POTENTIAL HUMAN HEALTH EFFECTS OF INGESTING FISH WHICH ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

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INTRODUCTION

This screening-level risk assessment is for a hazardous waste site. This analysis characterizes risks due to ingesting fish which have radioactive and nonradioactive contaminants and are taken from locations along the Savannah River near the Savannah River Site (SRS), which is located near Aiken, South Carolina. The potential human health effects of the radioactive contaminants in these fish are analyzed in Part I; the nonradioactive contaminants in Part II; and their combined effects in Part III. Part IV presents the overall risk characterization for this risk screening.

The risk characterization, Part IV, clearly highlights both the confidence and the uncertainty associated with this screening-level risk assessment. This risk characterization conveys the assessor's judgment as to the nature and existence of both human and ecological risks. However, even though there is a limited discussion of the ecological considerations of chemical releases from this site in Part IV, the primary site-specific focus of this analysis is potential human health risks.

RESULTS IN BRIEF

This section provides an executive summary of overall risks derived in this analysis. Individual risk (including both central tendency and high end) are presented, along with population risk. Important subgroups, such as highly exposed or highly susceptible, are identified. Refer to Part IV, the risk characterization section, for more detailed information from several types of exposure scenarios and the use of multiple risk descriptors (e.g., central tendency, high end of individual risk, population risk, important subgroups, if known) consistent with terminology in the Agency's Guidance on Risk Characterization, Agency Risk Assessment Guidelines (RAGs) and program-specific guidance.

Hazard Indexes (HIs) for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Four nonradioactive contaminants were analyzed. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. Of the four nonradioactive contaminants studied, mercury had the highest hazard index (0.62). However, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

Summary of Part I Results

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected radioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Estimated risks for rural resident with RME to Strontium-90 (SR-90), Cesium-137 (CS-137), Tritium (H-3), and Gross Alpha (α)

- The estimated lifetime excess total cancer risk for a Reasonably Maximally Exposed (RME) rural resident ingesting Savannah River fish taken from the Vogtle Electric Generating Plant Discharge (VEGPD) (which is close to Four Mile Creek), the mouth of Four Mile Creek, the mouth of Steel Creek, and the mouth of Lower Three Runs Creek (radioactive combined) is 5.46E-5

  - In short, with arithmetic rounding, this risk from SR-90, CS-137, H-3, and α combined for a RME rural resident should be considered to be a "1.00E-4" risk

  - Stated in other terms, this is roughly equivalent to one extra case of cancer in every 10,000 individuals with maximum exposure to SR-90, CS-137, H-3, and α

Estimated risks for rural residents with *average* exposure to SR-90 and CS-137, H-3, and α

- The upper bound estimate of lifetime excess total cancer risk due to SR-90, CS-137, H-3, and α combined for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) (radioactive combined) is 8.40E-6.

  - In short, with arithmetic rounding, the upper bound estimate of this risk from SR-90, CS-137, H-3, and α combined for an *average* rural resident should be considered to be a "1.00E-5" risk

  - Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with *average* exposure to SR-90, CS-137, H-3, and α

- The lower bound estimate of lifetime excess total cancer risk due to SR-90, CS-137, H-3, and α combined for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) (radioactive combined) is 3.98E-6.

  - In short, with arithmetic rounding, the lower bound estimate of this risk from SR-90, CS-137, H-3, and α combined for an *average* rural resident should be considered to be a "1.00E-6" risk

● ●   Stated in other terms, this is roughly equivalent to one extra case of cancer in every 1,000,000 individuals with *average* exposure to SR-90, CS-137, H-3, and α

Summary of Part II results

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Estimated risks for rural resident with RME to As, b-BHC, and DDE

●   The estimated lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for a Reasonably Maximally Exposed (RME) rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.06E-5**

     ● ●   In short, with arithmetic rounding, this risk from As, b-BHC, and DDE combined for a RME rural resident should be considered to have a "1.00E-5" risk

     ● ●   Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with maximum exposure to As, b-BHC, and DDE

Estimated risks for rural resident with *average* exposure to As, b-BHC, and DDE

●   The upper bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **6.19E-6**

     ● ●   In short, with arithmetic rounding, the upper bound estimate of this risk from As, b-BHC, and DDE combined for an *average* rural resident should be considered to have a "1.00E-5" risk

     ● ●   Stated in other terms, this is roughly equivalent to one extra case of cancer in every 100,000 individuals with *average* exposure to As, b-BHC, and DDE

● `   The lower bound estimate of lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **2.78E-6**

●● In short, with arithmetic rounding, the lower bound estimate of
this risk from As, b-BHC, and DDE combined for an *average*
<u>rural</u> resident should be considered to have a "1.00E-6" risk

●● Stated in other terms, this is roughly equivalent to one extra
case of cancer in every 1,000,000 individuals with *average*
exposure to As, b-BHC, and DDE

Summary of Part III Results

*Estimated lifetime excess total cancer risk for a resident ingesting fish which are
contaminated with selected radioactive and nonradioactive contaminants and are taken
from various locations along the Savannah River near the Savannah River Site (SRS)*

<u>Estimated risks for rural resident with RME to radioactive and nonradioactive contaminants</u>

● The estimated lifetime excess total cancer risk due to <u>radioactive and
nonradioactive contaminants combined</u> for a Reasonably Maximally Exposed
(RME) <u>rural</u> resident ingesting Savannah River fish taken from these locations
is **6.52E-5**

●● In short, with arithmetic rounding, this risk from both
radioactive and nonradioactive contaminants for a RME <u>rural</u>
resident should be considered to be a "1.00E-4" risk

●● Stated in other terms, this is roughly equivalent to one extra
case of cancer in every 10,000 individuals with <u>maximum</u>
exposure to both radioactive and nonradioactive contaminants

<u>Estimated risks for rural resident with *average* exposure to radioactive and nonradioactive</u>
<u>contaminants</u>

● The upper bound estimate of lifetime excess total cancer risk due to
radioactive and nonradioactive contaminants combined for an *average* <u>rural</u>
resident ingesting Savannah River fish taken from various locations along the
Savannah River near the Savannah River Site (SRS) is **1.46E-5**

●● In short, with arithmetic rounding, this risk from radioactive
and nonradioactive contaminants combined for an *average*
<u>rural</u> resident should be considered to be a "1.00E-5" risk

●● Stated in other terms, this is roughly equivalent to one extra
case of cancer in every 100,000 individuals with *average*
exposure to radioactive and nonradioactive contaminants

● The lower bound estimate of lifetime excess total cancer risk due to
radioactive and nonradioactive contaminants combined for an *average* <u>rural</u>

resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **6.76E-6**

●● In short, with arithmetic rounding, this risk from radioactive and nonradioactive contaminants combined for an average <u>rural</u> resident should be considered to be a **"1.00E-5"** risk

●● Stated in other terms, this is roughly equivalent to one extra case of cancer in every **100,000** individuals with <u>average</u> exposure to radioactive and nonradioactive contaminants

An executive summary of overall risks derived in this analysis is shown in Tables 1. and 2. which follow:

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	Reasonably Maximally Exposed (RME)	0.62
	Maximum Estimate of Average Exposure	0.30
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive and Nonradioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Radioactive	Nonradioactive	Radioactive and Nonradioactive Combined
Reasonably Maximally Exposed (RME)	5.46E-5	1.06E-5	1.30E-4
Maximum Estimate of Average Exposure	8.40E-6	6.19E-6	1.46E-5
Minimum Estimate of Average Exposure	3.98E-6	2.78E-6	6.76E-6

POTENTIAL HUMAN HEALTH EFFECTS OF INGESTING FISH WHICH ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART I. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE RADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART II. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART III. RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART IV. OVERALL RISK CHARACTERIZATION OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

PART I.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE RADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

	Key to Radioactive Risk Screening Tables	
Table Number	**Title**
1	Summary Table Of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Mean Levels of Selected Radioactive Contaminants in Edible Portions of Fish From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
3	Mean Annual Dose Of Radioactivity From Selected Radioactive Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
4	Summary Table Of Unit Risk Factors (q₁*s) for Oral Exposure To Selected Radioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
5	Estimated Lifetime Excess Total Cancer Risk From Selected Radioactive Contaminants to a Resident Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
6-1	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)
6-2	Mean Annual Dose Of Radioactivity Per kg of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth Of Four Mile Creek Near the Savannah River Site (SRS)
6-3	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)
6-4	Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)
7-1	Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)
7-2	Estimated Lifetime Excess Total Cancer Risk for a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth Of Four Mile Creek Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	α Hot Zone (STN 360) Resident Consumes Fish From Vogtle Electric Generating Plant Discharge (VEGPD) Here SR-90, CS-137, H-3, and α all are present, but [α] is highest	SR-90 Hot Zone (STN 365) Resident Consumes Fish From Mouth Of Four Mile Creek Here SR-90, CS-137, H-3, and α all are present, but [SR-90] is highest	H-3 Hot Zone (STN 410) Resident Consumes Fish From Mouth Of Steel Creek Here SR-90, CS-137, H-3, and α all are present, but [H-3] is highest	CS-137 Hot Zone (STN 440) Resident Consumes Fish From Mouth Of Lower Three Runs Creek Here SR-90, CS-137, H-3, and α all are present, but [CS-137] is highest	Radioactive Hot Zones Combined Resident Consumes Fish From VEGPD, Four Mile Creek, Steel Creek, and Lower Three Runs Creek Here Resident consumes Fish With the Highest Concentrations of SR-90, CS-137, H-3, and α together
Reasonably Maximally Exposed (RME) Resident Consumes Fish From Specific Hot Zones at the Mouths of Streams Leaving SRS	4.53E-5	1.18E-4	4.64E-5	1.05E-5	**5.46E-5**

Maximum Estimate of Average Exposure Resident Consumes Fish From Various Locations Along the Savannah River Near SRS (Assumes Higher Annual Consumption Rate)	7.39E-6	1.09E-5	9.84E-8	1.52E-5	8.40E-6
Minimum Estimate of Average Exposure Resident Consumes Fish From Various Locations Along the Savannah River Near SRS (Assumes Lower Annual Consumption Rate)	3.50E-6	5.18E-6	4.66E-8	7.20E-6	3.98E-6

Table 2.

Mean Levels Of Selected Radioactive Contaminants In Edible Portions of Fish From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: Lab results (i.e. dry) were converted to fresh (i.e. wet) concentrations in this risk screening; the dry concentration results were multiplied by 0.3, which approximates the typical dry/wet (D/W) ratios observed in these samples (which were 0.3 +/-0.1)

Sampling Station Number (STN)	CS-137		SR-90		H-3		α	
	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)	(picoCuries per dry kilogram)	(picoCuries per wet kilogram)
330	667.14	200.14	543.33	163.00	1,128.57	338.57	305.00	91.50
335	394.33	118.30	---	---	166.67	50.00	---	---
350	2,078.75	623.63	5,295.00	1588.5	5,612.50	1,683.75	185.00	55.50
355	116.67	35.00	---	---	---	---	---	---
360 (VEGPD, which is close to the Mouth of Four Mile Creek)	386.67	116.00	475.00	142.50	916.67	275.00	504.29	151.29
365 (Mouth of Four Mile Creek)	2,154.55	646.37	8,642.86	2,592.86	28,411.11	8,523.33	296.67	89.00
375	620.00	186.00	---	---	2,000.00	600.00	425.00	127.50
410 (Mouth of Steel Creek)	2,560.00	768.00	273.33	82.00	31,138.46	9,341.54	345.00	103.50
420	970.00	291.00	---	---	1,733.33	520.00	---	---

440 (Mouth of Lower Three Runs Creek)	2,851.42	855.43	---	---	1,771.43	531.43	300.00	90.00
460	213.33	64.00	---	---	1,575.00	472.50	165.00	49.50
530	186.67	56.00	---	---	1,800.00	540.00	215.00	64.50
540	138.29	41.49	30.00	9.00	2,216.67	665.00	---	---
Overall Arithmetic Means	1,025.99	307.80	1,173.81	352.14	6036.19	1810.86	210.84	63.25

Table 3.

Mean Annual Dose of Radioactivity From Selected Radioactive Contaminants Per kg of Fish Obtained by Ingesting Fish Taken from Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	307.80 pCi/kg X 9 kg/yr = 2,770.20 pCi/yr	352.14 pCi/kg X 9 kg/yr = 3,169.26 pCi/yr	1,810.86 pCi/kg X 9 kg/yr = 16,297.74 pCi/yr	63.25 pCi/kg X 9 kg/yr = 569.25 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	307.80 pCi/kg X 19 kg/yr = 5,848.20 pCi/yr	352.14 pCi/kg X 19 kg/yr = 6,690.66 pCi/yr	1,810.86 X 19 kg/yr = 34,406.34 pCi/yr	63.25 pCi/yr X 19 pCi/yr = 1,201.75 pCi/yr

Table 4.

Summary Table Of Unit Risk Factors (q_1*s) for Oral Exposure To Selected Radioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	CS-137	SR-90	H-3	α
q_1* (mg/kg-d)$^{-1}$	3.16E-11 (Risk/pCi)	4.09E-11 (Risk/pCi)	7.15E-14 (Risk/pCi)	3.16E-10 (Risk/pCi)

Table 5.

Estimated Lifetime Excess Total Cancer Risk From Selected Radioactive Contaminants to a
Resident Obtained By Ingesting Fish Taken From Various Locations
Along the Savannah River Near the Savannah River Site (SRS)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	2,770.20 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 3.50E-6	3,169.26 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 5.18E-6	16,297.74 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 4.66E-8	569.25 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 7.20E-6	3.98E-6
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	5,848.20 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 7.39E-6	6,690.66 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 1.09E-5	34,406.34 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 9.84E-8	1,201.75 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.52E-5	8.40E-6

Table 6-1.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)

(STN 360)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	116.00 pCi/kg X 9 kg/yr = 1,044.00 pCi/yr	142.50 pCi/kg X 9 kg/yr = 1,282.50 pCi/yr	275.00 pCi/kg X 9kg/yr = 2,475.00 pCi/yr	151.29 pCi/kg X 9kg/yr = 1,361.61 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	116.00 pCi/kg X 19 kg/yr = 2204.00 pCi/yr	142.50 pCi/kg X 19 kg/yr = 2,707.50 pCi/yr	275.00 pCi/kg X 19 kg/yr = 5,225.00 pCi/yr	151.29 pCi/kg X 19 kg/yr = 2,874.51 pCi/yr

Table 6-2.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Four Mile Creek Near the Savannah River Site (SRS)

(STN 365)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	646.37 pCi/kg X 9 kg/yr = 5,817.33 pCi/yr	2,592.86 pCi/kg X 9 kg/yr = 23,335.74 pCi/yr	8,523.33 pCi/kg X 9 kg/yr = 76,709.97 pCi/yr	89.00 pCi/kg X 9 kg/yr = 801.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	646.37 pCi/kg X 19 kg/yr = 12,281.03 pCi/yr	2,592.86 pCi/kg X 19 kg/yr = 49,264.34 pCi/yr	8,523.33 pCi/kg X 19 kg/yr = 161,943.27 pCi/yr	89.00 pCi/kg X 19 kg/yr = 1,691.00 pCi/yr

Table 6-3.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)

(STN 410)

Consumption Scenario	CS-137	SR-90	H-3	α
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	768.00 pCi/kg X 9 kg/yr = 6,912.00 pCi/yr	82.00 pCi/kg X 9 kg/yr = 738.00 pCi/yr	9,341.54 pCi/kg X 9 kg/yr = 84,073.86 pCi/yr	103.50 pCi/kg X 9 kg/yr = 9,315.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	768.00 pCi/kg X 19 kg/yr = 14,592.00 pCi/yr	82.00 pCi/kg X 19 kg/yr = 1,558.00 pCi/yr	9,341.54 pCi/kg X 19 kg/yr = 177,489.26 pCi/yr	103.50 pCi/kg X 19 kg/yr = 1,966.50 pCi/yr

Table 6-4.

Mean Annual Dose Of Radioactivity Per kg Of Fish From Selected Radioactive Contaminants Obtained by Ingesting Fish Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)

(STN 440)

Consumption Scenario	CS-137	SR-90	H-3	a
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	855.43 pCi/kg X 9 kg/yr = 7,698.87 pCi/yr	---	531.43 pCi/kg X 9 kg/yr = 4,782.87 pCi/yr	90.00 pCi/kg X 9 kg/yr = 810.00 pCi/yr
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	855.43 pCi/kg X 19 kg/yr = 16,253.17 pCi/yr	---	531.43 pCi/kg X 19 kg/yr = 10,097.17 pCi/yr	90.00 pCi/kg X 19 kg/yr = 1,710.00 pCi/yr

Table 7-1.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Vogtle Electric Generating Plant Discharge (VEGPD) Near the Savannah River Site (SRS)

(STN 360)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	σ	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	1,044.00 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.32E-6	1,282.50 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 2.10E-6	2,475.00 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 7.08E-9	1,361.61 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.72E-5	= 2.06E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	2,204.00 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 2.79E-6	2,707.50 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 4.43E-6	5,225.00 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 1.49E-8	2,874.51 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 3.63E-5	= 4.35E-5

Table 7-2.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected **Radioactive** Contaminants And Are Taken From the Mouth of Four Mile Creek Near the Savannah River Site (SRS)

(STN 365)

Note: The standard consumption period used in this risk screening is that usually used for <u>rural</u> residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	5,817.33 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 7.35E-6	23,335.74 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 3.82E-5	76,709.97 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.19E-7	801.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.01E-5	= 5.59E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	12,281.03 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.55E-5	49,264.34 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 8.06E-5	161,943.27 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 4.634E-7	1,691.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.14E-5	= 1.18E-4

Table 7-3.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Steel Creek Near the Savannah River Site (SRS)

(STN 410)

Note: The standard consumption period used in this risk screening is that usually used for _rural_ residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	α	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	6,912.00 pCi/yr X 40 yrs X 8.74E-6 (Risk/pCi) = 8.74E-6	738.00 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 1.21E-6	84,073.86 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.40E-7	931.50 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.18E-5	= 2.20E-5
Maximum Estimate (Assumes Higher Annual Consumption Rate)	14,592 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = 1.84E-5	1,558.00 pCi/yr X 40 yrs X 4.09E-11 (Risk/pCi) = 2.55E-6	177,489.26 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 5.08E-7	1,966.50 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.49E-5	= 4.64E-5

Table 7-4.

Estimated Lifetime Excess Total Cancer Risk For a Reasonably Maximally Exposed (RME) Resident Ingesting Savannah River Fish Which Have Selected Radioactive Contaminants And Are Taken From the Mouth of Lower Three Runs Creek Near the Savannah River Site (SRS)

(STN 440)

Note: The standard consumption period used in this risk screening is that usually used for rural residents (40 yr); the standard consumption period for an urban resident would be less (30 yr)

Consumption Scenario	CS-137	SR-90	H-3	a	Radioactive Combined
Minimum Estimate (Assumes Lower Annual Consumption Rate)	7,698.87 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = **9.73E-6**	---	4,782.87 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 1.37E-8	810.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 1.02E-5	= 4.99E-6
Maximum Estimate (Assumes Higher Annual Consumption Rate)	16,253.17 pCi/yr X 40 yrs X 3.16E-11 (Risk/pCi) = **2.05E-5**	---	10,097.17 pCi/yr X 40 yrs X 7.15E-14 (Risk/pCi) = 2.89E-8	1,710.00 pCi/yr X 40 yrs X 3.16E-10 (Risk/pCi) = 2.16E-5	= 1.05E-5

PART II.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Key to Nonradioactive Risk Screening Tables	
Table · Number	**Title**
1	Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
3	Mean Levels Of Selected **Nonradioactive** Contaminants In Edible Portions of Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
4	Mean Daily Doses of Selected **Nonradioactive** Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
5	Summary Table Of Reference Doses (RfDs) For Oral Exposure To Selected **Nonradioactive** Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
6	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Contaminated With **Arsenic** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
7	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Mercury** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
8	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Selenium** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
9	Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Zinc** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	Reasonably Maximally Exposed (RME)	0.62
	Maximum Estimate of Average Exposure	0.30
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	As	b-BHC	DDE	Nonradioactive Combined
Reasonably Maximally Exposed (RME)	1.86E-9	2.68E-5	5.06E-6	**1.06E-5**
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	7.45E-10	1.73E-5	1.26E-6	**6.19E-6**
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	3.53E-10	8.24E-6	5.94E-7	**2.78E-6**

Table 3.

Mean Levels of Selected Nonradioactive Contaminants In Edible Portions Of Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

County	Locus	Species Sampled	Average Length in Inches	Contaminant of Concern (mg/kg)											
				As		Hg		Se		Zn		b-BHC		DDE	
				run	avg	run	avg	run	avg	run	avg	run	avg	run	avg
Richmond	Downstream Lock & Dam	Largemouth Bass	14.8	—	—	0.18 to 0.21	0.20	0.32 to 0.38	0.35	8.80 to 10.00	9.40	—	0.02	< 0.01	< 0.1
		Sucker	14.9	—	—	0.10 to 0 26	0.18	0.26 to 0.35	0.31	8.30 to 12.00	9.70	< 0.01	< 0.01	< 0.01 to 0.02	0.006
Chatham	US 17	Channel Catfish	16.1	0.02 to 0.05	0.03	0.04 to 0.08	0 06	0.06 to 0.14	0.10	5.10 to 6.30	5.35	—	—	—	—
		Largemouth Bass	13.3	< 0 02 to 0.03	0.01	0.02 to 0 06	0 04	0.11 to 0.19	0.14	4 20 to 5.70	5.17	—	—	—	—
Combined Counties		Composite	14.8	0 02 to 0.05	0.02	0 02 to 0.25	0.12	0.06 to 0.38	0.23	4.20 to 12.00	7.40	< 0.01 to 0.02	0.013	< 0.01 to 0.02	0.006

Table 4.

Mean Daily Doses Of Selected Nonradioactive Contaminants Per kg Of Fish Obtained By Ingesting Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Consumption Scenario	As	Hg	Se	Zn	b-BHC	DDE
Minimum Estimate of Average Exposure (Assumes Lower Annual Consumption Rate)	0.02 mg/kg X 9 kg/yr = 0.18 mg/yr = 4.93E-4 mg/d = 7.05E-6 mg/kg-d	0.12 mg/kg X 9 kg/yr = 1.08 mg/yr = 2.96E-3 mg/d = 4.23E-5 mg/kg-d	0.23 mg/kg X 9 kg/yr = 2 07 mg/yr = 5.67E-3 mg/d = 8.10E-5 mg/kg-d	7.40 mg/kg X 9 kg/yr = 66.6 mg/yr = 0.18 mg/d = 2.61E-3 mg/kg-d	0.013 mg/kg X 9 kg/yr = 0.117 mg/yr = 3.21E-4 mg/d = 4.58E-6 mg/kg-d	0.005 mg/kg X 9 kg/yr = 0.045 mg/yr = 1.23E-4 mg/d = 1.76E-6 mg/kg-d
Maximum Estimate of Average Exposure (Assumes Higher Annual Consumption Rate)	0 02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	0.12 mg/kg X 19 kg/yr = 2.28 mg/yr = 6.25E-3 mg/d = 8.93E-5 mg/kg-d	0.23 mg/kg X 19 kg/yr = 4.37 mg/yr = 1.20E-2 mg/d = 1.71E-4 mg/kg-d	7.40 mg/kg X 19 kg/yr = 140.60 mg/yr = 3.85E-1 mg/d = 5.50E-3 mg/kg-d	0.013 mg/kg X 19 kg/yr = 0.247 mg/yr = 6.77E-4 mg/d = 9.67E-6 mg/kg-d	0.005 mg/kg X 19 kg/yr = 0.950 mg/yr = 2.60E-4 mg/d = 3.72E-6 mg/kg-d

Table 5.

Summary Table Of Reference Doses (RfDs) For Oral Exposure To Selected Nonradioactive Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	As	Hg	Se	Zn	b-BHC	DDE
RfD (mg/kg-day)	3.00E-4	3.00E-4	5.00E-3	3.00E-1	Not Available at this time	Not Available at this time

Table 6.

Hazard Index (HI) for Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With **Arsenic** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Channel Catfish Taken Solely at US 17, Chatham County]	0.05 mg/kg X 19 kg/yr = 0.95 kg/yr = 2.60E-3 mg/d = 3.72E-5 mg/kg-d	3.72E-5 mg/kg-d ─────────── = 3.00E-4 mg/kg-d 0.12
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.49E-5 mg/kg-d	1.49E-5 mg/kg-d ─────────── = 3.00E-4 mg/kg-d 0.05

Table 7.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Mercury and Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Sucker Taken Solely at Downstream Lock & Dam, Richmond County]	0.25 mg/kg 19 kg/yr = 4.75 mg/yr = 1.30E-2 mg/d = 1.86E-4 mg/kg-d	$\dfrac{1.86\text{E-4 mg/kg-d}}{3.00\text{E-4 mg/kg-d}} = 0.62$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	8.93E-5 mg/kg-d	$\dfrac{8.93\text{E-5 mg/kg-d}}{3.00\text{E-4 mg/kg-d}} = 0.30$

Table 8.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Selenium And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.38 mg/kg X 19 kg/yr = 7.22 mg/yr = 1.98E-2 mg/d = 2.83E-4 mg/kg-d	$\dfrac{2.83\text{E-}4 \text{ mg/kg-d}}{5.00\text{E-}3 \text{ mg/kg-d}} = 0.06$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.71E-4 mg/kg-d	$\dfrac{1.71\text{E-}4 \text{ mg/kg-d}}{5.00\text{E-}3 \text{ mg/kg-d}} = 0.03$

Table 9.

Hazard Index (HI) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained By Ingesting Fish Which Are Contaminated With Zinc And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	HI
Reasonably Maximally Exposed (RME) [Sucker Taken Solely at Downstream Lock & Dam, Richmond County]	12.00 mg/kg X 19 kg/yr = 228 mg/yr = 0.62 mg/d = 8.92E-3 mg/kg-d	$\dfrac{8.92\text{E-3 mg/kg-d}}{3.00\text{E-1 mg/kg-d}} = 0.03$
Maximum Estimate of Average Exposure - [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	5.50E-3 mg/kg-d	$\dfrac{5.50\text{E-3 mg/kg-d}}{3.00\text{E-1 mg/kg-d}} = 0.02$

Table 10.

Summary Table of Unit Risk Factors (q_1*s) For Oral Exposure To Selected **Nonradioactive** Contaminants Found In Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Contaminant of Concern	As	b-BHC	DDE
q_1* (mg/kg-d)$^{-1}$	5.00E-5	1.80E+0	3.40E-1

Table 11.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With Arsenic And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Channel Catfish Taken Solely at US 17, Chatham County]	0.05 mg/kg X 19 kg/yr = 0.95 kg/yr = 2.60E-3 mg/d = 3.72E-5 mg/kg-d	3.72E-5 mg/kg-d X $\qquad$ = 1.86E-9 5.00E-5 (mg/kg-d)$^{-1}$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X $\qquad$ = 7.45E-10 5.00E-5 (mg/kg-d)$^{-1}$
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	7.05E-6 mg/kg-d	7.05E-6 mg/kg-d X $\qquad$ = 3.53E-10 5.00E-5 (mg/kg-d)$^{-1}$

Table 12.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With **b-BHC** And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Maximum Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X $\qquad$ = 2.68E-5 1.80E+0 (mg/kg-d)$^{-1}$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the · Savannah River Near the Savannah River Site (SRS)]	9.67E-6 mg/kg-d	9.67E-6 mg/kg-d X $\qquad$ = 1.73E-5 1.80E+0 (mg/kg-d)$^{-1}$
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	4.58E-6 mg/kg-d	4.58E-6 mg/kg-d X $\qquad$ = 8.24E-6 1.80E+0 (mg/kg-d)$^{-1}$

Table 13.

Upper Estimates Of Lifetime Excess Total Cancer Risk For a Resident Obtained By Ingesting Fish Which Are Contaminated With DDE And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Individual Risk = Unit Risk Factor X Individual Dose

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Daily Dose	Individual Risk
Reasonably Maximally Exposed (RME) [Largemouth Bass Taken Solely at Downstream Lock & Dam, Richmond County]	0.02 mg/kg X 19 kg/yr = 0.38 mg/yr = 1.04E-3 mg/d = 1.49E-5 mg/kg-d	1.49E-5 mg/kg-d X = 5.06E-6 3.40E-1 (mg/kg-d)$^{-1}$
Maximum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	3.72E-6 mg/kg-d	3.72E-6 mg/kg-d X = 1.26E-6 3.40E-1 (mg/kg-d)$^{-1}$
Minimum Estimate of Average Exposure [Fish Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)]	1.76E-6 mg/kg-d	1.76E-6 mg/kg-d X = 5.94E-7 3.40E-1 (mg/kg-d)$^{-1}$

PART III.

RISK SCREENING ESTIMATES OF POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE SAVANNAH RIVER SITE (SRS)

Key to Combined Radioactive and Nonradioactive Risk Screening Tables	
Table Number	**Title**
1	Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)
2	Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected Radioactive and Nonradioactive Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Table 1.

Summary Table Of Hazard Indexes (HIs) For Deleterious Non-Cancer Systemic Effects During a Lifetime Obtained by Ingesting Fish Which Are Contaminated With Selected Nonradioactive Contaminants And Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

HI = Human Dose / RfD

If this number is = or > "1", this indicates that the RfD has been exceeded. Usually, doses less than the RfD are not likely to be associated with any systemic health risks and are therefore less likely to be of regulatory concern. However, as the frequency of exposure exceeding the RfD increases, and as the size of the excess increases, the probability increases that adverse effects may be observed in a human population.

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Contaminant of Concern	Consumption Scenario	HI
Arsenic	Reasonably Maximally Exposed (RME)	0.12
	Maximum Estimate of Average Exposure	0.05
Mercury	Reasonably Maximally Exposed (RME)	0.62
	Maximum Estimate of Average Exposure	0.30
Selenium	Reasonably Maximally Exposed (RME)	0.06
	Maximum Estimate of Average Exposure	0.03
Zinc	Reasonably Maximally Exposed (RME)	0.03
	Maximum Estimate of Average Exposure	0.02
b-BHC	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown
DDE	Can Not Be Estimated Because a Reference Dose (RfD) Is Not Available At This Time	Unknown

Table 2.

Summary Table of Estimated Lifetime Excess Cancer Risk For a Resident Ingesting Fish Which Are Contaminated With Selected **Radioactive and Nonradioactive** Contaminants And Are Taken From Various Locations Along the Savannah River Near the Savannah River Site (SRS)

Note: The maximum (19 kg/yr) fish consumption rate was used to obtain these upper estimates; the minimum (9 kg/yr) consumption rate was used elsewhere in this risk screening to obtain lower estimates as well.

Consumption Scenario	Radioactive	Nonradioactive	Radioactive and Nonradioactive Combined
Reasonably Maximally Exposed (RME)	5.46E-5	1.06E-5	6.52E-5
Maximum Estimate of Average Exposure	8.40E-6	6.19E-6	1.46E-5
Minimum Estimate of Average Exposure	3.98E-6	2.78E-6	6.76E-6

PART IV.

OVERALL RISK CHARACTERIZATION OF
POTENTIAL HUMAN HEALTH EFFECTS DUE TO INGESTING FISH WHICH
HAVE COMBINED RADIOACTIVE AND NONRADIOACTIVE
CONTAMINANTS AND ARE TAKEN FROM LOCATIONS NEAR THE
SAVANNAH RIVER SITE (SRS)

I. Risk Characterization

The purpose of this section is to clearly communicate results of the risk assessment to the risk manager. Key scientific concepts, data, and methods are discussed here. This section provides an evaluation of the overall quality of the assessment and the degree of confidence the authors have in the estimates of risk and conclusions drawn. Section also describes risks to individuals and populations in terms of extent and severity of probable harm. This section integrates individual characterizations from:

A. Hazard Identification

1. *What is known about the capacity of the contaminants of concern for causing cancer or other adverse health effects in humans, laboratory animals, or wildlife species?*

EPA classifies all radionuclides as Group A (known human) carcinogens. Radionuclide slope factors are calculated by EPA's Office of Radiation and Indoor Air (ORIA) to assist HEAST (Health Effects Assessment Summary Tables) users with risk-related evaluations and decision-making at various stages of the remediation process. Therefore, the radioactive contaminants of concern in this risk screening, Strontium-90 (SR-90), Cesium-137 (CS-137), Tritium (H-3), and Gross Alpha (α) are analyzed as Group A (known human) carcinogens.

The unit risk factors (q_1's) for these four radioactive contaminants appear in Part I, Table 4. These q_1's have been obtained from the most currently available version of HEAST (November, 1994).

There are six nonradioactive contaminants of concern in this risk screening: Arsenic (As); Mercury (Hg); Selenium (Se); Zinc (Zn); Hexachlorocyclohexane, Beta (b-BHC); and 2,2-BIS(p-CHLOROPHENYL)-1,1-DICHLOROETHYLENE (DDE).

Three of these nonradioactive contaminants of concern are also carcinogens:

- As is a Group A (known human) carcinogen
- b-BHC is a Group B2 (probable human) carcinogen
- DDE is a Group B2 (probable human) carcinogen

The q_1's for these three nonradioactive contaminants appear in Part II, Table 10. These q_1's have been obtained from an on line search of EPA's IRIS (Integrated Risk Information System) on July 25, 1995.

All six of these nonradioactive contaminants of concern can cause deleterious non-cancer systemic effects. However,

Reference Doses (RfDs) for b-BHC and DDE are not available at this time in IRIS. Consequently, these two nonradioactive contaminants of concern were not analyzed further.

The RfDs for four of the nonradioactive contaminants appear in Part II, Table 5. These RfDs have been obtained from an on line search of EPA's IRIS (Integrated Risk Information System) on July 25, 1995.

2.   *What are the related uncertainties and science policy choices?*

Since b-BHC and DDE were not analyzed, due to RfDs for these two contaminants not being available, it is not known if consumption of fish with existing levels of these two pollutants can produce deleterious non-cancer systemic effects.

B.   **Dose-Response Assessment**

1.   *What is known about the biological mechanisms and dose-response relationships underlying any effects observed in the laboratory or epidemiology studies providing data for this assessment?*

See entries for these contaminants of concern in EPA's Integrated Risk Information System (IRIS).

2.   *What are the related uncertainties and science policy choices?*

See entries for these contaminants of concern in EPA's Integrated Risk Information System (IRIS).

C.   **Exposure Assessment**

In this subsection several types of risk information are presented on the range of exposures derived from exposure scenarios and on the use of multiple risk descriptors consistent with terminology in the EPA Guidance on Risk Characterization, Agency risk assessment guidelines, and program-specific guidance.

1.   *What is known about the principle paths, patterns, and magnitudes of human and wildlife exposure and numbers of persons or wildlife species likely to be exposed?*

All aquatic species are likely to be affected. No attempt has been made to evaluate the bioaccumulation of these aquatic species through selected food chains from smaller species of

fish to other wetland species such as the raptors (e.g., kingfishers, hawks, owls, cormorants, osprey, and eagles), as well as several varieties of turtles and alligators. Since bones and carcass are usually taken whole as prey, the bone seeking characteristic of SR-90 should be considered, because one could reasonably hypothesize that levels of SR-90 might be successively magnified through the food chains of these predacious species.

The principle human pathway is fish ingestion. All individuals in the general population who ingest these fish should sustain some small, but measurable, additional risk. Recreational and subsistence fishermen, because of higher consumption rates, should be expected to sustain relatively higher levels of these risks than the general population.

2.   *What are the related uncertainties and science policy choices?*

Subsistence fishermen frequently do not release undersized fish. This is especially true for small panfish like bluegills, sunfish, and suckers. These small fish frequently are simply gutted, fried whole and consumed "bones and all". This local consumption practice would necessarily increase SR-90 levels, because there would be relatively more SR-90 in the bones of the fish vis-à-vis the filet.

Additionally, subsistence fishermen frequently don't simply consume pan fish. Local subsistence fishermen in this area are known to include other aquatic species such as eels, turtles, and alligators in their catch. One would expect that these particular aquatic species, because they are further along the food chain than pan fish, might successively magnify levels of SR-90 in the bones of fish that they prey on. Subsistence fishermen may thereby obtain higher levels of SR-90 in their diet than either recreational fishermen or fish consumers in the general population. Therefore, the risks for subsistence fishermen, who in this analysis are consuming only fish filets, would probably be underestimated.

Locally grown vegetable crops around SRS are monitored for radionuclide content. Vegetable crops which normally have high calcium content, e.g., collard greens, can also have relatively increased levels of SR-90. As a local favorite, particularly among people of color, this staple of the local diet may serve as an additional avenue of exposure, in addition to that which is obtained by Savannah River fish consumption. However, the potential pathway for SR-90 in locally grown

collard greens is not analyzed here. The amount of SR-90 consumed by fish consumers thereby may be higher than the amounts calculated here, and this would tend to underestimate the risk due to SR-90.

II. Discussion of Uncertainty in the Overall Assessment

The purpose of this section is to discuss fully the uncertainty in the overall assessment. The quality and quantity of available data, gaps in the database for specific chemicals, and the quality of the measured data are discussed. Use of default assumptions is reviewed. Any incomplete understanding of general biological phenomena is discussed here. Importantly, scientific judgments or science policy positions that were employed to bridge information gaps are presented here.

A. Quality and Quantity of Available Data

1. Variability

There are two separate sets of data which have been analyzed in this screening-level risk assessment. the nonradioactive contaminants and the radioactive contaminants were measured in separate groups of fish samples at two different periods. Further, there is incomplete overlap of the portions of the Savannah River selected for sampling the fish. Ideally, simultaneous analyses of both radioactive and nonradioactive contaminants should be obtained in the same fish, from the same locations. However, to the Agency's knowledge these are the only sets of fish sampling data available for analysis at this time.

2. Uncertainty

There are many more aquatic species, and many more samples for each of these species, in the radioactive data set than in the nonradioactive data set. Therefore, one should be much more confident about the risks identified in this analysis for the radioactive contaminants vis-à-vis the nonradioactive contaminants.

B. Data Gaps

The special circumstance of a lack of data for nonradioactive contaminants in the Savannah River basin limit a detailed analysis of the impacts of these pollutants on human health and the environment of this community. There is relatively much more data on radioactive contaminants for this geographic area, and the analysis of the potential effects of this class of pollutants is consequently more robust. The authors are therefore much more confident

about the risk characterization of the radioactive contaminants vis-à-vis the nonradioactive contaminants.

C.   Process of Alternatives Selection

1.   Rationale for the Choice

Maximum estimate of *average* exposure is based on fish samples taken at random along a 132.8 mile stretch of the Savannah River, this length being determined by the availability of sampling data near the Savannah River Site.

Georgia Department of Natural resources provided the data used in this risk screening.

a.   *Radioactive Contaminant Data*
      Source

In December, 1994, the Georgia Department of Natural Resources (DNR) Environmental Protection Division (Environmental Radiation Section) had provided EPA Region IV the document titled: "Environmental Radioactivity Data: SRS (Savannah River Site) area ...1/1/90 - 4/20/94" (compiled 4/20/94).

Radioactivity levels in fish samples, reported in picoCuries per dry kilogram, appear on pp 72-75 of this document, which was the primary source of radioactive contaminant data used in this risk screening.

b.   *Nonradioactive Contaminant Data*
      Source

Data sheets for the Augusta and Savannah site sampling of fish on the Savannah River was collected September 22 - 23, 1993 as part of the Georgia Department of Natural Resources River Assessment Project.

c.   *Scope and Methodology*

Levels for CS-137, K-40, H-3, ALPHA, BETA, BETAS, and SR-90 are reported for several aquatic species. On advice of the Region IV Office of Radiation, the alpha levels are considered to be contributed predominantly by

a. This risk screening focuses on only CS-137, SR-90, H-3, and *a* levels in fish taken from a 132.8 mile stretch of the Savannah River close to the Savannah River Site.

Even though levels of radioactivity in both edible and inedible portions of fish are reported, only portions designated as "edible" or "filet" have been used in this risk screening. Lab results (i.e. dry) were converted to fresh (i.e. wet) concentrations by multiplying by 0.3, which approximates the typical Dry/Wet (D/W) ratios observed in these samples (which were 0.3 +/- 0.1).

Both minimum (9 kg/yr) and maximum (19 kg/yr) consumption rates, for both urban and rural residents were used in this risk screening. Risks for urban residents (consumption period 30 years) and rural residents (consumption period 40 years) were estimated.

Arithmetic means of radioactivity levels in fish for various locations along this 132.8 mile stretch of the Savannah River adjacent to the Savannah River Site (SRS) were calculated. Next, a mean dose of radioactivity per kg of fish for various locations along this stretch of the Savannah River was obtained. This mean dose of radioactivity was then used to estimate *average* cancer risk for both urban residents and rural residents taking fish from various locations along this 132.8 mile stretch of the Savannah River.

In like fashion, a mean dose of radioactivity per kg of fish was obtained for fish taken at the Vogtle Electric Generating Plant Discharge (VEGPD) [which is close to the mouth of Four Mile Creek], and the confluences of Four Mile Creek, Steel Creek, and Lower Three Runs Creek. Similarly, this mean dose of radioactivity was then used to estimate *Reasonable Maximum Exposure (RME)* cancer risk for rural residents taking fish from each respective confluence.

Sport fish data were derived from a creel survey
conducted by the Georgia Department of Natural
Resources from the Savannah River Lock and
Dam to the Atlantic Ocean 1/10/88 - 12/24/88.
See report by Dennis Schmidt (DNR-Fisheries
@912-727-2112), "Savannah River Creel
Survey", Report F-30-16.

Two consumption rates were used in this risk
screening: a minimum estimate of 9 kg/yr and a
maximum estimate of 19 kg/yr. These
consumption rates are taken from WSRC-RP-91-
17, "Land and Water Use Characteristics of the
Savannah River Site (U)", published in March,
1991. Nuclear Regulatory commission (NRC)
default values for average and maximum
consumption are 6.3 and 21 kg respectively.

2.   Effects of Alternatives Selected on the
      Assessment

These Savannah River sampling sites are spread along 132.8
miles of stream near the vicinity of the Savanah River Site
(SRS). The Vogtle Electric Generating Plant discharge is 3.5
miles downstream from the first sampling site and 0.9 miles
upstream of the mouth of Four Mile Creek. Although the
Vogtle Plant is believed to discharge a small quantity of CS-
137, DNR considers SRS to be the major contributor of CS-
137 and the sole contributor of SR-90.

Samples taken at the mouth Four Mile Creek contained the
highest concentrations of SR-90. The highest concentrations
of H-3 were found at the mouth of Steel Creek, and the
highest levels of α were found 50 yards downstream of
VEGPD. The highest concentrations of CS-137 were found in
samples taken near the confluence of Lower Three Runs
Creek.

3.   Comparison with Other Plausible Alternatives

Actual risk estimates that might be obtained from a formal risk
assessment could vary substantially from this initial risk
screening; most probably they would be greater than the
estimates presented here. For instance, some risk assessors
may chose to include all portions of the available fish samples
and not restrict the analysis to the edible flesh portions. It is
likely that the SR-90 risk estimates could be substantially

greater if the whole fish were to be consumed, because SR-90 is a known "bone seeker"; this would increase risk estimates. Additionally, some risk assessors may choose to use 70 years of fish consumption, instead of the 40 year period used in this risk screening; this would further increase risk estimates shown above.

III.   Conclusions

This risk characterization is separate from any risk management considerations. In decision-making, risk managers should use risk information appropriate to their program legislation.

This risk characterization presents several types of information. Information is presented on the range of exposures derived from exposure scenarios and the use of multiple risk descriptors (e.g., central tendency, high end of individual risk, population risk, important subgroups, if known) consistent with terminology in the Agency's Guidance on Risk Characterization, Agency Risk Assessment Guidelines (RAGs) and program-specific guidance.

A.   Noncancer Systemic Effects

Hazard Indexes (HIs) for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with selected **nonradioactive** contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

Four nonradioactive contaminants were analyzed. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. however, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

B.   Cancer Effects

1.   Risk due to selected **radioactive** contaminants

Estimated lifetime excess total cancer risk for a resident ingesting fish which are contaminated with selected **radioactive** contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS)

a.   <u>Estimated risks for rural resident with RME to SR-90, CS-137, H-3, and α:</u>

An analysis of an individual <u>rural</u> resident with a *Reasonable Maximum Exposure (RME)* to SR-90, CS-137,H-3, and α was performed for sampling data from VEGPD, and the mouths of Four Mile Creek, *Steel Creek, and Lower Three Runs* Creek, those locations of this stretch of the Savannah River which have the highest levels these radionuclides. The estimated lifetime excess total **cancer risk due to SR-90, CS-137,** H-3, and α for a *Reasonably Maximally Exposed (RME)* <u>rural</u> resident ingesting Savannah River fish taken solely from these locations is **5.46E-5.** In short, with arithmetic rounding, the risk from these radionuclides combined for a RME <u>rural</u> resident should be considered to be a **"1.00E-4"** risk.

b.   <u>Estimated risks for rural residents</u>
      <u>with *average* exposure to SR-90,</u>
      <u>CS-137, H-3, α</u>:

An analysis was performed of an individual <u>rural</u> resident consuming fish from various locations along the Savannah River near the Savannah River Site (SRS). In this consumption scenario this rural resident consumes fish from the VEGPD as well as from the mouths of Four Mile Creek, Steel Creek, and Lower Three Runs Creek. Thereby this rural resident obtains fish with the highest concentrations of SR-90, CS-137, H-3, and α.

The <u>upper bound</u> estimate of lifetime excess total **cancer risk due to SR-90, CS-137, H-3, and** α for a <u>rural</u> resident ingesting the upper limit of an *average* amount of Savannah River fish taken solely from these locations is **8.40E-6.** In short, with arithmetic rounding, the upper bound estimate of this risk from these radionuclides for an *average* <u>rural</u> resident should be considered to be a **"1.00E-5"** risk.

The <u>lower bound</u> estimate of lifetime excess total *cancer risk due to SR-90, CS-137, H-3, and* α for a <u>rural</u> resident ingesting the lower limit of an *average* amount of Savannah River fish taken solely from these locations is **3.98E-6.** In short,

with arithmetic rounding, the upper bound
estimate of this risk from these radionuclides for
an *average* rural resident should be considered to
be a "1.00E-6" risk.

2.   Risk Due to Selected Nonradioactive
      Contaminants

Estimated lifetime excess total cancer risk for a resident
ingesting fish which are contaminated with selected
nonradioactive contaminants and are taken from various
locations along the Savannah River near the Savannah River
Site (SRS)

   a.   Estimated risks for rural resident
         with RME to As, b-BHC, and DDE

   i.   *Arsenic (As)*

   An analysis of an individual rural resident with a
   Reasonable Maximum Exposure (RME) to As
   was performed for sampling data from various
   locations along the Savannah River near the
   Savannah River Site (SRS).

   The estimated lifetime excess total cancer risk
   due to As for a Reasonably Maximally Exposed
   (RME) rural resident ingesting Savannah River
   fish taken from these locations is 1.86E-9. In
   short, with arithmetic rounding, this risk from As
   for a RME rural resident should be considered to
   be a "1.00E-9" risk.

   ii.   *b-BHC*

   Likewise, an analysis of an individual rural
   resident with a *Reasonable Maximum Exposure
   (RME)* to b-BHC was performed for sampling
   data from the from various locations along the
   Savannah River near the Savannah River Site
   (SRS).

   The estimated lifetime excess total cancer risk
   due to b-BHC for a *Reasonably Maximally
   Exposed (RME)* rural resident ingesting Savannah
   River fish taken from these locations is 2.68E-5.
   In short, with arithmetic rounding, the upper
   bound estimate of this risk from b-BHC for a

RME rural resident should be considered to be "1.00E-5".

iii. *DDE*

Again, an analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to DDE was performed for sampling data from the from various locations along the Savannah River near the Savannah River Site (SRS).

The estimated lifetime excess total cancer risk due to DDE for a Reasonably Maximally Exposed (RME) rural resident ingesting Savannah River fish taken solely from these locations is 5.06E-6. In short, with arithmetic rounding, this risk from DDE for a RME rural resident should be considered to be "1.00E-5".

iv. *As, b-BHC, and DDE*
     (nonradioactive combined)

Therefore, the estimated lifetime excess total cancer risk due to As, b-BHC, and DDE (nonradioactive combined) for a *Reasonably Maximally Exposed (RME)* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is 1.06E-5. In short, with arithmetic rounding, this risk from As, b-BHC, and DDE combined for a RME rural resident should be considered to be "1.00E-5".

b. **Estimated risks for rural resident**
    with *average* exposure to As, b-
    BHC, and DDE

An analysis of an individual rural resident with a maximum estimate of *average* exposure to **As** was performed for sampling data from various locations along the Savannah River near the Savannah River Site.

i. *Arsenic (As)*

The upper bound estimate of lifetime excess total cancer due to As risk for a rural resident

ingesting an *average* amount of Savannah River fish taken from these locations is **7.45E-10**. In short, with arithmetic rounding, the upper bound estimate of this risk from As for an *average* <u>rural</u> resident should be considered to be **"1.00E-9"**.

The lower bound estimate of lifetime excess total cancer due to As risk for a <u>rural</u> resident ingesting an *average* amount of Savannah River fish taken from these locations is **3.53E-10**. In short, with arithmetic rounding, the lower bound estimate of this risk from As for an *average* <u>rural</u> resident should be considered to be **"1.00E-10"**.

ii. *b-BHC*

Likewise, an analysis of an individual <u>rural</u> resident with an *average* exposure to **b-BHC** was performed for sampling data from these locations.

The upper bound estimate of lifetime excess total cancer risk due to b-BHC for an *average* <u>rural</u> resident ingesting Savannah River fish taken solely from these locations is **1.73E-5**. In short, with arithmetic rounding, the upper bound estimate of this risk from b-BHC for an *average* <u>rural</u> resident should be considered to be **"1.00E-5"**.

The lower bound estimate of lifetime excess total cancer risk due to b-BHC for an *average* <u>rural</u> resident ingesting Savannah River fish taken solely from these locations is **8.24E-6**. In short, with arithmetic rounding, the lower bound estimate of this risk from b-BHC for an *average* <u>rural</u> resident should be considered to be **"1.00E-5"**.

iii. *DDE*

Again, an analysis of an individual <u>rural</u> resident with an *average* exposure to **DDE** was performed for sampling data from the from various locations along the Savannah River near the Savannah River Site (SRS).

The upper bound estimate of lifetime excess
total cancer risk due to DDE for an *average* rural
resident ingesting Savannah River fish taken
solely from these locations is **1.26E-6. In short,
with arithmetic rounding, the upper bound
estimate of this risk from DDE for an *average*
rural** resident should be considered to be **"1.00E-
6"**.

The lower bound estimate of lifetime excess
total cancer risk due to DDE for an *average* rural
resident ingesting Savannah River fish taken
solely from these locations is **5.94E-7. In short,
with arithmetic rounding, the upper bound
estimate of this risk from DDE for an *average*
rural** resident should be considered to be **"1.00E-
6"**.

iv.   *As, b-BHC, and DDE
        (nonradioactive combined)*

Therefore, the combined upper bound estimate
of lifetime excess total cancer risk due to As, b-
BHC, and DDE (nonradioactive combined) for an
average rural resident ingesting Savannah River
fish taken from various locations along the
Savannah River near the Savannah River Site
(SRS) is **1.86E-5**. In short, with arithmetic
rounding, the upper bound estimate of this risk
from As, b-BHC, and DDE combined for an
average rural resident should be considered to be
"1.00E-5".

Similarly, the lower bound estimate of lifetime
excess total cancer risk due to As, b-BHC, and
DDE (nonradioactive combined) for an *average*
rural resident ingesting Savannah River fish
taken from various locations along the Savannah
River near the Savannah River Site (SRS) is
2.78E-6. In short, with arithmetic rounding, the
lower bound estimate of this risk from As, b-
BHC, and DDE combined for an *average* rural
resident should be considered to be **"1.00E-6"**.

3.   Estimated lifetime excess total cancer risk for a resident
       ingesting fish which are contaminated with selected
       radioactive and nonradioactive contaminants and are taken

from various locations along the Savannah River near the Savannah River Site (SRS)

a. Estimated risks for rural resident with RME to radioactive and nonradioactive contaminants

   i.   The estimated lifetime excess total cancer risk for an individual rural resident with a *Reasonable Maximum Exposure (RME)* to radioactive contaminants (see above) is **1.19E-4.**

   ii. The analysis of an individual rural resident with a *Reasonable Maximum Exposure (RME)* to nonradioactive contaminants (see above) is **1.06E-5.**

   iii. Therefore, the estimated lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for a *Reasonably Maximally Exposed (RME)* rural resident ingesting Savannah River fish taken from these locations is **1.30E-4.** In short, with arithmetic rounding, this risk from both radioactive and nonradioactive contaminants for a RME rural resident should be considered to be a "1.00E-4" risk.

   iv. *Stated in other terms, this is roughly equivalent to one extra case of cancer in every 10,000 individuals with maximum exposure.*

b. Estimated risks for rural resident with *average* exposure to radioactive and nonradioactive contaminants:

   i.   The upper bound estimate of lifetime excess total cancer due to all radioactive contaminants studied for a rural resident

ingesting an *average* amount of Savannah River fish taken from these locations is **8.40E-6, roughly a 1.00E-5 risk.**

The lower bound estimate of lifetime excess total **cancer due to all radioactive contaminants studied for a rural** resident ingesting an *average* amount of Savannah River fish taken from these locations is **3.98E-6, roughly a 1.00E-6 risk.**

ii. The upper bound estimate of lifetime excess total **cancer risk due to all nonradioactive** contaminants for an *average* **rural** resident ingesting Savannah River fish taken solely from these locations is **6.19E-6, roughly a 1.00E-5 risk.**

The lower bound estimate of lifetime excess total **cancer risk due to all nonradioactive** contaminants for an *average* **rural** resident ingesting Savannah River *fish taken solely from these* locations is **2.78E-6, roughly a 1.00E-6 risk.**

iii. The upper bound estimate of lifetime excess total **cancer risk due to radioactive and nonradioactive contaminants combined** for an average **rural** resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is **1.46E-5.** In short, with arithmetic rounding, this risk for a RME **rural** resident from nonradioactive and radioactive contaminants combined should be considered to be a **"1.00E-5"** risk.

The lower bound estimate of
lifetime excess total cancer risk
due to all radioactive and
nonradioactive contaminants
combined for an *average* rural
resident ingesting Savannah River
fish taken solely from these
locations is **6.76E-6**. In short,
with arithmetic rounding, this risk
for a RME rural resident from
nonradioactive and radioactive
contaminants combined should be
considered to be a "1.00E-5" risk.

iv.   *Stated in other terms, this is
roughly equivalent to one extra
case of cancer in every 100,000
individuals with average exposure.*

IV.   Information Regarding Strengths and Limitations of this Risk Assessment
For:

A.   Other Risk Assessments

The Office of Radiation of APTMD uses a different method which compares
levels of environmental radioactivity to radiation protection standards, not
the estimation of excess cancer. This may be problematic, in that a level of
radioactivity which may be deemed "safe" under these radiation protection
standards may nevertheless account for an excess total number of cancers
that can be estimated using standard risk screening methods.

Importantly, of many potential human health risks, only lifetime excess total
cancer risks from two radionuclides, strontium-90 (SR-90) and cesium (CS-
137), are estimated in this analysis. Even though data may exist for a
variety of radionuclides in these waters, only cancer risks from ingestion of
fish containing concentrations of these two radionuclides have been
evaluated. Consideration of other radionuclides which are known to exist in
this stream would increase the risk estimates derived in this risk screening.
One should realize that the individual levels of contaminants used in the
Reasonably Maximally Exposed (RME) estimates were, in fact, high-end, not
maximum, values. The radioactive contaminant levels of all fish samples for
each sampling station (STN) were averaged for that respective location.
Next, those locations with the highest levels of specific radionuclides were
selected as loci for further *RME* analysis. This *RME* approach is consistent
with the Administrator's policy guidance on risk characterization.

This risk screening is based on preliminary data provided by the Georgia Department of Natural resources. The Georgia Department of Natural Resources is cooperating with EPA on further analysis of non-radiological contaminants in this waterway. We have learned that the Georgia Department of Natural Resources has new fish sampling data, but these data are not available to the Agency at this time. We hope to obtain these new data for further analysis of the risks in this community.

B.   Relevance of this Risk Assessment for EPA Decision-Makers

The SRS F & H Area groundwater plume drains into Four Mile Creek. EPA Records of Decision (RODs) require groundwater remediation to prevent additional contamination of Four Mile Creek.

There is one perspective of this analysis which deserves special mention. Fish consumers in the Savannah River community may be highly exposed. In this community some of these fish consumers have been identified as poor people of color. EPA has evidence that some of these same people are, in fact, subsistence fishermen. Selection of this population segment was a matter of discovery of a highly exposed subgroup during the assessment process, and not a matter of a priori interest in the subgroup because of environmental justice considerations. These findings must be given careful consideration.

C.   Caveats for the Risk Manager

For the most part, this risk screening addresses human health considerations, not ecological risks. There are other potential adverse human health effects, besides cancer, that could be produced by other non-radiological contaminants. The contributions of non-radioactive toxic compounds to the production of adverse human health effects, including cancer, are not analyzed here.

D.   Public Involvement Issues

1.   Ecological Considerations

    a.   Alligators and aquatic turtles (especially soft back and snapping turtles) have not been included in this risk screening. Even though these species are know to be harvested by local fishermen, creel survey-type data on these edible game species have not been located to date.

    b.   Another species of special interest are catadromous eels of the genus *anguilla*. These eels are apparently a favorite delicacy of local

residents, some adult eels reaching about three feet in length. These eels migrate from the Savannah River to the Sargossa Sea (part of the North Atlantic between the West Indies and the Azores) to spawn. Some of these eels have been found on the Savannah River Site, specifically in Par Pond. However, to date, neither the Georgia DNR or Region IV's Environmental Services Division (ESD) have sampled these eels for heavy metals or radionuclides.

c.   In consideration of these potential ecological impacts the reader should note that this risk screening focuses primarily on potential human health risks, not ecological risks. Nevertheless, in so far as several of these aquatic species are part of the human diet in this community, there are probably shared adverse impacts.

2.   Human Health Considerations

1.   Who are the people at greatest risk?

The people at greatest risk are subsistence fishermen, who in this area have been identified as primarily poor people of color.

2.   What risk levels are they subjected to?

The estimated lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for a *Reasonably Maximally Exposed (RME)* rural resident ingesting Savannah River fish taken from these locations is 5.08E-4. In short, with arithmetic rounding, this risk from both radioactive and nonradioactive contaminants for a RME rural resident should be considered to be a "1.00E-3" risk.

In other terms, one would expect one extra case of cancer in 1,000 such individuals with similar exposure.

3. What are they doing, where do they live, etc., that might place them at this higher risk?

These individuals are placed at greater risk by fishing at the Savannah River confluences of Four Mile Creek and Steel Creek, because these are the locations along the Savannah River with the highest concentration of radioactive pollutants.

4. What is the average risk for individuals in the population of interest?

The upper bound estimate of lifetime excess total cancer risk due to radioactive and nonradioactive contaminants combined for an *average* rural resident ingesting Savannah River fish taken from various locations along the Savannah River near the Savannah River Site (SRS) is 6.25E-5. In short, with arithmetic rounding, this risk from radioactive and nonradioactive contaminants combined for a RME rural resident should be considered to have a "1.00E-4" risk.

In other terms, one would expect one extra case of cancer in 10,000 such individuals with similar exposure.

Hazard Indexes (HIs) obtained by ingesting fish which are contaminated with selected nonradioactive contaminants and are taken from various locations along the Savannah River near the Savannah River Site (SRS).

Four nonradioactive contaminants were analyzed for deleterious non-cancer systemic effects during a lifetime. None of the doses of these four contaminants exceeded their respective reference doses (RfDs) and are therefore not likely to be associated with any systemic health risks. The highest Hazard Index obtained was that for mercury (0.61). However, RfDs for b-BHC and DDE are not available at this time, and any hazard for these contaminants presently cannot be estimated. Consequently, the overall

hazard for deleterious non-cancer systemic effects during a lifetime obtained by ingesting fish which are contaminated with these two pollutants is unknown.

E.   EPA Region IV Comments

The Office of Risk Assessment of WMD reviewed a draft of this risk screening. They considered it a balanced presentation of the potential risks associated with ingesting fish contaminated with CS-137, SR-90, H-3, and α along this 132.8 stretch of the Savannah River. Also, their technical comments were incorporated as appropriate.

6/27/46

DATE DUE