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MEMORANDUM

DATE: May 14, 1998

SUBJECT: Evaluation of Human Health Risks from Exposure to Elevated Levels of PCBs in Housatonic River Sediment, Bank Soils and Floodplain Soils in Reaches 3-1 to 4-6 (Newell Street to the confluence of the East and West Branches)

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I. INTRODUCTION

The purpose of this memorandum is to evaluate the human health risks from exposure to elevated levels of polychlorinated biphenyls (PCBs) in Housatonic River sediments, riverbank soils and floodplain soils in reaches 3-1 to 4-6 in Pittsfield, Massachusetts. The information in this memorandum will support determinations about whether PCBs in Housatonic River reaches 3-1 to 4-6 may present an "Imminent and Substantial Endangerment" pursuant to Section 7003 of the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. § 6973 and pursuant to Section 106 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9606 (a), and also presents an "Imminent Hazard to Human Health" pursuant to Section 40.0955 of the Massachusetts Contingency Plan (MCP) and M.G.L 21e.

This evaluation focuses on exposures to three different receptor groups. The first receptor group is a youth (aged 9<18) who walks and plays in Housatonic River sediments, riverbank soils and floodplain soils on a regular and continuing basis during the warmer months of the year (April through October). This receptor group is referred to as the "youth trespasser."

The second receptor group is a young child (age 5<12 years) who contacts PCBs in soils and sediments adjacent to his/her residence while playing and wading at the river's edge. The Agencies have referred to this receptor group as the "child wader".

Also evaluated in this memorandum are exposures to a very young child (age 1<6 years) who contacts PCBs in soils and sediments while playing at his/her residence and wading at the river's edge. The Agencies have referred to this receptor group as the "child resident".

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The Agencies have evaluated exposures to the youth trespasser, child wader and child resident. Exposure factors used in this evaluation reflect a combination of central tendency and upper end values. Given the purpose of this evaluation, a maximal exposure estimate was not generated.

This evaluation presents separate risk estimates for soil and sediment exposures. The reasons for this are to keep the risk assessment less complex and to allow risk managers to make separate risk management decisions for soil and sediment, if they so choose.

II. CONCLUSIONS

Based on the evaluation presented in this Memorandum, the Massachusetts Department of Environmental Protection and the Environmental Protection Agency conclude that short-term exposures to elevated levels of PCBs in Housatonic River floodplain soils, riverbank soils and river sediments in reaches 3-1 to 4-6 in Pittsfield, Massachusetts present significant risks to human health.

III. HAZARD IDENTIFICATION

The portion of the Housatonic River that is the subject of this memorandum begins at the Newell Street bridge (reach 3-1) and extends to the confluence of the East and West Branches (reach 4-6), within the City of Pittsfield. This section of the river (reaches 3-1 to 4-6) is called the "area of interest" in this memorandum. Reach designations are taken from the MCP Supplemental Phase II Investigation/RCRA Facility Investigation for the Housatonic River and Silver Lake (Blasland, Bouck and Lee 1996).

Elevated levels of PCBs have been found in Housatonic River sediments and soils in reaches 3-1 to 4-6. In these reaches, PCBs have been detected in surficial sediments at levels as high as 905 mg/kg. In surficial riverbank soils, PCBs have been found at levels as high as 5,800 mg/kg. PCBs have been detected in surficial floodplain soils at levels as high as 160 mg/kg. PCBs have also been found at high levels (over 1,000 mg/kg) in subsurface sediments and bank soils in reaches 3-1 to 4-6.

Contaminated river sediments are typically covered by one to two feet of water. However, sediments near the banks are exposed during periods of low water. There are also sandbars in the river which become exposed during periods of low water. In the area of interest, the river is approximately 40 to 60 feet wide.

The type and frequency of potential exposure to PCB-contaminated soils and sediments changes across the area of interest. For this reason, the Agencies have divided the area of interest into 3 exposure areas. In identifying exposure areas, the Agencies considered the current land use adjacent to the river, steepness and height of the banks, and the size of the sampling database. A brief description of each exposure area is presented below.

Each of the exposure areas described below is in the vicinity of densely settled residential areas and/or recreational areas and is very accessible at many points. The Housatonic is the largest waterway in the area and is an attractive place for children to walk and play, especially in the warmer months of the year.

Exposure Area A

Reaches 3-1 to 3-10 (Newell Street bridge to Elm Street bridge).

Land use along the river in this set of reaches is primarily commercial with several residences and one recreational property. In the commercial areas, the river is within easy walking distance of densely settled residential areas.

GE owns the property on the north side of the river in reaches 3-1 to 3-7 (Newell Street to Lyman Street bridges). The top of the north riverbank between Newell and Lyman Streets is currently completely fenced. Fences in this area are approximately eight feet in height. Immediately adjacent to the Newell Street bridge are densely settled residential areas (Lombard Street and Parkside Avenue). Teenagers from these residential areas could easily access the river from just above the Newell Street bridge. Teenager activity underneath the Newell and Lyman Street bridges is evidenced by the presence of graffiti.

On the south side, the top of the riverbank is currently almost completely fenced between Newell and Lyman Streets. There is at least one hole in the fence east of the Newell Street Parking Lot. On the south side of the river, Hibbard Park comprises reaches 3-1 to 3-4. Access to the river from Hibbard Park currently is restricted by a fence. Densely settled residential areas lie within a two minute walk of the south side of the river. Just above and below the Lyman Street bridge, there are two residences which directly abut the river. There is a footbridge across the river at the Newell Street Parking Lot site (reach 3-7).

Oxbow Areas A and C comprise part of reach 3-8 and all of reach 3-9 on the south side of the river. Oxbows A and C are undeveloped, forested land. PCB data from these oxbows was not included in this evaluation. No fences currently exist between Lyman and Elm Streets (reaches 3-8 to 3-10).

Riverbanks in exposure area A are steeply sloped and thickly vegetated.

Exposure Area B

Reaches 4-1 to 4-3 (Elm Street bridge to Dawes Avenue bridge).

Land use along the river in this set of reaches is entirely residential. Distance between residences and the river and steepness of the riverbanks varies somewhat. In reaches 4-1 and 4-2, the riverbank is moderately steeply sloped and some residences are set back as far as 100 feet from the river. In reach 4-3, the banks (especially on the north/east side) become much less steeply sloped and houses are closer to the river. During a site visit, Agency personnel observed childrens' toys in the sediment at the water's edge behind a residence in reach 4-3. Agency personnel also observed footpaths from the top of the bank down to the water.

Exposure Area C

Reaches 4-4 to 4-6 (Dawes Avenue to the Confluence of the East and West Branches).

Land use along the river in this section of reaches is primarily residential. In reach 4-4, houses are quite close to the river and riverbanks are moderately to slightly sloped and not very high. Fred Garner Park is located on the north/east side of the river in part of reach 4-5 and all of reach 4-6. Many of the residences on the south/west side of the river across from Fred Garner Park are set back from the river. Agency personnel have received anecdotal reports of children playing in the riverbed and of a 12-year old child digging in the riverbed in this area.

Land use described in each of the three exposure areas is current land use. This evaluation focuses only on current uses and does not consider potential future land use.

Separate Exposure Point Concentrations (EPCs) for PCBs were calculated for: 1) sediment, and; 2) floodplain/bank soils in each of the three exposure areas. Data used to calculate EPCs is provided in Attachment 1. Attachment 1 also contains references for the data.

In accordance with EPA risk assessment guidance (EPA 1994), EPA calculated the 95 percent upper confidence limit of the arithmetic mean (UCL_{95}) using the data in Attachment 1. The UCL_{95} was calculated using the procedure outlined in EPA guidance (EPA 1994; Gilbert 1987). In accordance with EPA Region I guidance, when the UCL_{95} exceeds the maximum concentration, the maximum concentration should be used as the EPC. Table 1 below presents the EPCs for each of the 3 exposure areas and indicates whether the EPC is the UCL_{95} or the maximum value.

It is DEP's general practice to use the arithmetic average rather than the UCL_{95} in risk assessments. Using the average concentration rather than the values in Table 1 results in a lower risk estimate but does not change the conclusions of the risk assessment. DEP has adopted the practice of using the average rather than the UCL_{95} to streamline the MCP risk assessment/risk management process. However, it should be recognized that using the average does not account for sampling error (i.e., error in the estimate of the "true" average) and may result in a substantial underestimate of the "true" average.

In selecting data, the Agencies included any sample result from a sample interval beginning at the surface. The majority of sample results are from the 0 to 6-inch interval. However, at 15 out of 110 sediment sampling locations, PCB surface sediment samples extended over an interval of greater than six inches but not more than two feet. These samples were included in the EPC. The Agencies decided that it was reasonable to include these datapoints in this evaluation even though they are from greater than "surficial" depth. If the EPC had been calculated using data only from the 0 to 6-inch depth interval, it would not change the conclusions of the risk assessment.

For sample results reported as non-detect, one-half the detection limit was used in the EPC calculation. For locations where duplicate samples were taken, the average of the two duplicates was used in the EPC calculation. Samples located within areas that have already been remediated (for example, sediment removal at Building 68 and residential short-term measures) were not included in the EPC calculation.

TABLE 1. EXPOSURE POINT CONCENTRATIONS USED TO EVALUATE RISKS IN REACHES 3-1 TO 4-6 OF THE HOUSATONIC RIVER

EXPOSURE AREA	PCB EPC (mg/kg)	Basis
Sediment		
A: Reaches 3-1 to 3-10 (Newell Street to Elm Streets)	**46**	**UCL_{95}***
B: Reaches 4-1 to 4-3 (Elm Street to Dawes Avenue)	**905**	**Maximum**
C: Reaches 4-4 to 4-6 (Dawes Avenue to confluence)	**30**	**UCL_{95}***
Floodplain & Bank Soil		
A: Reaches 3-1 to 3-10 (Newell Street to Elm Street)	**2400**	**UCL_{95}***
B: Reaches 4-1 to 4-3 (Elm Street to Dawes Avenue)	**377**	**Maximum**
C: Reaches 4-4 to 4-6 (Dawes Avenue to confluence)	**68**	**UCL_{95}***

* UCL_{95} have been rounded to 2 significant figures.

IV. DOSE RESPONSE

To evaluate human health risks from exposure to PCBs in soil and sediments in the Housatonic River in reaches 3-1 to 4-6, the Agencies estimated the cancer and noncancer risks associated with PCB exposure. To evaluate the cancer risk, the Agencies used the 95% upper confidence limit of the linear-slope factor (also known as the cancer slope factor) of 2 $(mg/kg/day)^{-1}$ for PCBs (IRIS 1998). In the cancer studies on which the slope factor is based, a 12-month exposure (i.e., one-half a lifetime exposure) produced a high incidence of tumors. This suggests that a less than lifetime exposure could have significant cancer risk implications (EPA 1996).

To evaluate chronic noncancer risks, the Agencies used the EPA-published Reference Dose (RfD) of 2×10^{-5} mg/kg/day for Aroclor 1254 (IRIS 1998). To evaluate subchronic noncancer risks, the Agencies used the EPA-published subchronic RfD of 5×10^{-5} mg/kg/day for Aroclor 1254 (HEAST 1997). The critical effects (i.e., those that occur at the lowest dose) for the chronic and subchronic RfDs are immunologic and reproductive effects. Reference Doses for Aroclor 1254 were used because they are the closest to being applicable to the type of PCB mixture found in the Housatonic River (Aroclor 1260). The toxicity study on which the RfD is based was conducted over a timeframe comparable to exposure periods evaluated in this memorandum.

A value of 14% was used for dermal absorption of PCBs from soil and sediment (Wester *et al* 1993, EPA 1998). This value was peer reviewed by a panel external to EPA (EPA 1996). A relative absorption factor (RAF) of 100% was used for oral absorption of PCBs from soil and sediment (DEP, 1992). An RAF of 100% means that the assumed absorption of PCBs from ingestion of Housatonic soil and sediment is equal to the absorption of PCBs in the laboratory toxicity studies.

PCB Toxicity
PCBs can have a number of effects other than the critical effects mentioned above. PCBs have been shown to produce a wide variety of effects in many animals, including severe acne, cancer, liver damage and reproductive and developmental effects. Monkeys, which are physiologically more similar to humans than other animals, have developed adverse immunological and neurological effects, as well as skin and eye irritations after being fed PCBs. Studies of PCB-exposed workers show that PCBs can cause skin problems such as acne and rashes and eye irritation. There are also studies which have reported neurological, behavioral, and developmental abnormalities in children born to mothers who ate PCB-contaminated fish. However, in these studies, the mothers' exposures to PCBs were estimated and not measured directly. Neurobehavioral effects reported in these studies are similar to effects seen in monkeys (IRIS, 1998, ATSDR, 1996, ATSDR 1997).

V. EXPOSURE ASSESSMENT

In exposure area A (Newell to Elm Streets), the Agencies evaluated exposures to PCB-contaminated soil by focusing on a youth trespasser between the ages of 9 and 18 years who walks and plays two days per week in riverbank and floodplain soils and river sediments while exploring the area during the warmer months of the year (April through October). Walking or playing in contaminated soils or sediments could lead to exposure to PCBs by dermal absorption or by incidental ingestion, so these two exposure routes are the focus of this evaluation. As described in the Hazard Identification section of this memorandum, exposure area A is primarily commercial property. Thus, it is the Agencies' view that a trespasser exposure scenario (which assumes less frequent exposure) rather than a residential scenario (which assumes more frequent exposure) is more appropriate.

In exposure area B (Elm Street to Dawes Avenue), the Agencies evaluated exposures to PCB-contaminated soil and sediment by focusing on a child wader between the ages of 5 and 12 years who wades in the water and plays in the soils and sediments five days per week during the warmest months of the year (June through August) in areas nearby his/her residence. The Agencies also evaluated exposures to a child wader who plays in riverbank and floodplain soils five days per week nearby his/her residence during the warmer months of the year (April through October). As described in the Hazard Identification section of this memorandum, exposure area B is dominated by residential property. However, riverbanks in Area B are more difficult to access because they are generally steeper and higher than riverbanks in Area C. Thus, it is the Agencies' view that a child younger than age 5 is not likely to come into contact on a regular and continuing basis with PCBs in soils and sediments in Area B. For this reason, the Agencies focused on an older child (aged 5<12 years) rather than a very young child as in Area C.

In exposure area C (Dawes Avenue to the confluence), the Agencies evaluated exposures to a very young child, aged 1<6 years. Riverbanks in area C are quite easily accessed because they are not as steeply sloped and not as high as in Areas A and B. In portions of the river in Area C, residences are located quite close to the river. Thus, the Agencies believe that is it reasonable that a very young child could come into contact with PCB-contaminated soils and sediments while playing and wading on the riverbank and at the water's edge in his/her backyard.

AREA A - Youth Trespasser

To estimate risks to the youth trespasser, the Agencies used exposure assumptions described in the following paragraphs. The Agencies believe that such assumptions are appropriate considering the amount of site data available and the site conditions.

This evaluation assumes that the youth (aged 9<18 years) contacts soils and sediments two days per week while walking or playing during the warmer months of the year (April through October). This is equivalent to approximately 61 days per year (30.57 weeks in the months April through October * 2 days per week = 61.1 days).

The Agencies assumed that dermal contact for the youth trespasser occurs to the hands, arms, feet, and lower legs. Values for surface area of exposed skin are taken from DEP Guidance (DEP 1995). Attachment 2 provides skin surface areas for each body part by age group. The Agencies used DEP's default skin-soil adherence factor of 0.51 mg/cm^2 (DEP 1995).

For incidental soil ingestion for the trespasser, the Agencies used 50 mg/day. This value was previously agreed upon by the Agencies in joint comments on General Electric's proposed Risk Assessment Scope of Work for the Housatonic River (DEP/EPA 1997). A soil ingestion rate of 50 mg/day is DEP's default rate for older children and adults (DEP 1995). This value is lower than the Reasonable Maximum Exposure (RME) value recommended by EPA guidance (EPA 1997). EPA considers this value to be a central tendency value. A high-end value for adult soil ingestion would be 100 mg/day (EPA 1997).

The body weight used in this evaluation is 46 kg, which represents an average of the 50th percentile body weights for females aged 9 < 18 years (DEP, 1995; EPA, 1989). For subchronic trespassing exposures, a body weight of 30 kg for the nine-year old female was used.

Exposures to the youth trespasser using the assumptions described above were evaluated using soil and sediment concentrations in Table 1 from exposure area A (Newell Street to Elm Street). Table 2A below summarizes some of the exposure factors used to evaluate the youth trespasser.

TABLE 2A: SUMMARY OF EXPOSURE FREQUENCY AND DURATION USED TO EVALUATE THE YOUTH TRESPASSER IN AREA A (REACH 3-1 TO 3-10), HOUSATONIC RIVER.

Medium	Risk Type	Age (years)	Exposure Frequency (events/days)	Exposure Period (days)	Averaging Time (days)
Soil	Cancer	9<18	0.167[A]	3285[C]	25550[E]
Soil	Chronic Noncancer	9<18	0.167[A]	3285[C]	3285[C]
Soil	Subchronic Noncancer	9	0.28[B]	214[D]	214[D]
Sediment	Cancer	9<18	0.167[A]	3285[C]	25550[E]
Sediment	Chronic Noncancer	9<18	0.167[A]	3285[C]	3285[C]
Sediment	Subchronic Noncancer	9	0.28[B]	214[D]	214[D]

[A] 2 days per week; April -October; averaged over one year = 61 events/365 days = 0.167
[B] 2 days per week; April - October; averaged over the period April - October = 61 events/214 days = 0.28
[C] 9 years * 365 days
[D] 214 days in the months April - October
[E] 70 years * 365 days

AREA B - Child Wader

To estimate risks to the child wader, the Agencies used exposure assumptions described in the following paragraphs. The Agencies believe that such assumptions are appropriate considering the amount of site data available and the site conditions.

This evaluation assumes that the child (aged 5<12 years) contacts floodplain and riverbank soil five days per week during the warmer months of the year (April through October). This is equivalent to approximately 153 days per year (30.57 weeks in the months April through October * 5 days per week = 152.85 days).

For exposures to sediment, this evaluation assumes that the child contacts sediment at the water's edge while wading and playing 5 times per week during the warmest months of the year (June through August). This is equivalent to approximately 65 days per year (13 weeks during the months June through August * 5 days per week = 65 days).

For subchronic noncancer risks to the child wader, this evaluation focused on a child (aged 5 years) who contacts sediments 5 days per week during the warmest months of the summer (June, July and August) and soils 5 days per week during April through October.

The Agencies assumed that dermal contact to sediment occurs to the hands, feet, arms, and legs and that dermal contact to soils occurs to the hands, arms, feet and lower legs. Skin surface areas are from DEP guidance (DEP 1995). Attachment 2 provides skin surface areas for each body part by age group. The Agencies used DEP's default skin-soil adherence factor of 0.51 mg/cm^2 (DEP 1995).

For incidental soil ingestion for the child , the Agencies used 50 mg/day. This value was previously agreed upon by the Agencies in joint comments on General Electric's proposed Risk Assessment Scope of Work for the Housatonic River (DEP/EPA, 1997). This value is DEP's default rate for children and adults over the age of 5 years (DEP 1995). As previously stated, a soil ingestion rate of 50 mg/day is lower than the RME value recommended by EPA guidance (EPA 1997). EPA considers 50 mg/day to be a central tendency value. A high-end value for adult soil ingestion would be 100 mg/day (EPA 1997).

In an effort to simplify the risk calculations, the Agencies used a soil ingestion rate of 50 mg/day for the 5 year-old child, rather than 100 mg/day which is the value normally applied to that age. Using 50 mg/day for the 5 year-old does not change the conclusions of the risk assessment presented in this memorandum.

The body weight used in this evaluation is 27.8 kg , which represents the average body weight for a female, aged 5<12 years (DEP, 1995; EPA, 1989). For subchronic exposures, a body weight of 18.8 kg for the five-year old female was used.

Exposures to the child wader using the assumptions described above were evaluated using soil and sediment concentrations in Table 1 from exposure area B (Elm Street to Dawes Avenue). Table 2B below summarizes some of the exposure factors used to evaluate the child wader.

TABLE 2B: SUMMARY OF EXPOSURE FREQUENCY AND DURATION USED TO EVALUATE THE CHILD WADER IN AREA B (REACH 4-1 TO 4-3), HOUSATONIC RIVER.

Medium	Risk Type	Age (years)	Exposure Frequency (events/days)	Exposure Period (days)	Averaging Time (days)
Soil	Cancer	5<12	0.419[A]	2555[E]	25550[H]
Soil	Chronic Noncancer	5<12	0.419[A]	2555[E]	2555[E]
Soil	Subchronic Noncancer	5	0.71[B]	214[F]	214[F]
Sediment	Cancer	5<12	0.178[C]	2555[E]	25550[H]
Sediment	Chronic Noncancer	5<12	0.178[C]	2555[E]	2555[E]
Sediment	Subchronic Noncancer	5	0.71[D]	92[G]	92[G]

[A] 5 days per week; April -October; averaged over one year = 153 events/365 days = 0.419
[B] 5 days per week; April - October; averaged over the period April - October = 153 events/214 days = 0.71
[C] 5 days per week; June-August, averaged over one year = 65 events/365 days = 0.178
[D] 5 days per week; June - August, averaged over the period June - August = 65 events/92 days = 0.71
[E] 7 years * 365 days
[F] 214 days in months April - October
[G] 92 days in months June - August
[H] 70 years * 365 days

AREA C - Child Resident

To estimate risks to the child resident, the Agencies used exposure assumptions described in the following paragraphs. The Agencies believe that such assumptions are appropriate and protective considering the amount of site data available and the site conditions.

This evaluation assumes that a resident (aged 1<6 years) contacts floodplain and riverbank soil five days per week during the warmer months of the year (April through October). This is equivalent to approximately 153 days per year (30.57 weeks in the months April through October * 5 days per week = 152.85 days).

For exposures to sediment, this evaluation assumes that a resident contacts sediment at the water's edge while wading and playing 5 times per week during the warmest months of the year (June through August). This is equivalent to approximately 65 days per year (13 weeks during the months June through August * 5 days per week = 65 days).

For subchronic noncancer risks to the resident, this evaluation focused on a child (aged 5 years) who contacts sediments and soils 5 days per week during the warmest months of the summer (June, July and Afigust) and soils 5 days per week during April through October.

The Agencies assumed that dermal contact to sediment occurs to the hands, feet, arms, and legs. Dermal contact to soils occurs to the hands, arms, feet and lower legs. Skin surface areas are taken from DEP guidance (DEP 1995). Attachment 2 provides skin surface areas for each body part by age group. The Agencies used DEP's default skin-soil adherence factor of 0.51 mg/cm^2 (DEP 1995).

For incidental soil ingestion for the child resident, the Agencies used 100 mg/day. This value was previously agreed upon by the Agencies in joint comments on General Electric's proposed Risk Assessment Scope of Work for the Housatonic River (DEP/EPA 1997). It is lower than the RME value recommended by EPA guidance (EPA 1997). EPA considers 100 mg/day to be a central tendency value. A high-end value for a child could be as high as 200 or 400 mg/day (studies by Calabrese reviewed in EPA 1997).

The body weight used in this evaluation is 14.6 kg, which represents the average body weight for a female, aged 1<6 years (DEP, 1995; EPA, 1989). For subchronic exposures, a body weight of 18.8 kg for the five-year old female was used.

Exposures to the child resident using the assumptions described above were evaluated using soil and sediment concentrations in Table 1 from exposure area C (Dawes Avenue to the confluence). Table 2C below summarizes some of the exposure factors used to evaluate the child resident.

TABLE 2C: SUMMARY OF EXPOSURE FREQUENCY AND DURATION USED TO EVALUATE THE CHILD RESIDENT IN AREA C (REACH 4-4 TO 4-6), HOUSATONIC RIVER.

Medium	Risk Type	Age (years)	Exposure Frequency (events/days)	Exposure Period (days)	Averaging Time (days)
Soil	Cancer	1<6	0.419[A]	1825[E]	25550[H]
Soil	Chronic Noncancer	1<6	0.419[A]	1825[E]	1825[E]
Soil	Subchronic Noncancer	5	0.71[B]	214[F]	214[F]
Sediment	Cancer	1<6	0.178[C]	1825[E]	25550[H]
Sediment	Chronic Noncancer	1<6	0.178[C]	1825[E]	1825[E]
Sediment	Subchronic Noncancer	5	0.71[D]	92[G]	92[G]

[A] 5 days per week; April -October; averaged over one year = 153 events/365 days = 0.419
[B] 5 days per week; April - October; averaged over the period April - October = 153 events/214 days = 0.71
[C] 5 days per week; June-August, averaged over one year = 65 events/365 days = 0.178
[D] 5 days per week; June - August, averaged over the period June - August = 65 events/92 days = 0.71
[E] 5 years * 365 days
[F] 214 days in months April - October
[G] 92 days in months June - August
[H] 70 years * 365 days

Table 3 below summarizes all of the exposure parameters used in this evaluation.

TABLE 3. EXPOSURE FACTORS USED IN EVALUATING RISKS IN REACHES 3-1 TO 4-6 OF THE HOUSATONIC RIVER

EXPOSURE PARAMETER	VALUE
Body Weight (kg); average for age 9<18 years	46
Body Weight (kg); age 9 years	30
Body Weight (kg); average for age 5<12 years	27.8
Body Weight (kg); age 5 years	18.8
Body Weight (kg); average for age 1<6 years	14.6
Skin Surface Area (cm^2/d); average for age 9<18 years, hands/arms/feet/lower legs	5,437
Skin Surface Area (cm^2/d); age 9 years, hands/arms/feet/lower legs	.3,889
Skin Surface Area (cm^2/d); average for age 5<12 years (soil), hands/arms/feet/lower legs	3,675
Skin Surface Area (cm^2/d); average for age 5<12 years (sediment), hands/arms/feet/legs	5,370
Skin Surface Area (cm^2/d); age 5 years (soil), hands/arms/feet/lower legs	2,970
Skin Surface Area (cm^2 d); age 5 years (sediment), hands/arms/feet/legs	4,269
Skin Surface Area (cm^2/d); average for age 1<6 years (soil), hands/arms/feet/lower legs	2,358
Skin Surface Area (cm^2/d); average for age 1<6 years (sediment), hands/arms/feet/legs	3,368
Skin-Soil Adherence Factor (mg/cm^2)	0.51
Soil ingestion rate (mg/day), 9<18 year olds, 5<12 year olds	50
Soil ingestion rate (mg/day), 1<6 year olds	100

VI. RISK CHARACTERIZATION

This evaluation estimates risks to three sensitive receptors: youth trespassers; child waders; and child residents. These receptor groups are appropriate given site data and current conditions in exposure areas A-C. Land use described in this evaluation is current land use. An evaluation considering current land use is appropriate for a removal action (or immediate response action) but does not restrict the Agencies to considering these land uses in decisions on final remedial actions. Final remedial actions consider both current and future land uses. Decisions on future land use are based on public participation, development plans, and detailed site-specific information (EPA, 1995).

Calculations presented in this memorandum are protective for a person who has regular and continuing contact with soils or sediment. Calculations are not necessarily protective for the worst case exposure scenario. For example, calculations in this memo could underestimate risks for a pica child, who intentionally consumes soil or sediment (Calabrese 1997), or the risks from activities such as dirt biking. Conversely, potential risks for the "average" or "typical" child should be lower than those calculated here.

This evaluation considers risks from exposure to PCBs in soils and sediment and does not evaluate potential risks from exposure to PCBs through other media such as river water.

Equations for calculating doses and risks from ingestion and dermal contact with soil are presented below. Detailed risk calculations are presented in Attachment 3. Tables 3A-3C below summarize the doses and risks that have been calculated for the three receptor groups in the three exposure areas. Risk estimates have been rounded to three significant figures.

A. Risk Equations

CANCER RISKS

Using the assumptions noted above in Table 2, and the equations below, a lifetime average daily dose of PCBs from ingestion and dermal contact with soil can be calculated.

$$LADD_{dermal} = \frac{[PCB] * C * AF * ABS_{dermal} * SA * EF * ED * EP}{BW * AP}$$

$$LADD_{oral} = \frac{[PCB] * C * IR * ABS_{oral} * EF * ED * EP}{BW * AP}$$

Where:

$LADD_{dermal}$ = lifetime average daily dose from dermal contact with soil; mg/kg/day
$LADD_{oral}$ = lifetime average daily dose from ingestion of soil; mg/kg/day
[PCB] = PCB concentration in soil; mg/kg
C = conversion factor; 10^{-6} kg/mg
AF = adherence factor of soil to skin; mg/cm^2 per event
ABS_{dermal} = dermal absorption fraction from soil; %
ABS_{oral} = oral absorption fraction from soil; %
SA = surface area of exposed skin; cm^2
IR = soil ingestion rate; mg/day

BW	= body weight; kg
EF	= exposure frequency; events/days
ED	= exposure duration; days/event
EP	= exposure period; days
AP	= averaging period; days

The Excess Lifetime Cancer Risk from exposure to contaminated soil and sediment via dermal contact and ingestion can be calculated using the following equation.

$$ELCR = (LADD_{dermal} + LADD_{oral}) * CSF$$

Where:

ELCR	= Excess Lifetime Cancer Risk
CSF	= Cancer Slope Factor; 2 $(mg/kg/day)^{-1}$
$LADD_{dermal}$	= lifetime average daily dose from dermal contact with soil; mg/kg/day
$LADD_{oral}$	= lifetime average daily dose from ingestion of soil; mg/kg/day

NONCANCER RISKS

Using the exposure assumptions in Table 2 and the equations below, an average daily dose of PCBs from ingestion and dermal contact with soil can be calculated.

$$ADD_{dermal} = \frac{[PCB] * C * AF * ABS_{dermal} * SA * EF * ED * EP}{BW * AP}$$

$$ADD_{oral} = \frac{[PCB] * C * IR * ABS_{oral} * EF * ED * EP}{BW * AP}$$

Where:

ADD_{dermal}	= average daily dose from dermal contact with soil; mg/kg/day
ADD_{oral}	= average daily dose from ingestion of soil; mg/kg/day
[PCB]	= PCB concentration in soil; mg/kg
C	= conversion factor; 10^{-6} kg/mg
AF	= adherence factor of soil to skin; mg/cm^2 per event
ABS_{dermal}	= dermal absorption fraction from soil; %
ABS_{oral}	= oral absorption fraction from soil; %
SA	= surface area of exposed skin; cm^2
IR	= soil ingestion rate; mg/day
BW	= body weight; kg
EF	= exposure frequency; events/days
ED	= exposure duration; days/event
EP	= exposure period; days
AP	= averaging period; days

The Hazard Index can be calculated using the equation below.

$$HI = \frac{[ADD_{dermal} + ADD_{oral}]}{RfD}$$

Where:

HI	= Hazard Index
RfD	= Reference Dose; mg/kg/day
ADD_{dermal}	= average daily dose from dermal contact with soil; mg/kg/day
ADD_{oral}	= average daily dose from ingestion of soil; mg/kg/day

B. Risk Results

Table 4A. Summary of Doses and Risks To the Trespasser From Exposure to PCBs in Area A of the Housatonic River.

	9 Year old Trespasser		9<18 year old Trespasser	
	SOIL	SEDIMENT	SOIL	SEDIMENT
Area A				
Subchronic				
ADD_{oral} mg/kg/day	0.00113	0.0000217	---	---
ADD_{dermal} mg/kg/day	0.00628	0.000120	---	---
$HI_{subchronic}$ *	**200**	**3**	---	---
Chronic				
ADD_{oral} mg/kg/day			0.000436	0.00000836
ADD_{dermal} mg/kg/day			0.00338	0.0000649
$HI_{chronic}$ *			**200**	**4**
Cancer				
$LADD_{oral}$ mg/kg/day			0.0000560	0.00000107
$LADD_{dermal}$ mg/kg/day			0.000435	0.00000834
ELCR*			**1 E-3**	**2 E-5**

*** Risk results have been rounded to one significant figure.**

Table 4B. Summary of Doses and Risks to the Child Wader (aged 5<12 years) From Exposure to PCBs in Area B of the Housatonic River.

	5 year-old Child		5<12 Year old Child	
	SOIL	SEDIMENT	SOIL	SEDIMENT
Area B				
Subchronic				
ADD_{oral} mg/kg/day	0.000708	0.00170	---	---
ADD_{dermal} mg/kg/day	0.00300	0.0104	---	---
$HI_{subchronic}$ *	**70**	**200**	---	---
Chronic				
ADD_{oral} mg/kg/day	---	---	0.000284	0.000290
ADD_{dermal} mg/kg/day	---	---	0.00149	0.00222
$HI_{chronic}$ *	---	---	**90**	**100**
Cancer				
$LADD_{oral}$ mg/kg/day	---	---	0.0000284	0.0000290
$LADD_{dermal}$ mg/kg/day	---	---	0.000149	0.000222
ELCR*	---	---	**4 E-4**	**5 E-4**

* Risk results have been rounded to one significant gifure

Table 4C. Summary of Doses and Risks to the Child Resident (aged 1<6 years) From Exposure to PCBs in Area C of the Housatonic River.

	5 year old Child		1<6 Year old Child	
	SOIL	SEDIMENT	SOIL	SEDIMENT
Area C				
Subchronic				
ADD_{oral} mg/kg/day	0.000252	0.000113	---	---
ADD_{dermal} mg/kg/day	0.000543	0.000344	---	---
$HI_{subchronic}$ *	**20**	**9**	---	---
Chronic				
ADD_{oral} mg/kg/day	---	---	0.000192	0.0000366
ADD_{dermal} mg/kg/day	---	---	0.000323	0.0000879
$HI_{chronic}$ *	---	---	**30**	**6**
Cancer				
$LADD_{oral}$ mg/kg/day	---	---	0.0000137	0.00000261
$LADD_{dermal}$ mg/kg/day	---	---	0.0000231	0.00000628
ELCR*	---	---	**7 E-5**	**2 E-5**

* Risk results have been rounded to one significant figure.

Federal RCRA/ CERCLA Risk Management Criteria

This analysis focuses on whether children or teenagers could receive enough dose through short-term exposures to present an unacceptable risk. Risk managers should note that exposure periods used in this analysis to evaluate residential cancer and noncancer risks (5 years) are shorter than those typically used for evaluating residential areas. Risk managers should take this into account when considering the management actions connected with risks.

As shown in Tables 4A-C above, exposure to PCB-contaminated soils and sediments in each of the three Exposure Areas presents risks higher than levels at which EPA considers taking action. EPA is justified in taking action when the excess lifetime cancer risk exceeds a range of 10^{-6} to 10^{-4}. EPA is justified in taking action when a noncancer Hazard Index exceeds one.

Moreover, PCB concentrations found in Housatonic River sediments, bank soils and floodplain soils exceed the EPA action level of 1 mg/kg for residential soils and 10-25 mg/kg for industrial soils (EPA 1990). Concentrations in soils also exceed DEP's default (Method 1) cleanup standard for residential and commercial/industrial soils of 2 mg/kg (310 CMR 40.0985(6)).

Exposure Area A: Newell to Elm Streets

PCB-contaminated sediments in Exposure Area A (Newell to Elm Streets), pose noncancer risks to the youth trespasser that are roughly 3 times higher than the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). Cancer risks from sediment exposure are within the risk range at which EPA is justified in taking action (i.e., 10^{-6} to 10^{-4}).

Chronic (9-year exposure) and subchronic (3-month exposure) noncancer Hazard Indices from soil exposure to the youth trespasser in Exposure Area A are approximately 200 times greater than the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). PCB-contaminated soils in Exposure Area A pose cancer risks to the youth trespasser that are roughly 10 times higher than the EPA risk range (i.e., 10^{-6} to 10^{-4}).

Exposure Area B: Elm to Dawes Avenue

PCB-contaminated sediments in Exposure Area B (Elm to Dawes Streets) pose chronic (7-year) and subchronic (3-month) risks to the child wader that are over 100 times the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). Cancer risks from sediment exposure to the child wader are approximately 5 times higher than the EPA risk range (i.e., 10^{-6} to 10^{-4}).

Chronic (7-year) and subchronic (3-month) noncancer risks from soil exposure to the child wader in Exposure Area B are over 70 times higher than the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). Cancer risks to the child wader from soil exposure are roughly 4 times higher than the EPA risk range (i.e., 10^{-6} to 10^{-4}).

Exposure Area C: Dawes to the Confluence

PCB-contaminated sediments in Exposure Area C pose chronic (5-year) and subchronic (3-month) noncancer risks to the child resident that are over 6 times the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). Cancer risks to the child resident from exposure to sediments are within the risk range at which EPA is justified in taking action (i.e., 10^{-6} to 10^{-4}).

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Chronic (5-year) and subchronic (3-month) noncancer risks to the child resident from exposure to PCB-contaminated soils in Exposure Area C are approximately 20 times higher than the level at which EPA is justified in taking action (i.e., Hazard Index greater than one). Cancer risks to the child resident from soil exposure is within the risk range at which EPA is justified in taking action (i.e., 10^{-6} to 10^{-4}).

MCP Risk Management Criteria

As stated previously in this memorandum, it is DEP's practice to use the arithmetic average concentration for the EPC rather than the UCL_{95} or the maximum, as was used to calculate risks presented in Tables 4A-C above. DEP generated cancer risk estimates using the average as the EPC. Results are contained in spreadsheets in Attachment 4. The following sections discuss the application of MCP risk management criteria to the risk estimates presented in Attachment 4.

Under the Massachusetts Contingency Plan (MCP), hazardous waste sites must be remediated such that long-term risks do not pose significant risk of harm to human health. Significant risk exists if the excess lifetime cancer risk exceeds the MCP risk limit of 1×10^{-5} or if the noncancer hazard index (HI) exceeds the MCP risk limit of one (310 CMR 40.0993(6)).

The MCP states that conditions at a disposal site pose an Imminent Hazard based upon the potential for cancer effects if the estimated excess lifetime cancer risk (ELCR) calculated for the "short period of time" under evaluation is greater than a cancer risk limit of 1×10^{-5} (310 CMR 40.0955(2)(b)(1)). The MCP also provides that a HI limit of 10 is used to evaluate imminent hazards when the level of uncertainty inherent in a Reference Dose is high (greater than a factor of 10). When the level of uncertainty inherent in a Reference Dose is low (less than or equal to a factor of 10), a HI limit of one is used (310 CMR 40.0955(2)(c)). In this evaluation, it is appropriate to use a HI limit of 10 to evaluate imminent hazards from chronic and subchronic exposures to PCBs because the level of uncertainty inherent in each of the chronic and subchronic PCB RfDs is greater than 10 (IRIS, 1998; HEAST, 1997). Imminent hazards are levels of risk at which the MCP requires an Immediate Response Action to abate, prevent, or eliminate the imminent hazard.

Cancer Risks
As shown in Attachment 4, the ELCR calculated for exposure to soils in each of the three exposure areas exceeds the MCP risk limit for significant risk to human health and exceeds the MCP Imminent Hazard risk limit. For sediments, the ELCR in Area B exceeds the MCP Imminent Hazard risk limit.

Therefore, it can be concluded that:

- PCB-contaminated soils in Exposure Areas A-C pose significant risk of harm to human health *and* an Imminent Hazard based upon the potential for cancer health effects.
- PCB-contaminated sediments in Exposure Area B pose significant risk of harm to human health *and* an Imminent Hazard based upon the potential for cancer health effects.

NonCancer Risks
As shown in Attachment 4, the HIs calculated for soils and sediment in each of the three exposure areas exceed the MCP risk limit for significant risk to human health. In Area A, the HI for soil exceeds the

MCP risk limit for an Imminent Hazard. In Area B, the HI for sediments also exceeds the MCP risk limit for an Imminent Hazard. Therefore, it can be concluded that:

- PCB-contaminated soils and sediments in exposure areas A-C pose significant risk of harm to human health based upon the potential for noncancer health effects.
- PCB-contaminated soils in exposure area A pose an Imminent Hazard to human health based upon the potential for noncancer health effects.
- PCB-contaminated sediments in exposure area B pose an Imminent Hazard to human health based upon the potential for noncancer health effects.

If conditions at a site constitute an Imminent Hazard based on the potential for either cancer or noncancer health effects, the MCP requires an Immediate Response Action to abate, prevent or eliminate the Imminent Hazard.

C. Other Risk Characterization/Risk Management Considerations

In order to make a judgment as to whether a specific dose level poses a health risk, the level of uncertainty in the risk assessment, along with qualitative information, should be considered *in addition* to risk results. This is discussed in more detail in the paragraphs which follow.

1. Characterization of PCB Contamination

a)° The number of soil and sediment samples available for the area of interest is one uncertainty about the risks associated with the exposure activities evaluated. There are large numbers of sediment and soil samples available for each exposure area. However, each exposure area is also fairly large. EPA's sampling effort in riverbank and floodplain soils was biased towards areas with high exposure potential but not necessarily to areas with high PCB concentration (EPA 1998a). Thus, EPA samples may not represent the highest concentrations present. Use of the UCL_{95} or the maximum concentration provides a conservative estimate of the concentrations to which a receptor is exposed. However, it is possible that additional sampling could indicate that even higher PCB levels are present in the area.

b) In this evaluation, samples were included in the EPC only if they began at the surface. In other words, a sample result from the interval 6 to 12 inches would not have been included in the EPC. In at least one stretch of the river (Newell to Elm Streets), there are samples from just below the 6-inch depth interval with PCB concentrations in the thousands of parts-per-million. (Blasland, Bouck & Lee 1997). The EPCs used in this evaluation do not reflect these high PCB concentrations at depth. Because of the dynamic nature of the river, it is possible that these highly-contaminated sediments could become exposed at the surface where a receptor could come into contact with them. If this is the case, then this evaluation could underestimate actual risks.

c) Another uncertainty about the risks evaluated in this memorandum is that some of the sediment data was collected from locations that are covered by shallow water for part of the year. This may over or underestimate the PCB concentration in sediments at the water's edge that a receptor may come into contact with on a regular and continuing basis.

d) It is possible that this evaluation could underestimate actual exposures and risks to the youth trespasser because PCB floodplain data from Oxbow Areas A and C were not included in the EPCs. As stated previously, Oxbows Area A and C are located in reaches 3-8 and 3-9.

2. Exposure Assessment

a) The youth trespasser evaluated in this memorandum could receive additional exposures from PCBs present in his or her residential yard. It is possible that a youth trespasser who receives PCB exposure to the sediments, floodplain soils, or bank soils may in fact have higher exposures and risks than estimated in this evaluation because of exposure to other sources of PCBs in other areas.

b) This analysis does not consider risks from fish consumption. Currently there is a fish consumption advisory in place for all fish species in the area of concern. However, there is no enforcement mechanism in the advisory and no monitoring of the advisory's effectiveness in preventing exposure. Currently, 37% of male and 31% of female Pittsfield residents surveyed by the Massachusetts Department of Public Health reported eating freshwater fish (not necessarily from the Housatonic) (MA DPH 1997). The fish consumption advisory is communicated by a brochure distributed when individuals receive fishing licenses. In addition, the advisory is posted on some locations on the river. However, young people under 16 years old can fish without a license and they may walk to and fish from locations that are not posted. If individuals ignore the advisory or are not aware of it, their cumulative risk may be much higher than the risks presented in this evaluation. Risks from consuming Housatonic River fish were not considered in this memorandum. However, for purposes of providing supplemental information to EPA risk managers, Appendix A to this memorandum contains risk calculations prepared by EPA, for fish consumption assuming full use of the Housatonic River fishing resource.

c) The exposure period evaluated for the child resident (7 years) may underestimate the actual exposure that a resident may receive because it does not account for continuing exposure a resident may receive after age 12. Moreover, PCBs have been present in the area of interest for many years already, making it likely that exposure has already occurred for many years.

d) In this evaluation, it is assumed that a receptor is exposed to either soil or sediment and not both. Because of the nature of the activity assumed to occur on the riverbanks and at the water's edge, a receptor would actually be exposed to both soil and sediment as he/she climbs up and down the bank to the water's edge. In areas A and C, PCB concentrations in bank and floodplain soils are higher than in sediments. If a receptor is contacting both soil and sediment, then his/her risks would be different than the estimated risks presented in this evaluation.

e) This analysis uses a dermal adherence value of 0.51 mg/cm^2 and an incidental soil ingestion rate for children 6 years and older of 100 mg/day and 50 mg/day for adults. There are not good quantitative estimates for soil ingestion for children between the ages of 6 and 18. Limited data on children playing in wet soils suggest that dermal adherence could be 1 mg/cm2 (EPA 1992) or higher (Kissel 1996). If the risk calculations in this evaluation had assumed a soil ingestion of 200 mg/day for children up to age 12, 100 mg/day for youth trespassers, and a dermal adherence of 1 mg/cm2, then the risks would be about 2 times those presented here. For example, the noncancer hazard index would be roughly 300 for the 9-year old contacting soil in area A and roughly 500 for the 5-year old contacting sediment in area B.

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A choice of more conservative, but still reasonable factors, given the uncertainty in the application of the scientific information to site conditions, could double the risks calculated in this memorandum.

3. PCB Toxicity

a) Because of a lack of data, this evaluation does not consider potential risks from exposure to dioxin-like PCBs. Dioxin-like PCBs are PCB congeners which resemble dioxin (i.e., 2,3,7,8-tetrachlorodibenzo-p-dioxin) in structure and toxicity. If dioxin-like PCBs are present, the risks could be much greater than those calculated. The presence of highly chlorinated PCBs such as Aroclor 1260 in the area of interest makes the presence of dioxin-like PCBs a strong possibility.

b) In many risk assessments, doses received by laboratory animals in toxicity studies are substantially higher than estimated doses received by exposed receptors. In this risk assessment, some of the estimated dose rates received by exposed receptors are similar to dose rates received in the noncancer PCB toxicity studies. Therefore, it can be concluded that there is less uncertainty about potential noncancer effects of PCB exposure at this site than in risk assessments for many other sites.

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ATTACHMENT 1

Data used to calculate Exposure Point Concentrations

HOUSATONIC RIVER SEDIMENT

Newell Street to Elm Street, Area A sediments

last modifie 05/11/98

STATION ID	DEPTH	DATA SOURC	conc PCB (ppm)	ND	Ln PCB's
S0-9-G	0-0.4'	GE/ECO 5/97	34.00		3.53
3-1A-3A	0.5-6 inches	GE/ECO 5/97	0.60		-0.51
3-2A-1	0-4 inches	GE/ECO 5/97	10.00		2.30
HCSE-5	0-1.0'	GE/ECO 5/97	0.10	*	-2.30
3-5A-3	0.5-6 inches	GE/ECO 5/97	66.40		4.20
S09F	0-0.3'	GE/ECO 5/97	1.40		0.34
S09E1	0-0.5'	GE/ECO 5/97	30.00		3.40
S09E2	0-0.5'	GE/ECO 5/97	0.52		-0.65
3-6A-1	0.5-6 inches	GE/ECO 5/97	4.90		1.59
3-6A	0-0.5'	GE/ECO 5/97	0.30		-1.20
S09D	0-0.3'	GE/ECO 5/97	67.00		4.20
BBS09D	0-0.5'	GE/ECO 5/97	0.94		-0.06
S09C	0-0.5'	GE/ECO 5/97	0.55		-0.60
S09B	0-0.5'	GE/ECO 5/97	5.70		1.74
3-7B	0.5-6 inches	GE/ECO 5/97	1.40		0.34
S09A	0-0.5'	GE/ECO 5/97	16.00		2.77
HCSE-15	0-1.8'	GE/ECO 5/97	100.00		4.61
3-7D-CRD	0-4 inches	GE/ECO 5/97	7.80		2.05
3-6C-18	0-6	BLDG68 5/97	27.00		3.30
3-6C-66	0-6	BLDG68 5/97	1.20		0.18
3-6C-20	0-6	BLDG68 5/97	140.00		4.94
3-6C-55	0-6	BLDG68 5/97	0.70		-0.36
3-6C-22	0-6	BLDG68 5/97	16.40		2.80
3-6C-49	0-6	BLDG68 5/97	0.24		-1.43
3-6C-48	0-6	BLDG68 5/97	10.20		2.32
3-6C-27	0-5	BLDG68 5/97	20.10		3.00
3-6C-79	0-7	BLDG68 5/97	1.20		0.18
3-6C-35	0-8.4	BLDG68 5/97	4.50		1.50
3-6C-38	0-8.4	BLDG68 5/97	1.35	*	0.30
3-6C-62	0-6	BLDG68 5/97	0.36		-1.02
3-6C-41	0-6	BLDG68 5/97	1.35		0.30
3-6C-65	0-6	BLDG68 5/97	0.16		-1.83
3-6C-63	0-6	BLDG68 5/97	1.02		0.02
3-6C-43	0-6	BLDG68 5/97	61.70		4.12
3-6C-44	0-6	BLDG68 5/97	1.70		0.53
3-6C-45	0-6	BLDG68 5/97	3.14		1.14
3-6C-46	0-7	BLDG68 5/97	3.34		1.21
3-6C-47	0-6	BLDG68 5/97	0.29		-1.24
3-1A	0-6	ATK	0.06	*	-2.81
3-2B	0-6	ATK	1.70		0.53
3-4A	0-6	ATK	0.15		-1.90
3-5D	0-6	ATK	0.63		-0.46
3-7E	0-6	ATK	1.80		0.59
3-8A	0.5-6 inches	GE/ECO 5/97	15.80		2.76
HCSE-4	0-1.6'	GE/ECO 5/97	15.00		2.71

S10B1	0-0.5'	GE/ECO 5/97	7.30	1.99	
S10B	0-0.5'	GE/ECO 5/97	90.00	4.50	
BBS10B	0-0.5'	GE/ECO 5/97	14.00	2.64	
3-8B-1	0.5-6 inches	GE/ECO 5/97	9.54	2.26	
[illegible]SE-3	0-1.5'	GE/ECO 5/97	8.60	2.15	
3-8C	0.5-6 inches	GE/ECO 5/97	5.90	1.77	
3-9A	0.5-6 inches	GE/ECO 5/97	1.40	0.34	
HCSE-A6	0.2"-0.8"	T 3-7, SUP PH	140.00	4.94	
3-9B-1	0.5-6 inches	GE/ECO 5/97	5.68	1.74	
HCSE-2	0-1.6'	GE/ECO 5/97	10.00	2.30	
3-9D	0.5-6 inches	GE/ECO 5/97	0.75	-0.29	
3-10B	0.5-6 inches	GE/ECO 5/97	4.40	1.48	
3-10C	0-0.5'	GE/ECO 5/97	9.60	2.26	
3-10C-1	0.5-6 inches	GE/ECO 5/97	85.40	4.45	
S10A	0-0.5'	GE/ECO 5/97	8.10	2.09	
3-10D	0.5-6 inches	GE/ECO 5/97	1.80	0.59	
HCSE-1	0-1.5'	GE/ECO 5/97	3.20	1.16	J
3-8C	0-6	ATK	25.20	3.23	
3-8E	0-6	ATK	1.40	0.34	
3-9FF	0-6	ATK	2.20	0.79	
3-9F	0-6	ATK	12.70	2.54	
3-10D	0-6	ATK	5.00	1.61	
3-10E	0-6	ATK	1.90	0.64	

mean	16.66	1.36
sample variance	964.31	3.45
sample stdev	31.05	1.86
maximum	**140.00**	
minimum	0.06	
n	68.00	68.00

Gilbert UCL	**45.489**
Gilbert Mean	21.939
H stat	*3.2125*

Elm Street to Dawes Avenue, Area B sediments

STATION ID	DEPTH	DATA SOURC	PCB conc (ppm)	ND	Ln PCB's
4-1A--CRD	0-4 inches	GE/ECO 5/97	123		4.81
HCSE-16	0-1.1'	GE/ECO 5/97	0.25		-1.39
4-2A	0.5-6 inches	GE/ECO 5/97	9.3		2.23
HCSE-17	0-1.8'	GE/ECO 5/97	17		2.83
4-2B	0-0.5'	GE/ECO 5/97	33		3.50
4-2B-1	0.5-6 inches	GE/ECO 5/97	17		2.83
BBS11	0-0.5'	GE/ECO 5/97	22		3.09
4-3B	0.5-6 inches	GE/ECO 5/97	5.1		1.63
S11	0-0.5'	GE/ECO 5/97	130		4.87
HCSE-18C	0-0.25'	GE/ECO 5/97	3.1		1.13
HCSE-18B	0-0.25'	GE/ECO 5/97	51		3.93
HCSE-18	0-0.5'	GE/ECO 5/97	905		6.81
4-3A	0.5-6 inches	GE/ECO 5/97	1.6		0.47
HCSE-18D	0-0.33'	GE/ECO 5/97	1.6		0.47
HCSE-18A	0-0.25'	GE/ECO 5/97	17		2.83

mean	89.06	2.67
sample variance	52659.87	4.20
sample stdev	229.48	2.05
maximum	**905.00**	
minimum	0.25	
n	15.00	15.00

Gilbert UCL	**1521.077**
Gilbert Mean	118.141
H stat	*4.6633*

Dawes to the confluence, Area C sediments

STATION ID	DEPTH	DATA SOURC	PCB conc (ppm)	ND	Ln PCB's
[illegible]	0.5-6 inches	GE/ECO 5/97	2.6		0.96
HCSE-19	0-2.0'	GE/ECO 5/97	3.3		1.19
4-4C	0.5-6 inches	GE/ECO 5/97	3.6		1.28
4-4B	0-0.5'	GE/ECO 5/97	32		3.47
4-4D	0.5-6 inches	GE/ECO 5/97	9.8		2.28
4-4E	0-0.5'	GE/ECO 5/97	0.93		-0.07
4-5A	0.5-6 inches	GE/ECO 5/97	9.2		2.22
4-5A(*)	0-0.5'	GE/ECO 5/97	1.6		0.47
HCSE-20	0-1.9'	GE/ECO 5/97	5.3		1.67
4-5A-1	0.5-6 inches	GE/ECO 5/97	10.1		2.31
BBS12	0-0.5'	GE/ECO 5/97	24		3.18
S12	0-0.5'	GE/ECO 5/97	28		3.33
4-5C-1	0.5-6 inches	GE/ECO 5/97	13.18		2.58
4-5E	0-0.5'	GE/ECO 5/97	4.7		1.55
4-5B	0.5-6 inches	GE/ECO 5/97	14.9		2.70
4-6B	0-0.5'	GE/ECO 5/97	1.7		0.53
4-6A	0.5-6 inches	GE/ECO 5/97	22.8		3.13
4-6C	0.5-6 inches	GE/ECO 5/97	10.5		2.35
4-6D	0.5-6 inches	GE/ECO 5/97	7.8		2.05
4-6F	0.5-6 inches	GE/ECO 5/97	5.6		1.72
4-6G	0-0.5'	GE/ECO 5/97	17		2.83
4-[illegible]	0-6	ATK	6.9		1.93
4 [illegible]	0-6	ATK	37.3		3.62
4-5H	0-6	ATK	1.8		0.59
4-5G	0-6	ATK	16.4		2.80
4-5F	0-6	ATK	14.2		2.65
4-6J	0-6	ATK	132		4.88

mean	16.19	2.16
sample variance	631.45	1.28
sample stdev	25.13	1.13
maximum	**132.00**	
minimum	0.93	
n	27.00	27.00

Gilbert UCL	**29.580**
Gilbert Mean	16.361
H stat	*2.67088*

ND - samples where ND was reported were listed as 1/2 the sample detection limit
ATK = Data from A.T. Kearney
GE/ECO 5/97 = Work Plan for the Ecological Risk Assessment of the Housatonic River Site Volume II, by ChemRisk
B[illegible]G68 5/9 Building 68 Removal Action Work Plan, May 1997, by BBL
[illegible]-7 Supplemental Phase II RCRA Facility Investigation Report for the Housatonic River and Silver Lake, Table 3-7, 1/96

GE Housatonic River Bank and Floodplain Data

Newell Street to Elm Street, Area A soils

last modified 05/11/98

Location	Type	Depth	PCB Conc.	Report	Ln Conc.	ND
BE-0043-A	Bank	0 to 6 "	2.50	Weston98	0.92	
BW-0030-A	Bank	0 to 6 "	27.00	Weston98	3.30	
BE-0040-A	Bank	0 to 6 "	5800.00	Weston98	8.67	
BE-0041-A	Bank	0 to 6 "	1000.00	Weston98	6.91	
BE-0042-A	Bank	0 to 6 "	0.21	Weston98	-1.56	
BE-0044-A	Bank	0 to 6 "	4.88	Weston98	1.58	
BE-0045-A	Bank	0 to 6 "	0.28	Weston98	-1.27	
BE-0046-A	Bank	0 to 6 "	1.15	Weston98	0.14	
BW-0031-A	Bank	0 to 6 "	2.69	Weston98	0.99	
HR-EB2	Bank	0 to 6 "	600.00	ECO-RA 5/97	6.40	
BW-0032-A	Bank	0 to 6 "	2.15	Weston98	0.77	
BW-0035-A	Bank	0 to 6 "	110.00	Weston98	4.70	
BW-0038-A	Bank	0 to 6 "	7.30	Weston98	1.99	
BW-0037-A	Bank	0 to 6 "	1.70	Weston98	0.53	
BW-0036-A	Bank	0 to 6 "	11.00	Weston98	2.40	
BW-0034-A	Bank	0 to 6 "	59.00	Weston98	4.08	
HR-EB1	Bank	0 to 6 "	12.40	ECO-RA 5/97	2.52	
BW-0033-A	Bank	0 to 6 "	4.47	Weston98	1.50	
BE-0039-A	Bank	0 to 6 "	140.00	Weston98	4.94	
I9-4-14D	Flood Plain	0 to 6 "	4.30	ECO-RA 5/97	1.46	
I9-4-14A	Flood Plain	0 to 6 "	6.20	ECO-RA 5/97	1.82	
I9-4-14B	Flood Plain	0 to 6 "	4.30	ECO-RA 5/97	1.46	
I9-4-14C	Flood Plain	0 to 6 "	47.00	ECO-RA 5/97	3.85	
I8-24-5A	Flood Plain	0 to 6 "	38.00	ECO-RA 5/97	3.64	
I8-24-5B	Flood Plain	0 to 6 "	0.70	ECO-RA 5/97	-0.36	
I8-24-5C	Flood Plain	0 to 6 "	2.10	ECO-RA 5/97	0.74	
BW-0029-A	Bank	0 to 6 "	43.00	Weston98	3.76	
BW-0028-A	Bank	0 to 6 "	0.15	Weston98	-1.90	*
BW-0040-A	Bank	0 to 6 "	36.00	Weston98	3.58	

mean	274.77	2.33
sample variance	1173344.57	6.25
sample stdev	1083.21	2.50
maximum	**5800.00**	
minimum	0.15	
n	29.00	29.00

Gilbert UCL	**2393.253**
Gilbert Mean	233.360
H stat	*4.928*

Elm Street to Dawes Avenue, Area B soils

Location	Type	Depth	PCB Conc.	Report	Ln Conc.	ND
Ib-4-6-1	Flood plain	0 to 6 "	0.10	ECO-RA 5/97	-2.30	*
BE-0020-A	Bank	0 to 6 "	0.18	Weston98	-1.71	*
BE-0014-A	Bank	0 to 6 "	0.10	Weston98	-2.30	*
BE-0018-A	Bank	0 to 6 "	17.00	Weston98	2.83	
BE-0017-A	Bank	0 to 6 "	0.20	Weston98	-1.63	
BE-0016-A	Bank	0 to 6 "	1.49	Weston98	0.40	
BE-0015-A	Bank	0 to 6 "	18.00	Weston98	2.89	
BE-0013-A	Bank	0 to 6 "	0.10	Weston98	-2.30	*
BE-0034-A	Bank	0 to 6 "	17.00	Weston98	2.83	
BE-0012-A	Bank	0 to 6 "	33.00	Weston98	3.50	
BE-0021-A	Bank	0 to 6 "	39.00	Weston98	3.66	
HR-EB4	Bank	0 to 6 "	377.00	ECO-RA 5/97	5.93	
HR-EB5	Bank	0 to 6 "	268.00	ECO-RA 5/97	5.59	
BE-0019-A	Bank	0 to 6 "	32.00	Weston98	3.47	
HR-EB3	Bank	0 to 6 "	0.07	ECO-RA 5/97	-2.66	*
BE-0033-A	Bank	0 to 6 "	28.96	Weston98	3.37	
BE-0022-A	Bank	0 to 6 "	2.49	Weston98	0.91	
BE-0023-A	Bank	0 to 6 "	0.45	Weston98	-0.81	
BE-0025-A	Bank	0 to 6 "	0.12	Weston98	-2.08	*
BE-0026-A	Bank	0 to 6 "	0.10	Weston98	-2.30	*
BE-0027-A	Bank	0 to 6 "	46.00	Weston98	3.83	
[illegible]0024-A	Bank	0 to 6 "	14.00	Weston98	2.64	
BE-0028-A	Bank	0 to 6 "	3.40	Weston98	1.22	
BE-0029-A	Bank	0 to 6 "	0.10	Weston98	-2.30	*
BE-0031-A	Bank	0 to 6 "	0.36	Weston98	-1.02	
BE-0032-A	Bank	0 to 6 "	0.10	Weston98	-2.30	*
BE-0030-A	Bank	0 to 6 "	65.00	Weston98	4.17	

	PCB Conc.	Ln Conc.
mean	35.72	0.87
variance	7363.24	8.13
sample stdev	85.81	2.85
maximum	**377.00**	
minimum	0.07	
n	27.00	27.00

Gilbert UCL	**2857.310**
Gilbert Mean	139.253
H statistic	5.403

Dawes Avenue to the confluence of the Housatonic with the West Branch, Area C soils

Location	Type	Depth	PCB Conc.	Report	Ln Conc	ND
I7-2-45A	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	
I7-2-45B	Flood Plain	0 to 6"	10	ECO-RA 5/97	2.30	
I7-2-45C	Flood Plain	0 to 6"	30	ECO-RA 5/97	3.40	
I7-2-33A	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	
I7-2-33B	Flood Plain	0 to 6"	49	ECO-RA 5/97	3.89	
I7-2-33B-1	Flood Plain	0 to 6"	6.2	ECO-RA 5/97	1.82	
I7-2-33B-2	Flood Plain	0 to 6"	16	ECO-RA 5/97	2.77	
I7-2-33B-6	Flood Plain	0 to 6"	34	ECO-RA 5/97	3.53	
I7-2-33C	Flood Plain	0 to 6"	4.6	ECO-RA 5/97	1.53	
I7-2-33D	Flood Plain	0 to 6"	3.6	ECO-RA 5/97	1.28	
I7-2-32A	Flood Plain	0 to 6"	92	ECO-RA 5/97	4.52	
I7-2-32A-5	Flood Plain	0 to 6"	2.5	ECO-RA 5/97	0.92	
I7-2-32B	Flood Plain	0 to 6"	24	ECO-RA 5/97	3.18	
I7-3–7A-1	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	
I7-3-7A	Flood Plain	0 to 6"	82	ECO-RA 5/97	4.41	
I7-3-7A-2	Flood Plain	0 to 6"	160	ECO-RA 5/97	5.08	
I7-3-7B	Flood Plain	0 to 6"	24	ECO-RA 5/97	3.18	
I7-3-7C	Flood Plain	0 to 6"	30	ECO-RA 5/97	3.40	
I7-3-6C-12	Flood Plain	0 to 6"	12.5	ECO-RA 5/97	2.53	
I7-3-6C-10	Flood Plain	0 to 6"	46	ECO-RA 5/97	3.83	
I7-3-6C	Flood Plain	0 to 6"	62	ECO-RA 5/97	4.13	
I7-3-6A	Flood Plain	0 to 6"	27	ECO-RA 5/97	3.30	
I7-3-6B	Flood Plain	0 to 6"	40	ECO-RA 5/97	3.69	
I7-2-25C	Flood Plain	0 to 6"	7.4	ECO-RA 5/97	2.00	
I7-2-25B	Flood Plain	0 to 6"	5.6	ECO-RA 5/97	1.72	
I7-2-25A	Flood Plain	0 to 6"	39	ECO-RA 5/97	3.66	
I7-3-1A	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	
I7-3-1B	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	
I7-3-1C	Flood Plain	0 to 6"	3.3	ECO-RA 5/97	1.19	
I7-3-1F	Flood Plain	0 to 6"	7.9	ECO-RA 5/97	2.07	
I7-1-3A	Flood Plain	0 to 6"	0.7	ECO-RA 5/97	-0.36	
I6-1-67B	Flood Plain	0 to 6"	6.4	ECO-RA 5/97	1.86	
I6-1-67A	Flood Plain	0 to 6"	44	ECO-RA 5/97	3.78	
I6-1-66A	Flood Plain	0 to 6"	15	ECO-RA 5/97	2.71	
I6-1-66B	Flood Plain	0 to 6"	34	ECO-RA 5/97	3.53	
I7-1-4A	Flood Plain	0 to 6"	8	ECO-RA 5/97	2.08	
I6-1-64A	Flood Plain	0 to 6"	40	ECO-RA 5/97	3.69	
I6-1-64B	Flood Plain	0 to 6"	1	ECO-RA 5/97	0.00	
I6-1-62A	Flood Plain	0 to 6"	6.2	ECO-RA 5/97	1.82	
I6-1-62B	Flood Plain	0 to 6"	12	ECO-RA 5/97	2.48	

I7-2-20-19	Flood Plain	0 to 6"	34.9	SITE EXAC 6/95	3.55	
I7-2-20-1	Flood Plain	0 to 6"	39.5	SITE EXAC 6/95	3.68	
I7-2-20-3	Flood Plain	0 to 6"	5.7	SITE EXAC 6/95	1.74	
I7 [illegible]-20-2	Flood Plain	0 to 6"	17	SITE EXAC 6/95	2.83	
[illegible]-20-12	Flood Plain	0 to 6"	2.9	SITE EXAC 6/95	1.06	
I7-2-20-11	Flood Plain	0 to 6"	2.6	SITE EXAC 6/95	0.96	
I7-2-20-6	Flood Plain	0 to 6"	4	SITE EXAC 6/95	1.39	
I7-2-20-16	Flood Plain	0 to 6"	2.2	SITE EXAC 6/95	0.79	
I7-2-3-2	Flood Plain	0 to 6"	1.2	SITE EXAC 6/95	0.18	
BE-0011-A	Bank	0 to 6 "	30.0	Weston98	3.40	
BE-0010-A	Bank	0 to 6 "	18.0	Weston98	2.89	
BW-0023-A	Bank	0 to 6 "	2.9	Weston98	1.07	
BW-0025-A	Bank	0 to 6 "	40.0	Weston98	3.69	
BW-0027-A	Bank	0 to 6 "	83.0	Weston98	4.42	
BW-0026-A	Bank	0 to 6 "	27.0	Weston98	3.30	
BW-0024-A	Bank	0 to 6 "	16.5	Weston98	2.80	
BE-0009-A	Bank	0 to 6 "	29.0	Weston98	3.37	
BE-0004-A	Bank	0 to 6 "	48.0	Weston98	3.87	
BE-0008-A	Bank	0 to 6 "	28.0	Weston98	3.33	
HR-EB6	Bank	0 to 6 "	3.1	ECO-RA 5/97	1.14	
HR-EB7	Bank	0 to 6 "	0.7	ECO-RA 5/97	-0.37	
BE-0002-A	Bank	0 to 6 "	65.0	Weston98	4.17	
BW-0021-A	Bank	0 to 6 "	29.0	Weston98	3.37	
BE-0003-A	Bank	0 to 6 "	14.0	Weston98	2.64	
BE-0007-A	Bank	0 to 6 "	0.1	Weston98	-2.30	*
[illegible]-0001-A	Bank	0 to 6 "	4.1	Weston98	1.41	
[illegible]-0005-A	Bank	0 to 6 "	25.0	Weston98	3.22	
BE-0006-A	Bank	0 to 6 "	0.2	Weston98	-1.49	
BW-0022-A	Bank	0 to 6 "	59.0	Weston98	4.08	
BW-0008-A	Bank	0 to 6 "	13.0	Weston98	2.56	
BW-0020-A	Bank	0 to 6 "	37.0	Weston98	3.61	
BW-0019-A	Bank	0 to 6 "	34.0	Weston98	3.53	
BW-0002-A	Bank	0 to 6 "	69.0	Weston98	4.23	
BW-0004-A	Bank	0 to 6 "	48.0	Weston98	3.87	
BW-0003-A	Bank	0 to 6 "	21.0	Weston98	3.04	
BE-0037-A	Bank	0 to 6 "	2.4	Weston98	0.89	
BW-0001-A	Bank	0 to 6 "	4.1	Weston98	1.42	
BW-0006-A	Bank	0 to 6 "	13.0	Weston98	2.56	
BE-0036-A	Bank	0 to 6 "	23.0	Weston98	3.14	
BE-0035-A	Bank	0 to 6 "	21.0	Weston98	3.04	

BW-0005-A	Bank	0 to 6 "	8.2	Weston98	2.10	
BW-0009-A	Bank	0 to 6 "	12.0	Weston98	2.48	
BW-0007-A	Bank	0 to 6 "	9.1	Weston98	2.21	
BW-0018-A	Bank	0 to 6 "	47.0	Weston98	3.85	
BW-0015-A	Bank	0 to 6 "	0.2	Weston98	-1.90	*
BW-0017-A	Bank	0 to 6 "	36.0	Weston98	3.58	
BW-0016-A	Bank	0 to 6 "	10.0	Weston98	2.30	
BW-0013-A	Bank	0 to 6 "	0.1	Weston98	-2.30	*
BW-0014-A	Bank	0 to 6 "	0.1	Weston98	-2.30	*
BW-0010-A	Bank	0 to 6 "	18.0	Weston98	2.89	
BW-0012-A	Bank	0 to 6 "	0.1	Weston98	-2.30	*
BW-0011-A	Bank	0 to 6 "	20.0	Weston98	3.00	

mean	23.10	2.36
sample variance	635.98	2.68
sample stdev	25.22	1.64
maximum	**160.00**	
minimum	0.10	
n	92.00	92.00

Gilbert UCL	**67.810**
Gilbert Mean	40.448
H stat	*3.0098*

ND - samples where ND was reported were listed as 1/2 the sample detection limit

ECO-RA 5/97 = Work Plan for the Ecological Risk Assessment of the Housatonic River Site, Volume II, May 24, 1997, by Chem Risk
SITE EXCAVATION PLAN 95-03-47-4, dated 6/95
Note: Flood plain samples selected were those samples located within the 1 ppm isopleth that were not excavated or capped during short term measures or immediate response actions performed by GE
Weston98 = Samples collected by Weston in March 1998

ATTACHMENT 2

Table of Skin Surface Areas by Age Group

Part of the Body	Skin Surface Area (cm^2)[1]
Age 9<18	
Hands	746.2
Arms	1863.8
Feet	1071.0
Lower Legs	1756.3
Age 9	
Hands	561.8
Arms	1303.8
Feet	805.6
Lower Legs	1216.9
Age 5<12	
Hands	516.02
Arms	1292.6
Feet	736.5
Lower Legs	1130.1
Legs	2825.2
Age 5	
Hands	444.0
Arms	1090.6
Feet	568.7
Lower Legs	866.2
Legs	2165.6
Age 1<6	
Hands	365.0
Arms	861.7
Feet	457.8
Lower Legs	673.5
Legs	1683.7

[1] Skin Surface Areas are 50th percentile values for females (DEP 1995).

ATTACHMENT 3

Spreadsheets showing risk calculations

RISK CALCULATIONS								
PCB Exposure in Reaches 3-1 to 4-6								
Housatonic River								
REACH A: 3-1 TO 3-10	Media	ELCR	HI	(L)ADDoral	(L)ADDdermal	EPC	RfD	CSF
NEWELL TO ELM				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Trespasser, Age 9<18 - CANCER	Soil	9.83E-04		5.6054E-05	4.3520E-04	2400.00	2E-05	2
Trespasser, Age 9<18 - CHRONIC NONCANCER	Soil		191.0445	4.3597E-04	3.3849E-03	2400.00	2E-05	2
Trespasser, Age 9 - SUBCHRONIC	Soil		148.1659	1.1304E-03	6.2779E-03	2400.00	5E-05	2
Trespasser, Age 9<18 - CANCER	Sediment	1.88E-05		1.0744E-06	8.3414E-06	46.00	2E-05	2
Trespasser, Age 9<18 - CHRONIC NONCANCER	Sediment		3.661686	8.3562E-06	6.4878E-05	46.00	2E-05	2
Trespasser, Age 9 - SUBCHRONIC	Sediment		2.839847	2.1667E-05	1.2033E-04	46.00	5E-05	2
REACH B: 4-1 TO 4-3	Media	ELCR	HI	ADDoral	ADDdermal	EPC	RfD	CSF
ELM TO DAWES				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Wader, Age 5<12 - CANCER	Soil	3.55E-04		2.8423E-05	1.4916E-04	377.00	2E-05	2
Wader, Age 5<12 - CHRONIC NONCANCER	Soil		88.79105	2.8423E-04	1.4916E-03	377.00	2E-05	2
Wader, Age 5 - SUBCHRONIC	Soil		74.25684	7.0840E-04	3.0044E-03	377.00	5E-05	2
Wader, Age 5<12 - CANCER	Sediment	5.03E-04		2.8986E-05	2.2228E-04	905.00	2E-05	2
Wader, Age 5<12 - CHRONIC NONCANCER	Sediment		125.6323	2.8986E-04	2.2228E-03	905.00	2E-05	2
Wader, Age 5 - SUBCHRONIC	Sediment		241.3448	1.7005E-03	1.0367E-02	905.00	5E-05	2
REACH C: 4-4 TO 4-6	Media	ELCR	HI	ADDoral	ADDdermal	EPC	RfD	CSF
DAWES TO CONFLUENCE				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Young Resident, Age 1< 6 - CANCER	Soil	7.37E-05		1.3734E-05	2.3123E-05	67.00	2E-05	2
Young Resident, Age 1 < 6 - CHR NONCANCER	Soil		25.80036	1.9228E-04	3.2373E-04	67.00	2E-05	2
Young Resident, Age 5 - SUBCHRONIC	Soil		15.7254	2.5196E-04	5.3431E-04	67.00	5E-05	2
Young Resident, Age 1 < 6 - CANCER	Sediment	1.78E-05		2.6125E-06	6.2825E-06	30.00	2E-05	2
Young Resident, Age 1 < 6 - CHR NONCANCER	Sediment		6.226499	3.6575E-05	8.7955E-05	30.00	2E-05	2
Young Resident, Age 5 - SUBCHRONIC	Sediment		9.133987	1.1282E-04	3.4388E-04	30.00	5E-05	2

RISK CALCULATIONS									
PCB Exposure in Reaches 3-1 to 4-6									
Housatonic River									
REACH A: 3-1 TO 3-10	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
NEWELL TO ELM	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Trespasser, Age 9<18 - CANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	25550
Trespasser, Age 9<18 - CHRONIC NONCANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	3285
Trespasser, Age 9 - SUBCHRONIC	1.00E-06	50	0.283	1	214	1	0.14	30	214
Trespasser, Age 9<18 - CANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	25550
Trespasser, Age 9<18 - CHRONIC NONCANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	3285
Trespasser, Age 9 - SUBCHRONIC	1.00E-06	50	0.283	1	214	1	0.14	30	214
REACH B: 4-1 TO 4-3	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
ELM TO DAWES	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Wader, Age 5<12 - CANCER	1.00E-06	50	0.419	1	2555	1	0.14	27.8	25550
Wader, Age 5<12 - CHRONIC NONCANCER	1.00E-06	50	0.419	1	2555	1	0.14	27.8	2555
Wader, Age 5 - SUBCHRONIC	1.00E-06	50	0.707	1	214	1	0.14	18.8	214
Wader, Age 5<12 - CANCER	1.00E-06	50	0.178	1	2555	1	0.14	27.8	25550
Wader, Age 5<12 - CHRONIC NONCANCER	1.00E-06	50	0.178	1	2555	1	0.14	27.8	2555
Wader, Age 5 - SUBCHRONIC	1.00E-06	50	0.707	1	92	1	0.14	18.8	92
REACH C: 4-4 TO 4-6	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
DAWES TO CONFLUENCE	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Young Resident, Age 1< 6 - CANCER	1.00E-06	100	0.419	1	1825	1	0.14	14.6	25550
Young Resident, Age 1 < 6 - CHR NONCANCER	1.00E-06	100	0.419	1	1825	1	0.14	14.6	1825
Young Resident, Age 5 - SUBCHRONIC	1.00E-06	100	0.707	1	214	1	0.14	18.8	214
Young Resident, Age 1 < 6 - CANCER	1.00E-06	100	0.178	1	1825	1	0.14	14.6	25550
Young Resident, Age 1 < 6 - CHR NONCANCER	1.00E-06	100	0.178	1	1825	1	0.14	14.6	1825
Young Resident, Age 5 - SUBCHRONIC	1.00E-06	100	0.707	1	92	1	0.14	18.8	92

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RISK CALCULATIONS		
PCB Exposure in Reaches 3-1 to 4-6		
Housatonic River		
REACH A: 3-1 TO 3-10	SA	AF
NEWELL TO ELM	cm2/d	mg/cm2
Trespasser, Age 9<18 - CANCER	5437	0.51
Trespasser, Age 9<18 - CHRONIC NONCANCER	5437	0.51
Trespasser, Age 9 - SUBCHRONIC	3889	0.51
Trespasser, Age 9<18 - CANCER	5437	0.51
Trespasser, Age 9<18 - CHRONIC NONCANCER	5437	0.51
Trespasser, Age 9 - SUBCHRONIC	3889	0.51
REACH B: 4-1 TO 4-3	SA	AF
ELM TO DAWES	cm2/d	mg/cm2
Wader, Age 5<12 - CANCER	3675	0.51
Wader, Age 5<12 - CHRONIC NONCANCER	3675	0.51
Wader, Age 5 - SUBCHRONIC	2970	0.51
Wader, Age 5<12 - CANCER	5370	0.51
Wader, Age 5<12 - CHRONIC NONCANCER	5370	0.51
Wader, Age 5 - SUBCHRONIC	4269	0.51
REACH C: 4-4 TO 4-6	SA	AF
DAWES TO CONFLUENCE	cm2/d	mg/cm2
Young Resident, Age 1< 6 - CANCER	2358	0.51
Young Resident, Age 1 < 6 - CHR NONCANCER	2358	0.51
Young Resident, Age 5 - SUBCHRONIC	2970	0.51
Young Resident, Age 1 < 6 - CANCER	3368	0.51
Young Resident, Age 1 < 6 - CHR NONCANCER	3368	0.51
Young Resident, Age 5 - SUBCHRONIC	4269	0.51

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ATTACHMENT 4

Spreadsheets showing risk calculations using Arithmetic Average PCB Concentrations for the EPCs

RISK CALCULATIONS								
Using AVERAGE PCB concentration as EPC								
REACH A : 3-1 TO 3-10	Media	ELCR	HI	ADDoral	ADDdermal	EPC	RfD	CSF
NEWELL TO ELM				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Trespasser, Age 9<18 - CANCER	Soil	1.05E-04		5.9903E-06	4.6509E-05	274.80	2E-05	2
Trespasser, Age 9<18 - CHRONIC NONCANCER	Soil		21.8746	4.9919E-05	3.8757E-04	274.80	2E-05	2
Trespasser, Age 9 - SUBCHRONIC	Soil		16.965	1.2943E-04	7.1882E-04	274.80	5E-05	2
Trespasser, Age 9<18 - CANCER	Sediment	6.38E-06		3.6382E-07	2.8247E-06	16.69	2E-05	2
Trespasser, Age 9<18 - CHRONIC NONCANCER	Sediment		1.328555	3.0318E-06	2.3539E-05	16.69	2E-05	2
Trespasser, Age 9 - SUBCHRONIC	Sediment		1.03037	7.8612E-06	4.3657E-05	16.69	5E-05	2
	Media	ELCR	HI	ADDoral	ADDdermal	EPC	RfD	CSF
REACH B: 4-1 TO 4-3				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Wader, Age 5<12 - CANCER	Soil	3.15E-05		2.5191E-06	1.3220E-05	35.80	2E-05	2
Wader, Age 5<12 - CHRONIC NONCANCER	Soil		8.431617	2.6990E-05	1.4164E-04	35.80	2E-05	2
Wader, Age 5 - SUBCHRONIC	Soil		7.051445	6.7270E-05	2.8530E-04	35.80	5E-05	2
Wader, Age 5<12 - CANCER	Sediment	4.62E-05		2.6624E-06	2.0416E-05	89.06	2E-05	2
Wader, Age 5<12 - CHRONIC NONCANCER	Sediment		12.36333	2.8525E-05	2.1874E-04	89.06	2E-05	2
Wader, Age 5 - SUBCHRONIC	Sediment		23.75046	1.6735E-04	1.0202E-03	89.06	5E-05	2
	Media	ELCR	HI	ADDoral	ADDdermal	EPC	RfD	CSF
REACH C: 4-4 TO 4-6				mg/kg-d	mg/kg-d	mg/kg	mg/kg-d	(mg/kg-d)-1
Young Resident, Age 1< 6 - CANCER	Soil	2.33E-05		4.3354E-06	7.2991E-06	22.66	2E-05	2
Young Resident, Age 1 < 6 - CHR NONCANCER	Soil		8.725911	6.5031E-05	1.0949E-04	22.66	2E-05	2
Young Resident, Age 5 - SUBCHRONIC	Soil		5.318471	8.5216E-05	1.8071E-04	22.66	5E-05	2
Young Resident, Age 1 < 6 - CANCER	Sediment	8.87E-06		1.3021E-06	3.1312E-06	16.02	2E-05	2
Young Resident, Age 1 < 6 - CHR NONCANCER	Sediment		3.32495	1.9531E-05	4.6968E-05	16.02	2E-05	2
Young Resident, Age 5- SUBCHRONIC	Sediment		4.877549	6.0245E-05	1.8363E-04	16.02	5E-05	2

RISK CALCULATIONS									
Using AVERAGE PCB concentration as EPC									
REACH A : 3-1 TO 3-10	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
NEWELL TO ELM	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Trespasser, Age 9<18 - CANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	27375
Trespasser, Age 9<18 - CHRONIC NONCANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	3285
Trespasser, Age 9 - SUBCHRONIC	1.00E-06	50	0.283	1	214	1	0.14	30	214
Trespasser, Age 9<18 - CANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	27375
Trespasser, Age 9<18 - CHRONIC NONCANCER	1.00E-06	50	0.167	1	3285	1	0.14	46	3285
Trespasser, Age 9 - SUBCHRONIC	1.00E-06	50	0.283	1	214	1	0.14	30	214
	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
REACH B: 4-1 TO 4-3	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Wader, Age 5<12 - CANCER	1.00E-06	50	0.419	1	2555	1	0.14	27.8	27375
Wader, Age 5<12 - CHRONIC NONCANCER	1.00E-06	50	0.419	1	2555	1	0.14	27.8	2555
Wader, Age 5 - SUBCHRONIC	1.00E-06	50	0.707	1	214	1	0.14	18.8	214
Wader, Age 5<12 - CANCER	1.00E-06	50	0.178	1	2555	1	0.14	27.8	27375
Wader, Age 5<12 - CHRONIC NONCANCER	1.00E-06	50	0.178	1	2555	1	0.14	27.8	2555
Wader, Age 5 - SUBCHRONIC	1.00E-06	50	0.707	1	92	1	0.14	18.8	92
	C	IR	EF	ED	EP	RAF-o	RAF-d	BW	AP
REACH C: 4-4 TO 4-6	kg/mg	mg/d	ev/d	d/ev	days			kg	days
Young Resident, Age 1< 6 - CANCER	1.00E-06	100	0.419	1	1825	1	0.14	14.6	27375
Young Resident, Age 1 < 6 - CHR NONCANCER	1.00E-06	100	0.419	1	1825	1	0.14	14.6	1825
Young Resident, Age 5 - SUBCHRONIC	1.00E-06	100	0.707	1	214	1	0.14	18.8	214
Young Resident, Age 1 < 6 - CANCER	1.00E-06	100	0.178	1	1825	1	0.14	14.6	27375
Young Resident, Age 1 < 6 - CHR NONCANCER	1.00E-06	100	0.178	1	1825	1	0.14	14.6	1825
Young Resident, Age 5- SUBCHRONIC	1.00E-06	100	0.707	1	92	1	0.14	18.8	92

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RISK CALCULATIONS		
Using AVERAGE PCB concentration as EPC		
REACH A : 3-1 TO 3-10	SA	AF
NEWELL TO ELM	cm2/d	mg/cm2
Trespasser, Age 9<18 - CANCER	5437	0.51
Trespasser, Age 9<18 - CHRONIC NONCANCER	5437	0.51
Trespasser, Age 9 - SUBCHRONIC	3889	0.51
Trespasser, Age 9<18 - CANCER	5437	0.51
Trespasser, Age 9<18 - CHRONIC NONCANCER	5437	0.51
Trespasser, Age 9 - SUBCHRONIC	3889	0.51
	SA	AF
REACH B: 4-1 TO 4-3	cm2/d	mg/cm2
Wader, Age 5<12 - CANCER	3675	0.51
Wader, Age 5<12 - CHRONIC NONCANCER	3675	0.51
Wader, Age 5 - SUBCHRONIC	2970	0.51
Wader, Age 5<12 - CANCER	5370	0.51
Wader, Age 5<12 - CHRONIC NONCANCER	5370	0.51
Wader, Age 5 - SUBCHRONIC	4269	0.51
	SA	AF
REACH C: 4-4 TO 4-6	cm2/d	mg/cm2
Young Resident, Age 1< 6 - CANCER	2358	0.51
Young Resident, Age 1 < 6 - CHR NONCANCER	2358	0.51
Young Resident, Age 5 - SUBCHRONIC	2970	0.51
Young Resident, Age 1 < 6 - CANCER	3368	0.51
Young Resident, Age 1 < 6 - CHR NONCANCER	3368	0.51
Young Resident, Age 5- SUBCHRONIC	4269	0.51

Appendix A. Memo on Potential Human Health Risks from Consuming Fish from the Housatonic River in Massachusetts

United States
Environmental Protection Agency
New England Region
J.F. Kennedy Federal Building
Boston, Massachusetts 02203
(617) 565-3420

MEMORANDUM

DATE: May 14, 1998

SUBJ: Potential Human Health Risks from Consuming Fish from the Housatonic River in Massachusetts

FROM: Mary Ballew, Environmental Scientist, EPA MAB
TO: Bryan Olson, Project Manager, Office of Site Remediation and Restoration, EPA

I. INTRODUCTION

This memo provides calculations and a limited discussion of potential risks from consuming fish from the Housatonic River in Massachusetts. Currently there is a fishing advisory on the Housatonic which may help to limit fish consumption.

II. CONCLUSIONS

Consumption of fish in the Housatonic river, even for periods as short as one summer, presents a significant risk to human health.

III. HAZARD IDENTIFICATION

For the Housatonic River in Massachusetts, there is a fish consumption advisory in place for all fish species. However, there is no enforcement mechanism in the advisory and no monitoring of the advisory's effectiveness in preventing exposure. Currently, 37% of male and 31% of female Pittsfield residents surveyed by the Massachusetts Department of Public Health reported eating freshwater fish (not necessarily from the Housatonic) (MA DPH 1997). The fish consumption advisory is communicated by a brochure distributed when individuals receive fishing licenses. In addition, the advisory is posted on some locations on the river. However, young people under 16 years old can fish without a license and they may walk to and fish from locations that are not posted. The river has numerous access points by foot or by boat. Under the fishing advisory, catching and releasing the fish is allowed, which adds to the difficulty of monitoring its effectiveness. If individuals ignore the advisory or are not aware of it, their cumulative risk may be represented by the risks presented in this memo.

GE collected "young of year"[1] fish to monitor changes (trends) in PCB levels over time, not to represent the type of fish people were likely to eat. Since these fish were about six months old (Finklestein 1998), they were too small to eat. GE reported that composites of young of year fish (pumpkinseeds, largemouth bass and yellow perch) caught in 1994 near New Lenox Road (just downriver of Pittsfield) in the Housatonic ranged from 22 to 35 mg PCBs per kilogram (ppm) of whole fish composite. Similarly, fish composites at Woods Pond (12 miles downriver of GE) ranged from 3 to 58 ppm (GE 1994). So although Woods Pond contained high levels of PCBs, the fish in sections of the river closer to Pittsfield contained comparable levels. For example, the 69 largemouth bass sampled at New Lenox Road averaged 31 ppm and the 70 largemouth bass sampled at Woods Pond averaged 23 ppm (young of year results, GE 1994).

In 1994, the National Biological Survey of the US Geological Survey (USGS) collected 28 largemouth bass from Woods Pond, which is a wide shallow section of the Housatonic River. PCB levels in 24 whole fish ranged from a minimum of 27 ppm to a maximum of 206 ppm and averaged 100 ppm (not adjusted for lipid). Four additional muscle tissue samples ranged from 13 to 70 ppm PCBs (Attachment A1). Woods Pond is twelve miles downriver from the GE facility and the sediment levels of PCBs in Woods Pond average 27 ppm (personal communication, Dean Tagliaferro, April 1998). The dominant Aroclors[2] found in the fish resemble Aroclors 1254 and 1260 which are the environmentally modified forms of the original Aroclor 1260 released from GE.

In 1997, EPA-New England asked the EPA Office of Research and Development for technical assistance to perform congener-specific[3] analysis of the USGS fish samples. Since this was the only congener-specific data for fish available for the Housatonic River, this data was selected for these risk calculations. The USGS had a limited amount of data on other species; however, EPA chose the largemouth bass for congener analysis because they are a popular game species. The largemouth bass caught by the USGS were all of a size that would provide good fillets. In

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1 "Young of year" fish are those less than one year old.

2 PCB mixtures manufactured in the United States carried the trademark "Aroclor" followed by a four-digit number; the first two digits are "12" and the last two digits indicate the percent chlorine by weight. For example, Aroclor 1260 was manufactured using 60% chlorine. Aroclor 1016 is an exception, because it contains 41 percent chlorine by weight (EPA 1996). Once released into the environment, distribution and bioaccumulation of an Aroclor can change the character of the mixture so that it may no longer resemble the original mixture (EPA 1996).

3 Each PCB molecule consists of two 6-carbon rings, with one chemical bond joining a carbon from each ring (imagine sunglasses with hexagonal frames). Chlorine can attach to any of the other 10 carbons. There are 209 possible arrangements, called congeners. The number and position of chlorines determine a PCB molecule's physical and chemical properties. Congeners are numbered 1 to 209. The coplanar congeners, those with the two rings aligned on the same plane, have dioxin-like properties (EPA 1996). Congener specific data improves our ability to identify the presence of bioaccumulated PCBs.

contrast, the GE young of year fish were too small to eat.

IV. DOSE RESPONSE

Toxicology

To determine whether exposure to PCBs in fish from the Housatonic River in Massachusetts presents a potential risk to human health, EPA evaluates the cancer and noncancer risks associated with PCB exposure. To evaluate the cancer risk, EPA uses the 95% upper confidence limit of the linear-slope factor (also known as the cancer slope factor) of 2 $(mg/kg/day)^{-1}$ for PCBs (IRIS 1998). The fish ingestion scenario involves ingestion of bioaccumulated PCBs. Ingestion of fish contaminated with these PCBs may result in a dose greater than that which occurred in the toxicity studies used to develop the potency estimates (EPA 1996). For that reason, EPA estimates the risk of consuming bioaccumulated PCBs using the Toxic Equivalence Factor (TEF) approach (outlined in EPA 1996). The TEF's are ratios for certain PCB congeners, that when multiplied by each congener's concentration in fish tissue and the cancer slope factor for dioxin, yield an estimate of the carcinogenicity of the bioaccumulated PCBs in the fish. Because of its toxicity, the cancer slope factor for dioxin is very high, 150,000 $(mg/kg/day)^{-1}$, so even small concentrations of these dioxin-like PCBs in the fish can present a cancer risk.

In the cancer study for Aroclor 1260 on which the slope factor is based, a 12-month exposure produced approximately the same cancer potency as a full two-year exposure. This suggests that a less than lifetime exposure could have significant risk implications (EPA 1996).

To evaluate chronic noncancer risks, EPA used a Reference Dose (RfD) of 2×10^{-5} mg/kg/day for Aroclor 1254 (IRIS 1998). To evaluate subchronic noncancer risks, EPA used the subchronic RfD of 5×10^{-5} mg/kg/day for Aroclor 1254 (HEAST 1997). Reference Doses for Aroclor 1254 were used because they are the closest ones applicable to the type of PCB mixture found in the Housatonic River (Aroclor 1260). The toxicity of Aroclor 1254 is much more similar to that of Aroclor 1260 than the toxicity of Aroclor 1016 (the other choice for an EPA accepted RfD). The toxicity study on which the RfDs are based was conducted over a shorter-term time frame (5 years). The subchronic exposure period evaluated in this memorandum (one summer) is consistent with that used in the toxicity study. The critical effects for the chronic and subchronic RfDs are immunologic and reproductive effects. In addition, PCBs have been associated with deficits in learning and neurological effects (see ATSDR 1996 for a recent review).

A relative absorption factor (RAF) of 100% was used for oral absorption of PCBs from fish (DEP, 1992). An RAF of 100% means that the assumed absorption of PCBs from ingestion of Housatonic fish is equal to the absorption of PCBs in the laboratory toxicity studies.

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Data Analysis
Of the available fish data, only the 1994 USGS 24 whole fish and 4 tissue samples were tested for dioxin like PCBs (see data in attachment A1 spreadsheets). The whole fish samples included skin, organs, and all other tissues. For the muscle tissue samples, USGS removed about 100 grams of muscle tissue and attached skin (about 2 inches wide, 4 inches long, and 1 inch deep) from the back of the fish directly above the gut (Steven Smith, personal communication, 1998).

To compare the fish on the same basis, EPA adjusted the whole fish data to its equivalent in fish tissue, thus:

(ppm PCBs in whole fish divided by % lipid in each fish) x 100 =
micrograms of PCB per gram of fat

The concentration of PCBs in fish muscle tissue equivalents were determined using the lipid normalized concentration of PCBs and the average lipid found in the four fish tissue samples (approximately 1%). While the use of lipid normalization data is not recommended in all cases [4], the lipid approximation of 1% was considered to be reasonable, given the very low levels of % lipid in whole fish (0.87-5.8%).

Following the procedure outlined in EPA 1996, EPA multiplied the concentrations of the individual PCB dioxin-like congeners by the toxic equivalence factors (TEF's) appropriate to each. This product, called dioxin toxic equivalents (TEQ's) is calculated for each tissue sample.

Next, EPA calculated the 95% upper confidence limit of the mean (Gilbert 1987) concentration for the non-dioxin PCBs and the dioxin-like PCBs. These calculations resulted in a UCL_{95} of 0.0013 for TEQ's and 52.2 ppm for nondioxin PCBs. These were the exposure point concentrations used with the exposure factors to calculate the risks of consuming the fish. Eleven of the 13 dioxin-like PCBs were detected in fish samples used for this risk evaluation.

V. EXPOSURE ASSESSMENT

Currently the waters of the Housatonic are under a fishing advisory by the Commonwealth of Massachusetts. The calculations for the adult fisher and subsistence fisher that follow assume that

[4] For human health risk assessment, adjusting for lipid requires site-specific samples of fish muscle tissue or fillet in addition to the data on whole fish. A standardized (not site-specific) lipid adjustment is not appropriate because the lipid levels of the fish may have been affected by the site contamination. Also, the adjustment does not make biological sense unless the contaminant sequesters in the fat.

people do not adhere to the advisory.

The calculations for the child fisher represent the short-term PCB doses and risks that a child could receive during one summer of consuming contaminated fish caught between GE and the Woods Pond Dam on the Housatonic River in Massachusetts.

Adult Fisher

To estimate risks to the adult fisher, EPA used exposure assumptions that consider the amount of site data available and the site conditions. The exposure assumptions described below are reflective of the Reasonable Maximum Exposure (RME) for adult residents who consume contaminated fish.

These calculations assume that an adult fisher[5] consumes a daily average of 26 grams of fish over the course of 365 days per year (Ebert et al., 1993). This could represent 3 or 4 (8-ounce) fish meals per month throughout a year or 7 (8-ounce) fish meals per month during the warmer months (April through October). A daily average of 26 grams represents the 95th percentile of fish consumption for all water bodies in Maine (Ebert et al., 1993). Because the Housatonic is the largest water body in the region and an attractive resource, this value is appropriate. This value was previously agreed upon by the Agencies in joint comments on General Electric's proposed Risk Assessment Scope of Work for the Housatonic River; GE did not dispute this value (DEP/EPA 1997).

The body weight used in this evaluation is 70 kg, which represents the average body weight for an adult (EPA, 1989).

Subsistence Fisher

To estimate risks to the subsistence fisher, EPA used exposure assumptions that consider the amount of site data available and the site conditions. The exposure assumptions described below are appropriate for a sensitive subpopulation that is highly exposed.

These calculations assume that a subsistence fisher[5] consumes a daily average of 140 grams of fish over the course of 365 days per year. This could represent 4 or 5 (8-ounce) fish meals per week during a year. The daily average of 140 grams per day was estimated by EPA Office of Water staff based on a review of the literature on fish consumption by Native Americans and subsistence anglers (EPA 1995). Given site conditions, this value is appropriate for subsistence fishers as a whole; a particular ethnic group or tribe of Native

[5]This is a person who has adult body weight and who would ingest adult-sized portions of fish. For example, for a thirty year exposure duration, this could be a person who ate fish each year when they were between the ages of 18 and 48.

Americans may consume more fish. This value for subsistence fish consumption was previously agreed upon by the Agencies in joint comments on General Electric's proposed Risk Assessment Scope of Work for the Housatonic River; GE did not dispute this value (DEP/EPA 1997).

The body weight used in this evaluation is 70 kg, which represents the average body weight for an adult (EPA, 1989).

Child fisher

To estimate the subchronic risks to the child fisher, EPA used exposure assumptions that consider the amount of site data available and the site conditions. The exposure assumptions described below are reflective of short term exposures and do not represent the RME.

These calculations assume that the child fisher (age 9 years) consumes one small (6- or 7-ounce) fish meal per week during the summer months (June, July, August). EPA assumes 13 weeks per summer (June, July and August).

The one summer exposure period used in this evaluation is shorter than the 30-year exposure period (for cancer risks) typically evaluated by EPA as part of the RME. The purpose of this calculation is to examine whether short term exposures could provide enough dose and present enough risk, at some point later in life, to be a concern.

For fish ingestion for the child fisher, EPA used 182.5 g/week. This is the same value for residential fish consumption mentioned above and adjusted to a weekly consumption rate (26 g/day * 365 days/yr divided by 52 weeks/yr).

The body weight used in these calculations is 30 kg, which represents an average of the 50th percentile body weights for females age 9 years (DEP, 1995; EPA, 1989).

TABLE 1. Exposure factors used to calculate the potential risks from fishing on the Housatonic River

EXPOSURE PARAMETER	VALUE
body weight (kg), adult or subsistence fisher	70
body weight (kg); age 9 years	30
exposure duration, subchronic, (weeks)	13
exposure duration (years)	30
fish ingestion rate (g/day), adults	26
fish ingestion rate (g/day), subsistence fishers	140
fish ingestion rate (g/week), children	182.5
averaging time (days); cancer	25,550
averaging time (days); chronic, noncancer	10,950
averaging time (days); subchronic, noncancer	92

VI. RISK CHARACTERIZATION

A. Risk Calculations

CANCER RISKS

Using the assumptions noted above in Table 1, and the equations below, a lifetime average daily dose of PCBs from ingestion of fish can be calculated.

$$LADD_{oral} = \frac{[PCB] * C * IR * ED}{BW * AT}$$

Where:

$LADD_{oral}$ = lifetime average daily dose from ingestion of fish; mg/kg/day
[PCB] = PCB concentration in fish; μg/kg
C = conversion factor; 10^{-6}
IR = fish ingestion rate; g/day
BW = body weight; kg
ED = exposure duration; years
AT = averaging time; period over which exposure is averaged - days or years

The Excess Lifetime Cancer Risk (ELCR) from ingestion of fish can be calculated using the following equations:

H9

ELCR $= (LADD_{oral}) * CSF$ (for cancer risks less than 1 in 100)

ELCR $= 1 - \exp(-LADD_{oral} * CSF)$ (for cancer risks greater than 1 in 100)

Where:

ELCR = Excess Lifetime Cancer Risk
CSF = Cancer Slope Factor; 2 $(mg/kg/day)^{-1}$ for nondioxin-like PCBs and 150,000 $(mg/kg/day)^{-1}$ for dioxin TEQ's
$LADD_{oral}$ = lifetime average daily dose from ingestion of fish
exp = e raised to the power of x, where x is the product of the dose and the cancer slope factor

NONCANCER RISKS

Using the exposure assumptions in Table 1 and the equations below, an average daily dose of PCBs from ingestion of fish can be calculated.

$$ADD_{oral} = \frac{[PCB] * C * IR * ED}{BW * AT}$$

Where:

ADD_{oral} = average daily dose from ingestion of fish; mg/kg/day
[PCB] = PCB concentration in fish; μg/kg
C = conversion factor; 10^{-6}
IR = fish ingestion rate; g/day or g/week
BW = body weight; kg
ED = exposure duration; weeks or years
AT = averaging time; period over which exposure is averaged - days or years

The Hazard Index can be calculated using the equation below.

$$HI = \frac{[ADD_{oral}]}{RfD}$$

Where:

HI = Hazard Index
RfD = Reference Dose; mg/kg/day
ADD_{oral} = average daily dose from ingestion of fish; mg/kg/day

B. Risk Results

RCRA/CERCLA Risk Management Criteria

The cancer risks for the adult fisher and the subsistence fisher whom consume PCB contaminated fish are two orders of magnitude (100 times) or more above the EPA cancer risk range (discussed in EPA 1991) of 10^{-6} to 10^{-4} (see tables attached) and this justifies EPA in taking an (remedial or removal) action.

Even a child who consumes one fish meal a week over the course of one summer has a cancer risk from that short term exposure which is nine times higher than the EPA cancer risk range of 10^{-6} to 10^{-4} and this justifies EPA in taking an action.

The chronic noncancer risks for the adult fisher and the subsistence fisher whom consume PCB contaminated fish are over 900 times the risk (ie., a chronic Hazard Index of 1) at which EPA is justified in taking an action.

The noncancer risks (subchronic) for a child who consumes one fish meal a week over the course of one summer are over 800 times the risk (ie., a subchronic Hazard Index of 1) at which EPA is justified in taking an action.

If adults or children are consuming the fish on a regular basis, they have a significant risk of cancer or noncancer health effects.

C. Discussion of Risk Characterization

Discussion Related to Exposure Scenarios

The exposure period evaluated for the child fisher (one summer) may underestimate the actual exposure that a child may receive because it does not account for continuing exposure. Moreover, PCBs have been present in the residential areas in Pittsfield for many years already, making it likely that exposure via some other environmental media has already occurred.

The exposure period selected for evaluation of cancer effects is one summer for the child fisher. However, different assumptions about the exposure period have a significant impact on the risk results. As the exposure period increases, the cancer risk estimate increases. For evaluating cancer risks, one could easily justify using a longer exposure period than the ones selected. Also, typically the calculation of cancer risks attributable to fish consumption may involve some weighting of child and adult exposures, which may make the risks higher than those calculated for the adult alone.

The risk calculations may not be conservative enough for ethnic groups whose members consume the whole fish. Also, particular Native American or ethnic groups may consume more fish than noted in the subsistence fishing calculations.

Pre-natal exposure to PCBs as well as post-natal exposure to PCBs via breast milk may have higher risks than those noted. Early stages of development may have an extra sensitivity to the effects of PCBs (reviewed in EPA 1993, IRIS 1998).

Toddlers consuming fish may have higher risks than those noted because of the large doses that these fish would provide given the small body size of a toddler. Also, the toddler may be more sensitive to the developmental effects of PCBs.

Discussion Related to Toxicity and Exposure

The cancer risks from the dioxin-like PCBs was about twice the risks from PCBs (without the properties of dioxin). This illustrates the importance of performing congener specific analysis of PCBs for estimates of cancer risk.

The PCB doses from eating the fish, even for as short a period as one summer, are higher than the doses at which monkeys showed marked reproductive effects (Arnold et al 1995) and effects on cognitive behavior (Rice 1995, 1997, Rice and Hayward 1997, Rice et al 1996) and activity (reviewed in EPA 1993). This suggests that there may be no safety margin between the exposure estimates for people who eat fish from the Housatonic river and the exposures in the monkey studies which show adverse health effects.

The risks from consuming the fish are substantial. If the fishing advisory is effective, then there is no risk from the fish. However, a report in the literature suggests that fishing advisories are violated regularly (Tilden et al 1997)[6]. And some people in the area may have consumed fish from the Housatonic before the fishing advisory was in place (about 10 years ago).

In sum, doses estimated for children and adults who ingest contaminated fish from the Housatonic river are higher than those received by the monkeys in the PCB noncancer toxicity study that demonstrated adverse health effects. This is true even in the case of children who ingest contaminated fish over the course of one summer. These exposure estimates raise significant concerns regarding potential health effects in children and adults who ingest contaminated fish from the Housatonic river.

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[6]Tilden estimates that, in one year, as many as 4.7 million people ate Great Lakes sport fish despite long standing (since the mid-70's) state fishing advisories.

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ATTACHMENT A1

Spreadsheets showing raw data and UCL calculations

Congener specific PCB concentrations and TEQ's in largemouth bass collected from Woods Pond, MA   last modified 5/10/98

Fish reference number	ppm PCBs, total	Lipid (%)	PCB's in Lipid (µg PCB's/g	Aroclor (ppm)				Dioxin-like Congeners(ppm)										
				1242	1248	1254	1260	77	105	114	118/106	126	156	167	169	170	189	157
whole fish																		
B01	57	2.25	2533.3	-	-	-	-	0	0.42	0.036	2.6	0.017	0.46	0.32	0.0023	3.1	0.096	0.091
B02	206	3.81	5406.8	<.05	<.05	110	96	0.001	0.52	0.043	3.3	0.02	0.6	0.41	0.0033	4.2	0.16	0.12
B03	65	1.61	4037.3	<.05	<.05	35	30	0	0.17	0.013	1.2	0.0073	0.21	0.15	0.0005	0.16	0.045	0.043
B04	117	1.06	11037.7	<.05	<.05	60	57	0	0.33	0.037	2.2	0.012	0.42	0.3	0.0014	3.3	0.11	0.087
B05	75	2.85	2631.6	-	-	-	-	0	0.26	0.02	1.7	0.0096	0.34	0.24	0.0016	2.6	0.087	0.071
B06	63	5.79	1088.1	-	-	-	-	0	0.27	0.02	1.6	0.01	0.34	0.25	0.018	2.7	0.09	0.07
B07	71	3.35	2119.4	<.05	<.05	38	33	0	0.21	0.015	1.3	0.0096	0.24	0.18	0.0012	2	0.057	0.05
B08	31	2.41	1286.3	-	-	-	-	0	0.23	0.018	1.6	0.0086	0.29	0.21	0.001	2.4	0.066	0.059
B09	157	4.33	3625.9	<.05	<.05	88	69	0	0.39	0.032	2.5	0.017	0.44	0.31	0.0022	3.4	0.11	0.089
B10	69	1.89	3650.8	<.05	<.05	36	33	0	0.19	0.016	1.4	0.01	0.25	0.2	0.0018	1.8	0.06	0.054
B11	56	2.02	2772.3	<.05	<.05	30	26	0	0.18	0.015	1.2	0.01	0.21	0.16	0.001	1.5	0.046	0.043
B12	196	3.44	5697.7	<.05	<.05	110	86	0	0.46	0.037	2.9	0.021	0.52	0.37	0.0027	4	0.12	0.11
B14	27	1.7	1588.2	-	-	-	-	0	0.3	0.026	2	0.0098	0.4	0.3	0.0014	2.9	0.097	0.078
B15	77	3.29	2340.4	<.05	<.05	42	35	0	0.25	0.022	1.7	0.014	0.03	0.23	0.0021	2.2	0.072	0.062
B19	110	3.99	2756.9	-	-	-	-	0	0.51	0.044	3	0.017	0.56	0.39	0.0022	4	0.12	0.11
B20	121	2.13	5680.8	<.05	<.05	61	60	0	0.33	0.27	2	0.015	0.45	0.32	0.0022	3.3	0.13	0.09
B21	198	3.69	5365.9	<.05	<.05	110	88	0.001	0.53	0.046	3.3	0.019	0.63	0.43	0.0024	4.2	0.14	0.13
B22	89	2.46	3617.9	<.05	<.05	48	41	0	0.26	0.022	1.7	0.012	0.32	0.23	0.0017	2.4	0.77	0.067
B23	130	3.18	4088.1	<.05	<.05	79	51	0	0.36	0.031	2.3	0.015	0.38	0.28	0.0015	2.3	0.073	0.083
B24	168	3.55	4732.4	<.05	<.05	95	73	0	0.43	0.038	2.7	0.017	0.5	0.35	0.0021	3.5	0.11	0.1
B25	87	2.38	3655.5	<.05	<.05	48	39	0	0.25	0.018	1.5	0.0093	0.3	0.22	0.0013	2.1	0.07	0.064
B31	47	1.39	3381.3	<.05	<.05	24	23	0	0.15	0.01	0.86	0.0054	0.19	0.14	0.0005	1.4	0.046	0.04
B33	50	1.39	3597.1	<.05	<.05	26	24	0	0.14	0.0096	0.68	0.0058	0.19	0.14	0.0005	1.4	0.053	0.039
B34	121	0.872	13876.1	<.05	<.05	62	59	0	0.31	0.023	1.9	0.081	0.42	0.3	0.0005	3.3	0.11	0.087
muscle tissue																		
B13	13.8	0.577	2391.7	<.05	<.05	7.9	5.9	0	0.045	0.0031	0.23	0.004	0.05	0.037	0.0005	0.39	0.01	0.0082
B16	70	1.86	3763.4	<.05	<.05	35	35	0	0.19	0.018	1.3	0.01	0.28	0.23	0.0024	2.1	0.075	0.057
B17	41	1.19	3445.4	<.05	<.05	21	20	0	0.12	0.01	0.64	0.0063	0.17	0.13	0.0012	1.2	0.044	0.034
B18	13.2	0.39	3384.6	<.05	<.05	7.2	6	0	0.036	0.0025	0.19	0.0013	0.047	0.045	0.0005	0.34	0.024	0.0078

Fish reference number	ppm PCBs, total	Lipid (%)	77	105	114	118/106	126	156	167	169	170	189	157	sum of TEQ's (mg TEQ/kg whole fish)	mcg TEQ /g fat	mcg TEQ /g tissue	Ln conc TEQ's	microgram PCB's/g tissue	Ln PCB
			TEF's and TEQ's for tested congeners																
whole fish			0.0005	0.0001	0.0005	0.0001	0.1	0.0005	0.00001	0.01	0.0001	0.0001	0.0005						
B01	57	2.25	0E+00	4E-05	2E-05	3E-04	2E-03	2E-04	3E-06	2E-05	3E-04	1E-05	5E-05	0.0026	0.1174	0.0012	-6.75	25.33	3.23
B02	206	3.81	6E-07	5E-05	2E-05	3E-04	2E-03	3E-04	4E-06	3E-05	4E-04	2E-05	6E-05	0.0032	0.0850	0.0008	-7.07	54.07	3.99
B03	65	1.61	0E+00	2E-05	7E-06	1E-04	7E-04	1E-04	2E-06	5E-06	2E-05	5E-06	2E-05	0.0010	0.0638	0.0006	-7.36	40.37	3.70
B04	117	1.06	0E+00	3E-05	2E-05	2E-04	1E-03	2E-04	3E-06	1E-05	3E-04	1E-05	4E-05	0.0021	0.1965	0.0020	-6.23	110.38	4.70
B05	75	2.85	0E+00	3E-05	1E-05	2E-04	1E-03	2E-04	2E-06	2E-05	3E-04	9E-06	4E-05	0.0017	0.0582	0.0006	-7.45	26.32	3.27
B06	63	5.79	0E+00	3E-05	1E-05	2E-04	1E-03	2E-04	3E-06	2E-04	3E-04	9E-06	4E-05	0.0019	0.0322	0.0003	-8.04	10.88	2.39
B07	71	3.35	0E+00	2E-05	8E-06	1E-04	1E-03	1E-04	2E-06	1E-05	2E-04	6E-06	3E-05	0.0015	0.0443	0.0004	-7.72	21.19	3.05
B08	31	2.41	0E+00	2E-05	9E-06	2E-04	9E-04	1E-04	2E-06	1E-05	2E-04	7E-06	3E-05	0.0015	0.0616	0.0006	-7.39	12.86	2.55
B09	157	4.33	0E+00	4E-05	2E-05	3E-04	2E-03	2E-04	3E-06	2E-05	3E-04	1E-05	4E-05	0.0026	0.0611	0.0006	-7.40	36.26	3.59
B10	69	1.89	0E+00	2E-05	8E-06	1E-04	1E-03	1E-04	2E-06	2E-05	2E-04	6E-06	3E-05	0.0015	0.0807	0.0008	-7.12	36.51	3.60
B11	56	2.02	0E+00	2E-05	8E-06	1E-04	1E-03	1E-04	2E-06	1E-05	2E-04	5E-06	2E-05	0.0014	0.0712	0.0007	-7.25	27.72	3.32
B12	196	3.44	0E+00	5E-05	2E-05	3E-04	2E-03	3E-04	4E-06	3E-05	4E-04	1E-05	6E-05	0.0032	0.0934	0.0009	-6.98	56.98	4.04
B14	27	1.7	0E+00	3E-05	1E-05	2E-04	1E-03	2E-04	3E-06	1E-05	3E-04	1E-05	4E-05	0.0018	0.1046	0.0010	-6.86	15.88	2.77
B15	77	3.29	0E+00	3E-05	1E-05	2E-04	1E-03	2E-05	2E-06	2E-05	2E-04	7E-06	3E-05	0.0019	0.0578	0.0006	-7.46	23.40	3.15
B19	110	3.99	0E+00	5E-05	2E-05	3E-04	2E-03	3E-04	4E-06	2E-05	4E-04	1E-05	6E-05	0.0028	0.0713	0.0007	-7.25	27.57	3.32
B20	121	2.13	0E+00	3E-05	1E-04	2E-04	2E-03	2E-04	3E-06	2E-05	3E-04	1E-05	5E-05	0.0025	0.1177	0.0012	-6.75	56.81	4.04
B21	198	3.69	5E-07	5E-05	2E-05	3E-04	2E-03	3E-04	4E-06	2E-05	4E-04	1E-05	7E-05	0.0031	0.0853	0.0009	-7.07	53.66	3.98
B22	89	2.46	0E+00	3E-05	1E-05	2E-04	1E-03	2E-04	2E-06	2E-05	2E-04	8E-05	3E-05	0.0019	0.0787	0.0008	-7.15	36.18	3.59
B23	130	3.18	0E+00	4E-05	2E-05	2E-04	2E-03	2E-04	3E-06	2E-05	2E-04	7E-06	4E-05	0.0023	0.0713	0.0007	-7.25	40.88	3.71
B24	168	3.55	0E+00	4E-05	2E-05	3E-04	2E-03	3E-04	4E-06	2E-05	4E-04	1E-05	5E-05	0.0027	0.0765	0.0008	-7.17	47.32	3.86
B25	87	2.38	0E+00	3E-05	9E-06	2E-04	9E-04	2E-04	2E-06	1E-05	2E-04	7E-06	3E-05	0.0015	0.0642	0.0006	-7.35	36.55	3.60
B31	47	1.39	0E+00	2E-05	5E-06	9E-05	5E-04	1E-04	1E-06	5E-06	1E-04	5E-06	2E-05	0.0009	0.0656	0.0007	-7.33	33.81	3.52
B33	50	1.39	0E+00	1E-05	5E-06	7E-05	6E-04	1E-04	1E-06	5E-06	1E-04	5E-06	2E-05	0.0009	0.0671	0.0007	-7.31	35.97	3.58
B34	121	0.87	0E+00	3E-05	1E-05	2E-04	8E-03	2E-04	3E-06	5E-06	3E-04	1E-05	4E-05	0.0089	1.0247	0.0102	-4.58	138.76	4.93
muscle tissue														mg TEQ's/kg tissue					
B13	13.8	0.58	0E+00	5E-06	2E-06	2E-05	4E-04	3E-05	4E-07	5E-06	4E-05	1E-06	4E-06	0.0005		0.0005	-7.59	13.8	2.62
B16	70	1.86	0E+00	2E-05	9E-06	1E-04	1E-03	1E-04	2E-06	2E-05	2E-04	8E-06	3E-05	0.0016		0.0016	-6.46	70	4.25
B17	41	1.19	0E+00	1E-05	5E-06	6E-05	6E-04	9E-05	1E-06	1E-05	1E-04	4E-06	2E-05	0.0010		0.0010	-6.96	41	3.71
B18	13.2	0.39	0E+00	4E-06	1E-06	2E-05	1E-04	2E-05	5E-07	5E-06	3E-05	2E-06	4E-06	0.0002		0.0002	-8.41	13.2	2.58

ave. % lipid, muscle tissue 1

GSD	0.66	GSD	0.61
n	28	n	28
H statistic	2.0923	H statistic	2.0502
95% UCL of the TEQ's: mcg TEQ/g tissue	**0.0013**	95% UCL, PCB's: mcg PCB/g tissue	**52.2**
max TEQ's	0.0102	max PCB's	138.8

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ATTACHMENT A2

Spreadsheets showing risk calculations

Potential risks from ingesting largemouth bass from the Housatonic River (Woods Pond area) in Massachusetts on a regular basis

last modified 5/14/98

The concentrations are based upon the 95% UCL of the mean concentration in muscle tissue.

adult who consumes PCB contaminated fish

		conc (mcg/kg)	ingestion (g/day)	ED (yrs)	BW (kg)	AT (yrs)	LADD (mg/kg-d)	slope (per mg/kg-d)	risk	
cancer risks	dioxin TEQ	1.30	26	30	70	70	2.06E-07	150000	3E-02	cancer risk from TEQ's
	nondioxin-like PCBs	5.2E+04	26	30	70	70	0.0083	2	2E-02	cancer risk, nondioxinlike PCB's
									5E-02	**excess cancer risk, lifetime**
							ADD(mg/kg-d)	RfD oral(1254)	HI	
noncancer risks	nondioxin-like PCBs	5.2E+04	26	30	70	30	0.0194	0.00002	969	rounding to one significant figure,
									1000	**noncancer risk (chronic)**

subsistence fisher who consumes PCB contaminated fish

		conc (mcg/kg)	ingestion (g/day)	ED (yrs)	BW (kg)	AT (yrs)	LADD (mg/kg-d)	slope (per mg/kg-d)	risk	
cancer risks	dioxin TEQ	1.30	140	30	70	70	1.11E-06	150000	2E-01	cancer risk from TEQ's
	nondioxin-like PCBs	5.2E+04	140	30	70	70	0.0447	2	9E-02	cancer risk, nondioxinlike PCB's
									2E-01	**excess cancer risk, lifetime**
							ADD(mg/kg-d)	RfD oral(1254)	HI	
noncancer risks	nondioxin-like PCBs	5.2E+04	140	30	70	30	0.1044	0.00002	5219	rounding to one significant figure,
									5000	**noncancer risk (chronic)**

9 year child who consumes PCB contaminated fish once per week for one summer

		conc (mcg/kg)	ingestion (g/week)	ED (weeks)	BW (kg)	AT (days)	LADD (mg/kg-d)	slope (per mg/kg-d)	risk	
cancer risks	dioxin TEQ	1.30	182.5	13	30	25,550	4.02E-09	150000	6E-04	cancer risk from TEQ's
	nondioxin-like PCBs	5.2E+04	182.5	13	30	25,550	0.00016	2	3E-04	cancer risk, nondioxinlike PCB's
									9E-04	**cancer risk due to dose from a short-term exposure**
							ADD(mg/kg-d)	RfD oral(1254), subchronic	HI	
noncancer risks	nondioxin-like PCB's	5.2E+04	182.5	13	30	92	0.0449	5E-05	897	rounding to one significant figure,
									900	**noncancer risk (subchronic)**