1,2,3,4,6,7,8-HpCDD	597		0.01	5.97
OCDD	5280	E	0.0003	1.584
2,3,7,8-TCDF	104		0.1	10.4
1,2,3,7,8-PeCDF	98.5		0.03	2.955
2,3,4,7,8-PeCDF	35.5		0.3	10.65
1,2,3,4,7,8-HxCDF	188		0.1	18.8
1,2,3,6,7,8-HxCDF	46.5		0.1	4.65
1,2,3,7,8,9-HxCDF	6.5		0.1	0.65
2,3,4,6,7,8-HxCDF	48.9		0.1	4.89
1,2,3,4,6,7,8-HpCDF	277		0.01	2.77
1,2,3,4,7,8,9-HpCDF	35.1		0.01	0.351
OCDF	260		0.0003	0.078
Total (ng/kg)				**123.3**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. C-15

Sample Location: C-15

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	5.7		1	5.7
1,2,3,7,8-PeCDD	7.2	B	1	7.2
1,2,3,4,7,8-HxCDD	34.2		0.1	3.42
1,2,3,6,7,8-HxCDD	24.4	B	0.1	2.44
1,2,3,7,8,9-HxCDD	43		0.1	4.3
1,2,3,4,6,7,8-HpCDD	610		0.01	6.1
OCDD	5860	E	0.0003	1.758
2,3,7,8-TCDF	32.3		0.1	3.23
1,2,3,7,8-PeCDF	31.9		0.03	0.957
2,3,4,7,8-PeCDF	18.7	B	0.3	5.61
1,2,3,4,7,8-HxCDF	68		0.1	6.8
1,2,3,6,7,8-HxCDF	17.8	B	0.1	1.78
1,2,3,7,8,9-HxCDF	0.2	U	0.1	0.01
2,3,4,6,7,8-HxCDF	27.5		0.1	2.75
1,2,3,4,6,7,8-HpCDF	145		0.01	1.45
1,2,3,4,7,8,9-HpCDF	9.9		0.01	0.099
OCDF	128		0.0003	0.0384
Total (ng/kg)				**53.6**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. TC-C

Sample Location: TC-C

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.7	U	1	0.35
1,2,3,7,8-PeCDD	1.8	J	1	1.8
1,2,3,4,7,8-HxCDD	2.9	J	0.1	0.29
1,2,3,6,7,8-HxCDD	4.4	J	0.1	0.44
1,2,3,7,8,9-HxCDD	11.2		0.1	1.12
1,2,3,4,6,7,8-HpCDD	160		0.01	1.6
OCDD	2170		0.0003	0.651
2,3,7,8-TCDF	1.7		0.1	0.17
1,2,3,7,8-PeCDF	0.6	U	0.03	0.009
2,3,4,7,8-PeCDF	0.6	U	0.3	0.09
1,2,3,4,7,8-HxCDF	1.5	J	0.1	0.15
1,2,3,6,7,8-HxCDF	0.64	J	0.1	0.064
1,2,3,7,8,9-HxCDF	0.6	U	0.1	0.03
2,3,4,6,7,8-HxCDF	1.2	J	0.1	0.12
1,2,3,4,6,7,8-HpCDF	5.8		0.01	0.058
1,2,3,4,7,8,9-HpCDF	0.7	U	0.01	0.0035
OCDF	5.1	J	0.0003	0.00153
Total (ng/kg)				6.9

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. CR-C

Sample Location: CR-C

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	0.2	U	1	0.1
1,2,3,7,8-PeCDD	1.2	J	1	1.2
1,2,3,4,7,8-HxCDD	3.4	J	0.1	0.34
1,2,3,6,7,8-HxCDD	5.2		0.1	0.52
1,2,3,7,8,9-HxCDD	61.8		0.1	6.18
1,2,3,4,6,7,8-HpCDD	347		0.01	3.47
OCDD	4020		0.0003	1.206
2,3,7,8-TCDF	0.2	U	0.1	0.01
1,2,3,7,8-PeCDF	0.3	U	0.03	0.0045
2,3,4,7,8-PeCDF	0.3	U	0.3	0.045
1,2,3,4,7,8-HxCDF	0.2	U	0.1	0.01
1,2,3,6,7,8-HxCDF	0.2	U	0.1	0.01
1,2,3,7,8,9-HxCDF	0.3	U	0.1	0.015
2,3,4,6,7,8-HxCDF	0.2	U	0.1	0.01
1,2,3,4,6,7,8-HpCDF	0.3	U	0.01	0.0015
1,2,3,4,7,8,9-HpCDF	0.3	U	0.01	0.0015
OCDF	0.5	U	0.0003	0.000075
Total (ng/kg)				**13.1**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. AL-J1-83

Sample Location: **AL-J1-83**

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	72		1	72
1,2,3,7,8-PeCDD	2.5	J	1	2.5
1,2,3,4,7,8-HxCDD	3.8	J Q	0.1	0.38
1,2,3,6,7,8-HxCDD	7.5	J	0.1	0.75
1,2,3,7,8,9-HxCDD	7	J	0.1	0.7
1,2,3,4,6,7,8-HpCDD	160	B	0.01	1.6
OCDD	1700	B	0.0003	0.51
2,3,7,8-TCDF	440	CON	0.1	44
1,2,3,7,8-PeCDF	4.2	J	0.03	0.126
2,3,4,7,8-PeCDF	5.9	J	0.3	1.77
1,2,3,4,7,8-HxCDF	4.8	J	0.1	0.48
1,2,3,6,7,8-HxCDF	2	J	0.1	0.2
1,2,3,7,8,9-HxCDF	0.33	J Q	0.1	0.033
2,3,4,6,7,8-HxCDF	2.1	J Q	0.1	0.21
1,2,3,4,6,7,8-HpCDF	21		0.01	0.21
1,2,3,4,7,8,9-HpCDF	1.5	U	0.01	0.0075
OCDF	38	B	0.0003	0.0114
Total (ng/kg)				**125.5**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. AL-D1-12

Sample Location: AL-D1-12

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	36		1	36
1,2,3,7,8-PeCDD	0.67	J Q	1	0.67
1,2,3,4,7,8-HxCDD	0.72	J Q	0.1	0.072
1,2,3,6,7,8-HxCDD	1.6	J	0.1	0.16
1,2,3,7,8,9-HxCDD	1.6	J	0.1	0.16
1,2,3,4,6,7,8-HpCDD	34	B	0.01	0.34
OCDD	350	B	0.0003	0.105
2,3,7,8-TCDF	230	CON	0.1	23
1,2,3,7,8-PeCDF	1.7	J Q	0.03	0.051
2,3,4,7,8-PeCDF	3.3	J	0.3	0.99
1,2,3,4,7,8-HxCDF	1.9	J	0.1	0.19
1,2,3,6,7,8-HxCDF	0.72	J	0.1	0.072
1,2,3,7,8,9-HxCDF	0	U	0.1	0
2,3,4,6,7,8-HxCDF	0.72	J	0.1	0.072
1,2,3,4,6,7,8-HpCDF	5.8	J	0.01	0.058
1,2,3,4,7,8,9-HpCDF	0.41	J	0.01	0.0041
OCDF	11	J B	0.0003	0.0033
Total (ng/kg)				**61.9**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. AL-M1-1

Sample Location: AL-M1-1

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	37		1	37
1,2,3,7,8-PeCDD	2.4	J	1	2.4
1,2,3,4,7,8-HxCDD	4.5	J	0.1	0.45
1,2,3,6,7,8-HxCDD	8	J	0.1	0.8
1,2,3,7,8,9-HxCDD	9.8	J	0.1	0.98
1,2,3,4,6,7,8-HpCDD	170	B	0.01	1.7
OCDD	1700	B	0.0003	0.51
2,3,7,8-TCDF	210	CON	0.1	21
1,2,3,7,8-PeCDF	4.3	J	0.03	0.129
2,3,4,7,8-PeCDF	5.2	J	0.3	1.56
1,2,3,4,7,8-HxCDF	5.7	J	0.1	0.57
1,2,3,6,7,8-HxCDF	2.9	J	0.1	0.29
1,2,3,7,8,9-HxCDF	0.24	U	0.1	0.012
2,3,4,6,7,8-HxCDF	3.4	J	0.1	0.34
1,2,3,4,6,7,8-HpCDF	26		0.01	0.26
1,2,3,4,7,8,9-HpCDF	1.6	U	0.01	0.008
OCDF	41	B	0.0003	0.0123
Total (ng/kg)				**68.0**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. AL-S1-32

Sample Location: AL-S1-32

COMPOUND	Result (ng/kg)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	11		1	11
1,2,3,7,8-PeCDD	0.98	J Q	1	0.98
1,2,3,4,7,8-HxCDD	1.7	J	0.1	0.17
1,2,3,6,7,8-HxCDD	2.9	J	0.1	0.29
1,2,3,7,8,9-HxCDD	3.4	J	0.1	0.34
1,2,3,4,6,7,8-HpCDD	76	B	0.01	0.76
OCDD	810	B	0.0003	0.243
2,3,7,8-TCDF	53	CON	0.1	5.3
1,2,3,7,8-PeCDF	1.6	J	0.03	0.048
2,3,4,7,8-PeCDF	1.5	J	0.3	0.45
1,2,3,4,7,8-HxCDF	2.7	J	0.1	0.27
1,2,3,6,7,8-HxCDF	1.1	J	0.1	0.11
1,2,3,7,8,9-HxCDF	0.1	U	0.1	0.005
2,3,4,6,7,8-HxCDF	1.5	J	0.1	0.15
1,2,3,4,6,7,8-HpCDF	12		0.01	0.12
1,2,3,4,7,8,9-HpCDF	1.4	J	0.01	0.014
OCDF	23	B	0.0003	0.0069
Total (ng/kg)				**20.3**

Note: 1 nanogram/kilogram (ng/kg) = 1 ppt

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-8 (W)				
COMPOUND	Result (pg/L)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2.200	U	1	1.1
1,2,3,7,8-PeCDD	2.6	U	1	1.3
1,2,3,4,7,8-HxCDD	3	U	0.1	0.15
1,2,3,6,7,8-HxCDD	2.8	U	0.1	0.14
1,2,3,7,8,9-HxCDD	2.8	U	0.1	0.14
1,2,3,4,6,7,8-HpCDD	4.9	U	0.01	0.0245
OCDD	45.6		0.0003	0.01368
2,3,7,8-TCDF	1.9	U	0.1	0.095
1,2,3,7,8-PeCDF	1.9	U	0.03	0.0285
2,3,4,7,8-PeCDF	1.9	U	0.3	0.285
1,2,3,4,7,8-HxCDF	2	U	0.1	0.1
1,2,3,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,7,8,9-HxCDF	2	U	0.1	0.1
2,3,4,6,7,8-HxCDF	2.4	U	0.1	0.12
1,2,3,4,6,7,8-HpCDF	2.7	U	0.01	0.0135
1,2,3,4,7,8,9-HpCDF	3.4	U	0.01	0.017
OCDF	5.5	U	0.0003	0.000825
Total (pg/L)				**3.72**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-8 (W)				
COMPOUND	Result (pg/L)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	2.200	U	1	1.1
1,2,3,7,8-PeCDD	2.6	U	1	1.3
1,2,3,4,7,8-HxCDD	3	U	0.5	0.75
1,2,3,6,7,8-HxCDD	2.8	U	0.01	0.014
1,2,3,7,8,9-HxCDD	2.8	U	0.01	0.014
1,2,3,4,6,7,8-HpCDD	4.9	U	0.001	0.00245
OCDD	45.6	U	0.0001	0.00228
2,3,7,8-TCDF	1.9		0.05	0.095
1,2,3,7,8-PeCDF	1.9	U	0.05	0.0475
2,3,4,7,8-PeCDF	1.9	U	0.5	0.475
1,2,3,4,7,8-HxCDF	2	U	0.1	0.1
1,2,3,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,7,8,9-HxCDF	2	U	0.1	0.1
2,3,4,6,7,8-HxCDF	2.4	U	0.1	0.12
1,2,3,4,6,7,8-HpCDF	2.7	U	0.01	0.0135
1,2,3,4,7,8,9-HpCDF	3.4	U	0.01	0.017
OCDF	5.5	U	0.0001	0.000275
Total TEQ fish(pg/L)				**4.2**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-6 (W)				
COMPOUND	**Result (pg/L)**	**Qualifier**	**Who TEF Factor (2005)**	**Converted Result**
2,3,7,8-TCDD	1.100	U	1	0.55
1,2,3,7,8-PeCDD	1.1	U	1	0.55
1,2,3,4,7,8-HxCDD	1.3	U	0.1	0.065
1,2,3,6,7,8-HxCDD	1.3	U	0.1	0.065
1,2,3,7,8,9-HxCDD	1.3	U	0.1	0.065
1,2,3,4,6,7,8-HpCDD	2.1	U	0.01	0.0105
OCDD	46.5		0.0003	0.01395
2,3,7,8-TCDF	0.7	U	0.1	0.035
1,2,3,7,8-PeCDF	0.9	U	0.03	0.0135
2,3,4,7,8-PeCDF	0.9	U	0.3	0.135
1,2,3,4,7,8-HxCDF	0.8	U	0.1	0.04
1,2,3,6,7,8-HxCDF	0.8	U	0.1	0.04
1,2,3,7,8,9-HxCDF	0.8	U	0.1	0.04
2,3,4,6,7,8-HxCDF	1	U	0.1	0.05
1,2,3,4,6,7,8-HpCDF	1.1	U	0.01	0.0055
1,2,3,4,7,8,9-HpCDF	1.4	U	0.01	0.007
OCDF	2.5	U	0.0003	0.000375
Total (pg/L)				**1.69**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-6 (W)				
COMPOUND	**Result (pg/L)**	**Qualifier**	**TEF Fish**	**Converted Result**
2,3,7,8-TCDD	1.100	U	1	0.55
1,2,3,7,8-PeCDD	1.1	U	1	0.55
1,2,3,4,7,8-HxCDD	1.3	U	0.5	0.325
1,2,3,6,7,8-HxCDD	1.3	U	0.01	0.0065
1,2,3,7,8,9-HxCDD	1.3	U	0.01	0.0065
1,2,3,4,6,7,8-HpCDD	2.1	U	0.001	0.00105
OCDD	46.5	U	0.0001	0.002325
2,3,7,8-TCDF	0.7		0.05	0.035
1,2,3,7,8-PeCDF	0.9	U	0.05	0.0225
2,3,4,7,8-PeCDF	0.9	U	0.5	0.225
1,2,3,4,7,8-HxCDF	0.8	U	0.1	0.04
1,2,3,6,7,8-HxCDF	0.8	U	0.1	0.04
1,2,3,7,8,9-HxCDF	0.8	U	0.1	0.04
2,3,4,6,7,8-HxCDF	1	U	0.1	0.05
1,2,3,4,6,7,8-HpCDF	1.1	U	0.01	0.0055
1,2,3,4,7,8,9-HpCDF	1.4	U	0.01	0.007
OCDF	2.5	U	0.0001	0.000125
Total TEQ fish(pg/L)				**1.9**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-15 (duplicate)				
COMPOUND	Result (pg/L)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	2.700	U	1	1.35
1,2,3,7,8-PeCDD	3.2	U	1	1.6
1,2,3,4,7,8-HxCDD	3.7	U	0.1	0.185
1,2,3,6,7,8-HxCDD	3.5	U	0.1	0.175
1,2,3,7,8,9-HxCDD	3.5	U	0.1	0.175
1,2,3,4,6,7,8-HpCDD	7.2	U	0.01	0.036
OCDD	60.6		0.0003	0.01818
2,3,7,8-TCDF	2	U	0.1	0.1
1,2,3,7,8-PeCDF	2.5	U	0.03	0.0375
2,3,4,7,8-PeCDF	2.5	U	0.3	0.375
1,2,3,4,7,8-HxCDF	2.7	U	0.1	0.135
1,2,3,6,7,8-HxCDF	2.4	U	0.1	0.12
1,2,3,7,8,9-HxCDF	2.8	U	0.1	0.14
2,3,4,6,7,8-HxCDF	3.2	U	0.1	0.16
1,2,3,4,6,7,8-HpCDF	3.1	U	0.01	0.0155
1,2,3,4,7,8,9-HpCDF	4	U	0.01	0.02
OCDF	7.3	U	0.0003	0.001095
Total (pg/L)				**4.64**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. C-15 (duplicate)				
COMPOUND	Result (pg/L)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	2.700	U	1	1.35
1,2,3,7,8-PeCDD	3.2	U	1	1.6
1,2,3,4,7,8-HxCDD	3.7	U	0.5	0.925
1,2,3,6,7,8-HxCDD	3.5	U	0.01	0.0175
1,2,3,7,8,9-HxCDD	3.5	U	0.01	0.0175
1,2,3,4,6,7,8-HpCDD	7.2	U	0.001	0.0036
OCDD	60.6	U	0.0001	0.00303
2,3,7,8-TCDF	2		0.05	0.1
1,2,3,7,8-PeCDF	2.5	U	0.05	0.0625
2,3,4,7,8-PeCDF	2.5	U	0.5	0.625
1,2,3,4,7,8-HxCDF	2.7	U	0.1	0.135
1,2,3,6,7,8-HxCDF	2.4	U	0.1	0.12
1,2,3,7,8,9-HxCDF	2.8	U	0.1	0.14
2,3,4,6,7,8-HxCDF	3.2	U	0.1	0.16
1,2,3,4,6,7,8-HpCDF	3.1	U	0.01	0.0155
1,2,3,4,7,8,9-HpCDF	4	U	0.01	0.02
OCDF	7.3	U	0.0001	0.000365
Total TEQ fish(pg/L)				**5.3**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. C-15 (W)

COMPOUND	Result (pg/L)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.500	U	1	0.75
1,2,3,7,8-PeCDD	1.9	U	1	0.95
1,2,3,4,7,8-HxCDD	2.3	U	0.1	0.115
1,2,3,6,7,8-HxCDD	2.2	U	0.1	0.11
1,2,3,7,8,9-HxCDD	2.2	U	0.1	0.11
1,2,3,4,6,7,8-HpCDD	9.3	U	0.01	0.0465
OCDD	102		0.0003	0.0306
2,3,7,8-TCDF	1.4	U	0.1	0.07
1,2,3,7,8-PeCDF	1.4	U	0.03	0.021
2,3,4,7,8-PeCDF	1.4	U	0.3	0.21
1,2,3,4,7,8-HxCDF	1.4	U	0.1	0.07
1,2,3,6,7,8-HxCDF	1.3	U	0.1	0.065
1,2,3,7,8,9-HxCDF	1.5	U	0.1	0.075
2,3,4,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,4,6,7,8-HpCDF	1.9	U	0.01	0.0095
1,2,3,4,7,8,9-HpCDF	2.6	U	0.01	0.013
OCDF	4.7	U	0.0003	0.000705
Total (pg/L)				**2.74**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet
for Sample No. C-15 (W)

COMPOUND	Result (pg/L)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	1.500	U	1	0.75
1,2,3,7,8-PeCDD	1.9	U	1	0.95
1,2,3,4,7,8-HxCDD	2.3	U	0.5	0.575
1,2,3,6,7,8-HxCDD	2.2	U	0.01	0.011
1,2,3,7,8,9-HxCDD	2.2	U	0.01	0.011
1,2,3,4,6,7,8-HpCDD	9.3	U	0.001	0.00465
OCDD	102	U	0.0001	0.0051
2,3,7,8-TCDF	1.4		0.05	0.07
1,2,3,7,8-PeCDF	1.4	U	0.05	0.035
2,3,4,7,8-PeCDF	1.4	U	0.5	0.35
1,2,3,4,7,8-HxCDF	1.4	U	0.1	0.07
1,2,3,6,7,8-HxCDF	1.3	U	0.1	0.065
1,2,3,7,8,9-HxCDF	1.5	U	0.1	0.075
2,3,4,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,4,6,7,8-HpCDF	1.9	U	0.01	0.0095
1,2,3,4,7,8,9-HpCDF	2.6	U	0.01	0.013
OCDF	4.7	U	0.0001	0.000235
Total TEQ fish(pg/L)				**3.1**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. TC-C				
COMPOUND	**Result (pg/L)**	**Qualifier**	**Who TEF Factor (2005)**	**Converted Result**
2,3,7,8-TCDD	1.300	U	1	0.65
1,2,3,7,8-PeCDD	1.2	U	1	0.6
1,2,3,4,7,8-HxCDD	1.3	U	0.1	0.065
1,2,3,6,7,8-HxCDD	1.3	U	0.1	0.065
1,2,3,7,8,9-HxCDD	1.3	U	0.1	0.065
1,2,3,4,6,7,8-HpCDD	5.2	U	0.01	0.026
OCDD	74.4		0.0003	0.02232
2,3,7,8-TCDF	0.8	U	0.1	0.04
1,2,3,7,8-PeCDF	1.1	U	0.03	0.0165
2,3,4,7,8-PeCDF	1	U	0.3	0.15
1,2,3,4,7,8-HxCDF	0.9	U	0.1	0.045
1,2,3,6,7,8-HxCDF	0.9	U	0.1	0.045
1,2,3,7,8,9-HxCDF	1	U	0.1	0.05
2,3,4,6,7,8-HxCDF	1.1	U	0.1	0.055
1,2,3,4,6,7,8-HpCDF	1.1	U	0.01	0.0055
1,2,3,4,7,8,9-HpCDF	1.3	U	0.01	0.0065
OCDF	2.4	U	0.0003	0.00036
Total (pg/L)				**1.91**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. TC-C				
COMPOUND	**Result (pg/L)**	**Qualifier**	**TEF Fish**	**Converted Result**
2,3,7,8-TCDD	1.300	U	1	0.65
1,2,3,7,8-PeCDD	1.2	U	1	0.6
1,2,3,4,7,8-HxCDD	1.3	U	0.5	0.325
1,2,3,6,7,8-HxCDD	1.3	U	0.01	0.0065
1,2,3,7,8,9-HxCDD	1.3	U	0.01	0.0065
1,2,3,4,6,7,8-HpCDD	5.2	U	0.001	0.0026
OCDD	74.4	U	0.0001	0.00372
2,3,7,8-TCDF	0.8		0.05	0.04
1,2,3,7,8-PeCDF	1.1	U	0.05	0.0275
2,3,4,7,8-PeCDF	1	U	0.5	0.25
1,2,3,4,7,8-HxCDF	0.9	U	0.1	0.045
1,2,3,6,7,8-HxCDF	0.9	U	0.1	0.045
1,2,3,7,8,9-HxCDF	1	U	0.1	0.05
2,3,4,6,7,8-HxCDF	1.1	U	0.1	0.055
1,2,3,4,6,7,8-HpCDF	1.1	U	0.01	0.0055
1,2,3,4,7,8,9-HpCDF	1.3	U	0.01	0.0065
OCDF	2.4	U	0.0001	0.00012
Total TEQ fish(pg/L)				**2.1**

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. CR-C

COMPOUND	Result (pg/L)	Qualifier	Who TEF Factor (2005)	Converted Result
2,3,7,8-TCDD	1.800	U	1	0.9
1,2,3,7,8-PeCDD	1.9	U	1	0.95
1,2,3,4,7,8-HxCDD	2.1	U	0.1	0.105
1,2,3,6,7,8-HxCDD	2.1	U	0.1	0.105
1,2,3,7,8,9-HxCDD	2	U	0.1	0.1
1,2,3,4,6,7,8-HpCDD	4.2	U	0.01	0.021
OCDD	40.6		0.0003	0.01218
2,3,7,8-TCDF	1.3	U	0.1	0.065
1,2,3,7,8-PeCDF	1.5	U	0.03	0.0225
2,3,4,7,8-PeCDF	1.5	U	0.3	0.225
1,2,3,4,7,8-HxCDF	1.5	U	0.1	0.075
1,2,3,6,7,8-HxCDF	1.5	U	0.1	0.075
1,2,3,7,8,9-HxCDF	1.6	U	0.1	0.08
2,3,4,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,4,6,7,8-HpCDF	1.8	U	0.01	0.009
1,2,3,4,7,8,9-HpCDF	2.1	U	0.01	0.0105
OCDF	4	U	0.0003	0.0006
Total (pg/L)				**2.85**

Note: 1 picogram/liter (pg/L) = 1 part per quadrillion

Toxic Equivalency Factor (Dioxins) Calculation Check Spreadsheet for Sample No. CR-C

COMPOUND	Result (pg/L)	Qualifier	TEF Fish	Converted Result
2,3,7,8-TCDD	1.800	U	1	0.9
1,2,3,7,8-PeCDD	1.9	U	1	0.95
1,2,3,4,7,8-HxCDD	2.1	U	0.5	0.525
1,2,3,6,7,8-HxCDD	2.1	U	0.01	0.0105
1,2,3,7,8,9-HxCDD	2	U	0.01	0.01
1,2,3,4,6,7,8-HpCDD	4.2	U	0.001	0.0021
OCDD	40.6	U	0.0001	0.00203
2,3,7,8-TCDF	1.3		0.05	0.065
1,2,3,7,8-PeCDF	1.5	U	0.05	0.0375
2,3,4,7,8-PeCDF	1.5	U	0.5	0.375
1,2,3,4,7,8-HxCDF	1.5	U	0.1	0.075
1,2,3,6,7,8-HxCDF	1.5	U	0.1	0.075
1,2,3,7,8,9-HxCDF	1.6	U	0.1	0.08
2,3,4,6,7,8-HxCDF	1.8	U	0.1	0.09
1,2,3,4,6,7,8-HpCDF	1.8	U	0.01	0.009
1,2,3,4,7,8,9-HpCDF	2.1	U	0.01	0.0105
OCDF	4	U	0.0001	0.0002
Total TEQ fish(pg/L)				**3.2**

ATTACHMENT 7

Estimation of Dioxin 2,3,7,8-TCDD protective levels in sediment of LCP

1. Estimation of Bioaccumulation Factors and Biota to Sediment Accumulation

Howell et al. 2011 measured the BAFs for 2,3,7,8-TCDD bioaccumulation in crabs and fish of the Houston Ship Channel, Texas. (Figure 3 of Howell et al. 2011)

Bioaccumulation Factor (BAF) for crabs	=	1,550	L water/ g lipid	
Bioaccumulation Factor (BAF) for fish	=	1,200	L water/ g lipid	
Literature Reported K_{OC} for 2,3,7,8-TCDD	=	12,600,000	L water/ kg oc	Lodge 2002
Total Organic Carbon in LCP Sediment	=	3.2%		
Estimated site-specific K_D for 2,3,7,8-TCDD	=	403,000	L water/ kg sed	

Lipid Contents of Fish and Crabs at LCP

	Lipid Content, wet weight	Estimated BAF, L water/kg tissue-dw*	Dioxin Estimated BSAF, Kg sed / kg tissue-dw‡
Fiddler Crab	3%	186,000	0.46
Blue Crab	5%	310,000	0.77
Mummichog	10%	480,000	1.19
Finfish	5%	240,000	0.60

*Assume 75% moisture content in tissue

‡ Estimated BSAF = Estimated BAF / Estimated Site-specific K_D

K_{OC} = Organic carbon partition coefficient, L water/ kg oc

K_D = Sediment-water partition coefficient, L water/ kg sed

References:

Howell, N. L., Rifai, H. S., Koenig, L. 2011. Comparative distribution, sourcing, and chemical behavior of PCDD/Fs and PCBs in an estuary environment. Chemosphere 83: 873–881.

Lodge, K. B. 2002. The measurement of the organic-carbon normalized partition coefficient, Koc, for dioxin from contaminated sediment. Advances in Environmental Research 7: 147-156.

2. Estimation of a Protective Sediment Concentration for Omnivorous Mammals
Estimated Daily Dose (EDD) for River Otter

EDD (mg/kg-day) = 0.33 kg dry food ingestion / day / 6.7 kg-bw *(Csed* (0.1 * BSAF fc + 0.1 * BSAF bc + 0.3 * BSAF mc + 0.5 * BSAF ff) + Csed * 0.015)

=	0.0487	*	(Csed *	0.778	+ Csed *	0.015	)	fc	fiddler crab
=	0.0487	*		0.793	Csed			bc	blue crab
=	0.0387	Csed						mc	mummichog
								ff	finfish
				NOAEL	LOAEL	mg/kg-bw/day			
	EDD / TRV = 1			0.000001	0.00001		These TRVs from Sample et al. (1996) are commonly used for dioxin.		

Estimation of Protective Sediment Concentration

Solve for C_{sed} when EDD/TRV = 1.

C_{sed} = Concentration in sediment

1	=	0.0387	Csed	/	0.000001
0.000001	=	0.0387	Csed		
C_{sed}	=	2.59E-05	mg/kg		

26	ng/kg	2,3,7,8-TCDD	NOAEL	Below threshold risk to mammalian wildlife
260	ng/kg	2,3,7,8-TCDD	LOAEL	At threshold of risk to mammalian wildlife
82	ng/kg		geomean	

Hence, 260 ng/kg TEQ in sediment is an estimate of a PRG for protection of the omnivorous mammal.

Reference:

Sample, B.E., Opresko, D.M., and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife 1996 Revision. U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge Tennessee. ES/ER/TM-86/R3. June 1996.

3. Estimation of a Remedial Goal Option, or Preliminary Remedial Goal, for Protection of Fish

Steevens et al. 2005 reported protective levels of 2,3,7,8-TCDD in fish tissue to protect fish in terms of ng dioxin TEQ /g lipid

Protects 95% of species:	0.386
Protects 90% of species:	0.909

Fish on average contain 5% lipids. Results are provided for 1% lipids and 0.5% lipids to compare with site-specific data.

50 g lipid / kg fish tissue

	ng / g lipid	ng / kg tissue (5% lipids)	ng / kg tissue (1% lipids)	ng / kg tissue (0.5% lipids)
Protects 95% of species	0.386	19.3	3.9	1.9
Protects 90% of species	0.909	45.5	9.1	4.5

19.25	ng 2,3,7,8-TCDD / kg fish tissue	for protection of 95% of species
50	ng 2,3,7,8-TCDD / kg fish tissue	induces significant mortality in sensitive fish species such as short-nose sturgeon (Chambers et al. 2012)

BSAF = 0.60 Kg sed / kg tissue-dw

Fish protective RGO =	32	ng 2,3,7,8-TCDD / kg sed	Protects 95% of species
	76	ng 2,3,7,8-TCDD / kg sed	Protects of 90% of species
	50	ng 2,3,7,8-TCDD / kg sed	Geomean

References:

Chambers, C.R. et al. 2012. Toxici effects of PCB 126 and TCDD on shortnose sturgeon and Atlantic sturgeon. Environ. Tox. Chem. 31(10): 2324–2337.

Steevens, J.A., Reiss, M.R., and A. V. Pawlisz. 2005. A Methodology for Deriving Tissue Residue Benchmarks for Aquatic Biota: A Case Study for Fish Exposed to 2,3,7,8-Tetrachlorodibenzo-p-Dioxin and Equivalents.

Integrated Environmental Assessment and Management — Volume 1, Number 2—pp. 142–151.

Measured lipid content in the two killifish samples was 0.5% (KM0513MD) and 1.1% (KM0701MD).

The actual lipid content in killifish sample KM0513MD was 0.5%

8.1 ng kg TEQ   5 g lipid fish = **1.6 ng TEQ/ g lipid**

The actual lipid content in killifish samples KM0701MD was 1.1%

8.2 ng kg TEQ   11 g lipid fish = **0.75 ng TEQ/ g lipid**

Concentrations of dioxin in the two killifish samples are greater than 0.386 ng TEQ kg-lipid and is estimated not to be protective. Note that the overwhelming contribution is due to the use of one half the detection limits for those congeners that were found to be below detection limits.

EDD (ng kg-day) = 0.33 kg dry food ingestion   day   6.7 kg-bw

0.0000016

1.58	*0.16*
NOAEL HQ	LOAEL HQ

Slight risk to fish-eating mammal but only if all detection limits were used to estimate concentration of non-detects.