Health Consultation

Evaluation of Stream Sediment and Floodplain Soil Downstream from the

WARD TRANSFORMER NPL SITE
RALEIGH, WAKE COUNTY, NORTH CAROLINA

EPA FACILITY ID: NCD003202603

Prepared by
North Carolina Department of Health and Human Services

JULY 24, 2017

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

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

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

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Occupational and Environmental Epidemiology Branch
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U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

Foreword

The North Carolina Department of Health and Human Services, Division of Public Health (DPH) Health Assessment, Consultation and Education (HACE) program prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for evaluating health issues related to hazardous waste. This health consultation was prepared in accordance with the methodologies and guidelines developed by ATSDR and DPH.

The purpose of this health consultation is to identify and prevent harmful health effects from exposure to hazardous substances in the environment. Health consultations focus on health issues associated with specific exposures that have happened in the past, are currently taking place, or are believed to be possible in the future based on current site conditions. The HACE program evaluates data collected from a hazardous waste site, determines if exposures occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time this health consultation was conducted. The findings might not be relevant if site conditions or land uses change.

For additional information or questions regarding the contents of this health consultation please contact:

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Summary

INTRODUCTION

The Ward Transformer site was listed on the U.S. Environmental Protection Agency's (EPA's) National Priorities List (NPL) in 2003 (EPA ID: NCD003202603). The federal Agency for Toxic Substances and Disease Registry (ATSDR) evaluates public health issues at NPL sites. In North Carolina, these evaluations are done through a cooperative agreement with the North Carolina Division of Public Health (DPH) in the Department of Health and Human Services. The DPH is evaluating this site because of its listing on the NPL. DPH's top priority in evaluating this site is to make sure the community near the Ward Transformer NPL site has the best information available to protect its health.

ATSDR and DPH previously released a public health assessment (ATSDR 2005b) and a health consultation (ATSDR 2008) evaluating potential health effects related to contamination from the Ward Transformer NPL site. The public health assessment evaluated the potential for health effects from exposure to contaminated fish, soil, sediment, and surface water (ATSDR 2005b)[1]. The previous health consultation evaluated the potential for health effects from exposure to contaminated fish downstream from the site (ATSDR 2008)[2]. These previous site investigations noted that the primary contaminant of concern for the downstream portions of this site is polychlorinated biphenyls (PCBs). PCBs were chemicals used until 1977 in electrical equipment and for other uses.

In 2014, EPA and the site contractors for the potentially responsible parties (PRPs) collected sediment and floodplain soil samples in the downstream areas of the site. This is part of the investigation to find out where PCB contamination has spread from former operations at the site. This health consultation includes an evaluation of the sediment and floodplain soil data for potential health effects from exposure to PCBs from the site. This report will focus on Reach B, Reach C, Reach D, and Lower Brier Creek sediment and floodplain soil. Because the downstream area under investigation is so large, each of the four stream sections are considered separately. Appendix A shows a map of the area under investigation. Brier Creek Reservoir, Lake Crabtree and Lower Crabtree Creek are included in the NPL site, but EPA and the PRP are not investigating sediment and floodplain soil contamination in these areas.

DPH released a Public Comment version of this health consultation on March 31, 2017. A 60-day public comment period was provided from March 31, 2017 to May 31, 2017. DPH did not receive any public comments.

[1] http://www.atsdr.cdc.gov/HAC/pha/WardTransformer031405-NC/WardTransformer031405-NC.pdf
[2] http://epi.publichealth.nc.gov/oee/hace/docs/NeuseRiverFishSamplingHC.pdf

OVERVIEW	**After reviewing the environmental data, DPH reached two important conclusions:**
CONCLUSION 1	**Children who come in contact with PCBs in Reach B stream sediment and floodplain soil during recreational activities might be at risk for harmful effects. Younger children (ages 1 to 2 years) are at the most risk.**
BASIS FOR DECISION	Concentrations of PCBs are elevated in Reach B soil and sediment. Estimated doses from incidental ingestion of and direct skin contact with soil exceed ATSDR's health guidelines for young persons (ages 1-21 years) visiting or playing in the area. These doses approach levels associated with immune system effects in animal studies. This poses a health concern for children ages 1 to 2 years who are assumed to have more contact with soil during the same amount of time spent in the floodplain as older children and adults. A low increased risk of cancer has been calculated with adult and childhood exposures, but only after decades of exposure, which might not be occurring at this site.
CONCLUSION 2	**People who come in contact with PCBs in Reach C, Reach D and Lower Brier Creek stream sediment and floodplain soil during recreational activities are not expected to be at risk for harmful effects.**
BASIS FOR DECISION	Available soil and sediment data have been evaluated using health-protective assumptions to consider exposures to recreational users of these areas through incidental ingestion of and direct skin contact with soil and sediment. The estimated doses of PCBs from sediment and soil for children and adults who play or wade in Reach C, Reach D, and Lower Brier Creek are not expected to cause adverse non-cancer health effects or result in an elevated cancer risk.
NEXT STEPS	The DPH recommends the: ▪ local health department post advisory signs in the Reach B area where the stream may be accessed to reduce the possibility of exposure to PCBs. ▪ local health department take steps to inform and educate local residents and businesses of potential health risks from contamination downstream of the Ward Transformer site. ▪ people who spend time in Reach B thoroughly wash with soap and water hands, feet, and any skin or clothing that comes in contact with the sediment or soil. ▪ EPA focus initial clean-up efforts on the Reach B portion of the site in order to eliminate exposure and protect human health. ▪ EPA continue monitoring sediment and floodplain soil in the contaminated streams yearly throughout the clean-up process to ensure people are not exposed to harmful amounts of PCBs. ▪ Potentially Responsible Party (PRP) and/or EPA contractors use

congener analysis instead of Aroclor analysis in future sampling in order to allow for a more accurate assessment of human health risk. If this level of analysis is not feasible, we recommend the PRP or EPA analyze at least 10% of samples for congener analysis per EPA Region 4 guidance (EPA 2013).

The DPH:

- held a public meeting on April 18, 2017 at Triangle Christian Center in Raleigh, NC to discuss the site, answer questions, and hear comments from the local community.
- prepared a summary factsheet that is available on the Health Assessment, Consultation & Education (HACE) program's website[3].
- will continue to work with the local health department to inform and educate the local community about potential health hazards from downstream contamination at the Ward Transformer site. This will include how to reduce exposures, developing and posting signs and distributing factsheets and other health education materials.
- will continue to monitor and assess the Ward Transformer NPL site and downstream areas while EPA and/or the PRP contractors collect additional data.

LIMITATIONS

The public health assessment process has limitations. These limitations include the availability of analytical data, the type and quantity of health effect study information, and the risk estimation process itself. In addition, the use of Aroclor analysis to test for PCBs at this site is less specific than congener analysis and adds uncertainty to the risk estimation.

FOR MORE INFORMATION

If you have concerns about your health, you should contact your doctor. Staff from the Division of Public Health is available to assist you in talking to your doctor. Contact us by calling (919) 707-5900, or by sending an email to nchace@dhhs.nc.gov and ask for information on the Ward Transformer NPL site.

[3] http://epi.publichealth.nc.gov/oee/hace/by_site.html#W

Background and Statement of Issues

The Ward Transformer NPL site (EPA ID NCD003202603) is located on Mount Herman Road in Raleigh, Wake County, North Carolina. The site was added to the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) in April 2003. ATSDR evaluates public health issues at NPL sites. In North Carolina, these evaluations are done through a cooperative agreement with the DPH. DPH is evaluating this site because of its listing on the NPL.

A former transformer recycling facility operated on the site from 1964 to 2006. Polychlorinated biphenyls (PCBs) were used in transformer oil until 1977, and their use was banned in 1979 (URS 2015b). Before the ban, PCBs contaminated soil on the site and were washed away from the site in runoff into an unnamed stream on the southern end of the property. Prior investigations have identified PCBs from the site in sediment, soil, surface water, and fish downstream from the site. Current investigations at the site aim to determine the extent of PCB contamination downstream from the former facility. (ATSDR 2005b)

This health consultation focuses on sediment and floodplain soil in the following portions of the downstream area south and west of the Ward Transformer property:

- Reach B – This portion of the unnamed stream flows under I-540 and through a small office park behind the Brier Creek Shopping Center to Lumley Road (0.3 miles).
- Reach C – This portion of the unnamed stream flows under Lumley Road back toward I-540 and past an apartment complex, where it empties into Little Brier Creek (0.4 miles).
- Reach D – This portion of Little Brier Creek flows under I-540, flows onto the Raleigh-Durham International Airport (RDU) property and continues until it empties into the north end of Brier Creek Reservoir (0.8 miles).
- Lower Brier Creek – The southern end of Brier Creek Reservoir discharges into Brier Creek near Airport Boulevard on the RDU property. Brier Creek flows under Airport Boulevard and I-40 and continues south until discharging into the northwest portion of Lake Crabtree (1.8 miles).

Brier Creek Reservoir, Lake Crabtree, and Lower Crabtree Creek are included in the Superfund site, but EPA is not investigating sediment and floodplain soil contamination in these areas (URS 2015a). Because the area under investigation is so large, each of the four stream sections is considered separately. Appendix A shows a map of the area under investigation.

The floodplain soils discussed in this report include areas bordering the stream and extending out from the stream to the area in the 10-year floodplain (URS 2015b). Stream waters sometimes breach the floodplain soils bordering the stream and submerge these soils under water, particularly during flooding events. The sediments discussed in this report are found in the stream bed and would be expected to be submerged under water a majority of the time. For this report, floodplain soils and sediments were evaluated using different exposure parameters to account for differences in locations in relation to the stream and sediments being submerged and less accessible (see Appendix C).

The objective of this health consultation was to determine if exposure to PCBs in stream sediment and floodplain soil poses a current health hazard to recreational users of the area. For the Ward Transformer NPL site, DPH evaluated stream sediment and floodplain soil samples collected in 2014 throughout areas downstream from the former facility. The information reviewed for this health consultation came from reports and data generated by EPA and contractors for the potentially responsible parties.

A Public Comment version of this health consultation was released on March 31, 2017. A 60-day public comment period was provided from March 31, 2017 to May 31, 2017. DPH did not receive any public comments.

Discussion

ATSDR Health Effects Evaluation Process

This section provides a summary of the DPH and the Agency for Toxic Substances and Disease Registry (ATSDR) health effects evaluation process. Appendix C discusses exposure dose equations and parameters.

The first step in the health effects evaluation process is the "environmental guideline comparison." This involves comparing site contaminant concentrations to water, soil, air, or food chain[4] comparison values (CVs). These comparison values are health protective values derived by ATSDR from default exposure values. During this first step of the screening process, site contaminants are divided into two categories: 1) those exceeding their media-specific CVs and 2) those not exceeding CVs. Those contaminant concentrations greater than CVs require a more in-depth evaluation of whether they might cause adverse health effects. However, concentrations greater than CVs do not always lead to adverse health effects. Contaminant concentrations below CVs are not expected to cause adverse health effects and require no further evaluation. However, further evaluation might be warranted based on site-specific conditions or community concerns.

The second step in the health effects evaluation process is the "health guideline comparison." This step is a closer look at the contaminants with concentrations greater than CVs from the environmental guideline comparison. The health guideline comparison involves estimating exposure doses, based on site-specific conditions, and comparing these doses to health guidelines. Health protective, site-specific dose estimates are developed for children and adults. These doses are then compared to ATSDR health guideline values to evaluate the potential for non-cancer health effects from exposure. The health guidelines are derived from epidemiologic and toxicologic data from the literature with multiple safety factors applied to be highly health protective. Health guidelines represent daily human exposure levels to a substance that are likely to have no appreciable risk of adverse, non-cancer health effects during specific exposure durations. Important factors in determining the potential for adverse health effects include:

- the concentration of the chemical;
- how long (duration) people are in contact with the chemical;

[4] Fish and other animals or plants that people can eat.

- how often (frequency) people are in contact with the chemical;
- the type of contact with the chemical (route of exposure), such as drinking, eating, touching or breathing it; and
- the health status of the people exposed.

Site-specific dose estimates for contaminants in which doses exceed health guidelines are also compared with data from animal and human health effects studies to determine the potential for adverse health effects. The health effects data are generally taken from ATSDR or EPA references that summarize well-validated human and animal studies. Comparisons are made on the basis of the exposure route (ingestion/eating, inhalation/breathing, or dermal/skin contact) and the length of the exposure. Preference is given to human study data and chemical doses or concentrations where no adverse health effects were observed. If no human data or no-adverse-effect data are available, animal data or the lowest chemical dose where adverse health effects were observed may be used.

In addition to a non-cancer health effects evaluation, a cancer risk evaluation is performed. Estimated exposure doses for individual age groups and chemical-specific cancer potency factors are used to estimate an increased cancer risk for persons who contact contaminated media. Exposure durations for each age group are averaged over a lifetime of exposure. These calculations assume there is no safe level of exposure to a contaminant that causes cancer.

The public health assessment process has limitations. These include the availability of analytical data collected for a site, the type and quantity of health effect study information, and the risk estimation process itself. In addition, the use of Aroclor analysis at this site for soil and sediment analysis adds uncertainty to the risk estimation process. Aroclor analysis can under- or over-estimate the PCB concentration. Weathering of Aroclor mixtures (see page 7) can also affect measurement of PCB concentrations and therefore the risk estimation process.

To overcome some of these limitations, health protective exposure assumptions were used to evaluate site data and interpret the potential for adverse health effects. The 95th percentile values were selected for exposure assumptions to represent a reasonable maximum exposure scenario for persons who contact environmental contamination that might be in the downstream areas of the site. ATSDR's CVs and health guideline values have large margins-of-safety to protect groups who might be particularly sensitive to contaminants. These groups include children, the elderly, or persons with impaired immune response. Exposure doses are calculated using the maximum concentrations of PCBs found in the soil or sediment at the site. The assumptions, interpretations, and recommendations made throughout this report are selected to provide a high level of protection.

Health guideline values used in this health consultation were developed by the ATSDR for chronic (more than 1 year) daily exposure to PCBs. Appendix C discusses equations and exposure parameters used to estimate exposure doses and evaluate cancer risk for recreational users near the Ward Transformer NPL site.

Exposure Pathway Analysis

Even if a contaminant is present in the environment, this does not automatically mean people will be exposed or that it will cause adverse health effects. A person first needs to be exposed to the contaminant in some way. They might swallow it in food or water, breathe it in dust, or absorb it through their skin. The ability of the contaminant to cause adverse health effects will also depend on:

- the amount of chemical a person is exposed to (dose),
- how long a person is exposed (duration),
- how often a person is exposed (frequency), and
- how much and what type of damage the chemical can cause in the body (toxicity).

Knowing or estimating the frequency with which people have contact with hazardous substances is essential to assessing the public health impact of exposure to these contaminants.

Individuals or groups of individuals, such as children, the elderly, or persons with weakened immune responses or other chronic health issues might be especially sensitive to potentially harmful substances. Compared with most people exposed at the same concentration to a particular chemical in the environment, these susceptible populations might have different or heightened responses as compared to most people exposed at the same concentration to a particular chemical in the environment. Some reasons for these differences include genetic makeup, age, health status, nutritional status, and exposure to other toxic substances (such as cigarette smoke or alcohol). Such factors can limit a person's ability to detoxify or eliminate the harmful chemicals from their body, or may increase the effects of damage to their organs or alter physiological systems. Child-specific exposure situations and susceptibilities are also considered in DPH health evaluations.

Exposure pathways (how people might come into contact with contaminants in their environment) are evaluated to determine if people have come into contact with site contaminants, or if they might in the future. An exposure pathway has:

- a source of contamination (i.e., hazardous waste site),
- movement of the contaminant through environmental media (i.e., air, water, or soil),
- a point of exposure where people come in contact with the contaminated media (i.e., soil in a garden),
- a route of exposure (i.e., eating contaminated soil on homegrown vegetables), and
- an exposed population of persons who can come in contact with the contaminants.

At the former Ward Transformer facility, PCBs traveled off the property in surface water and dispersed into downstream sediment and floodplain soil. Potentially exposed people include children and adults playing or wading in the stream areas. These people might be exposed to PCBs through incidental ingestion of or dermal (skin) contact with contaminated sediment or floodplain soil. Infants ages 6 weeks to 1 year are not expected to be playing or wading in the stream area. Therefore, this assessment only evaluated exposure scenarios for people age 1 year or older. The elements of an exposure pathway might change over time, so the time-frame of potential exposure is also considered. Past exposures to contaminants at the Ward Transformer site are discussed in detail in the 2005 Public Health Assessment (ATSDR 2005b). This health consultation will focus on current and future exposures.

Environmental Data

Contractors for the potentially responsible Parties collected 888 stream sediment and floodplain soil samples between August and November 2014. These samples were combined in the laboratory into 272 composites based on location and stream features. No more than five individual samples were combined into one composite. These composites were analyzed using Aroclor analysis. Aroclor analysis is acceptable for screening of PCB concentrations, although 209-congener analysis is preferred on at least 10% of samples to characterize specific PCB congener concentrations and risk from exposure (see limitations section below).

Concentrations of total PCBs in each composite were compared against a relative action level (RAL). The RAL for this site is equal to 1 mg/kg (milligram of PCBs per kilogram of soil), which is EPA's cleanup goal for this site[5], divided by the number of individual samples in each composite. If the PCB concentration in the composite was over the RAL, then each individual sample combined for that composite was analyzed separately. Of the 888 stream sediment and floodplain soil samples, 249 individual samples were directly analyzed after their respective composites exceeded the RAL (URS 2015b). Any areas where individual sample concentrations were greater than 1 mg/kg will be cleaned up to below this action level (EPA 2008).

Surface soil and sediment from the ground surface to depths of 3 inches are preferred for human health assessments. Surface floodplain soil and sediment included in this report were collected from the ground surface to a depth of 6 inches, reflecting the available surface soil and sediment data collected for this site. Surface soil and sediment collected from the ground surface to a depth of 12 inches were not included in this report because most people would not be exposed to soil and sediment from that depth (ATSDR 2005a). Of the 249 individually analyzed sediment and soil samples, 168 were surface soil and sediment as defined above. This health consultation evaluated the total PCB concentrations of the 168 individually analyzed surface sediment and floodplain soil samples.

Limitations of Aroclor Analysis

Aroclor is a brand name used for many commercial PCB mixtures. PCBs are made up of 209 individual chlorinated compounds, or congeners. Each Aroclor mixture is made up of 50-100 of the 209 individual congeners. The congeners making up a particular Aroclor mixture are not exclusive to that Aroclor. Each of the 209 congeners interacts differently within each environmental media and with each move from one type of media to another, depending on the physical and chemical characteristics of the media. For example, higher chlorinated PCB congeners in a stream will tend to stick to sediment and settle out of the surface water, whereas lower chlorinated PCB congeners will likely stay in the surface water and travel further downstream. Aroclor PCB mixtures are subject to a process known as weathering. Through weathering, the congener makeup of the PCB mixture is changed as it travels away from the release site and as time passes. This can make it difficult to match a congener plot to Aroclor reference standards during Aroclor analysis of a sample.

Using Aroclor analysis can over- or under-estimate the total PCB concentration in a sample. Congener analysis measures individual congener concentrations and can be more precise than

[5] Based on U.S. EPA's selected remedy in the Ward Transformer OU1 Record of Decision (EPA 2008)

Aroclor analysis. Sensitivity is also increased using congener analysis, as lower concentrations of PCBs can be detected using this method. Measurement of total PCB concentrations might be higher or lower using 209-congener analysis compared with results from Aroclor analysis.

It is also important to understand the specific congener make-up of the PCBs because individual congeners vary in toxicity. The World Health Organization has designated 12 PCB congeners as having "dioxin-like" toxicity. Because of this, the health effects evaluation is more accurately performed when 209-congener analysis is used (EPA 2013). The sediment and floodplain soil Aroclor PCB concentrations evaluated in this report are representative of the time and location of collection.

Evaluation of Soil and Sediment Data by Stream Section

The following discussions of environmental data focuses on samples in which PCB concentrations were greater than comparison values. For this health assessment, the ATSDR Cancer Risk Evaluation Guide (CREG) of 0.19 mg/kg for total PCBs was used as the environmental comparison value. Following the initial data screening, incidental ingestion and dermal doses were added together to derive a total exposure dose. The total exposure dose was compared with the health guideline and relevant toxicity data to assess the potential for health risks. The ATSDR chronic oral Minimal Risk Level (MRL) of 0.00002 mg/kg/day for Aroclor 1254 was used as the health guideline to evaluate the potential for non-cancer health effects. The health guideline for Aroclor 1254 was used because no health guidelines are currently available for total PCBs.

Because of differences in surroundings and potential differences in visitor frequency, the evaluation of contaminant data for the different site stream sections will be discussed separately below. To be health protective, DPH used maximum concentrations of PCBs in each stream section for the health effects evaluation because of the variability of PCB concentrations over short distances and the hydrologic features of each stream section. Appendix B includes tables summarizing contaminant concentrations, comparison values and dose calculations by stream section.

Reach B

The Reach B section of the stream runs through a small office park behind the Brier Creek Shopping Center. Arco Corporate Drive runs over top the stream in three places in this section and includes a sidewalk that is a popular walking area for people working in the office buildings nearby. The stream is easily accessible from the roadway, but is overgrown with vegetation during the late spring and summer. For this section of the stream, DPH assumed people might come in contact with the PCBs in the sediment and soil 26 days per year (see Appendix C for calculation of exposure factors).

PCBs were detected in all 21 sediment samples collected in Reach B. Only 12 of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the sediment in Reach B ranged from 0.0214 mg/kg to 7.54 mg/kg. Estimated doses of PCBs from exposure to the sediments in this area, based on the maximum concentration of 7.54 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely for children and adults who contact these sediments.

PCBs were detected in 20 of the 22 floodplain soil samples collected in Reach B. Eighteen of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the floodplain soil in Reach B ranged from 0.0213 mg/kg to 153 mg/kg. Estimated doses of PCBs for young persons ages 1 to 21 years from exposure to the soil in this area, based on the maximum concentration of 153 mg/kg, are above the health guideline value (0.00002 mg/kg/day MRL). However, the greatest estimated dose, which is for children ages 1 to 2 years, is below the no observed adverse effect level (NOAEL)[6] for chronic oral exposure in humans (0.093 mg/kg/day), based on neurodevelopmental effects in newborns exposed to PCBs through breast milk. The greatest estimated dose is also below the MRL-derived studies' lowest observed adverse effect level for chronic oral exposure (0.005 mg/kg/day), which noted immune system effects in animals (ATSDR 2000b). In addition, a low increased cancer risk is expected for children (4 in 100,000) and adults (1 in 100,000) from contact with the floodplain soils in this area considering decades of exposure, which might or might not be occurring at this site.

To summarize, contact with the sediments in Reach B is not expected to result in adverse health effects. However, contact with the floodplain soil near the stream could put younger children, particularly those ages 1 to 2 years, at risk for harmful effects. To protect their health, persons should avoid playing and wading in this area.

Reach C

The Reach C section of the stream runs between the Brierdale Shopping Center and I-540. The stream runs within 600 feet of an apartment complex. The complex has various recreational areas (i.e., picnic tables, outdoor grills, a dog park) located on the side of the property closest to the stream. However, during the late spring and summer this area is overgrown with vegetation making it difficult to access the contaminated area. For this section of the stream, DPH assumed people might come in contact with the PCBs in the sediment and soil 52 days per year (see Appendix C for calculation of exposure factors).

PCBs were detected in all 3 sediment samples collected in Reach C. These 3 samples were duplicated for laboratory quality control purposes resulting in 6 analytical lab results. For each sample, the two concentrations from the duplicates were averaged to provide one concentration for each sample location to be used in this evaluation. All 3 of these samples exceeded the CREG (0.19 mg/kg). PCB detections in the sediment in Reach C ranged from 0.857 mg/kg to 1.09 mg/kg. Estimated doses of PCBs from exposure to the sediment in this area, based on the maximum concentration of 1.09 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with these sediments for children or adults.

PCBs were detected in 37 of the 40 floodplain soil samples collected in Reach C. Thirty-three of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the floodplain soil in Reach C ranged from 0.0407 mg/kg to 2.04 mg/kg. Estimated doses of PCBs from exposure to the soil in this area, based on the maximum concentration of 2.04 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with the floodplain soil in this area for children or adults.

[6] The highest tested dose of a substance that has been reported to have no harmful (adverse) health effects on people or animals.

To summarize, contact with the sediment and floodplain soil in Reach C is not expected to result in adverse health effects for recreational users.

Reach D

The Reach D section of the stream runs west of the runways on the RDU property. This portion of the stream runs through an industrial area. Access to the stream is not restricted. However, the stream is hard to get to because access to the business and airport properties is limited. For this section of the stream, DPH assumed people might come in contact with the PCBs in the sediment and soil 26 days per year (see Appendix C for calculation of exposure factors).

PCBs were detected in all 22 sediment samples collected in Reach D. Ten of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the sediment in Reach D ranged from 0.0174 J mg/kg ("J" values indicate estimated concentrations) to 6.41 mg/kg. Estimated doses of PCBs from exposure to the sediment in this area, based on the maximum concentration of 6.41 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with these sediments for children or adults.

PCBs were detected in 26 of 30 floodplain soil samples collected in Reach D. Twenty-two of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the floodplain soil in Reach D ranged from 0.015 J mg/kg to 1.82 mg/kg. Estimated doses of PCBs from exposure to the soil in this area, based on the maximum concentration of 1.82 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with the floodplain soil in this area for children or adults.

To summarize, contact with the sediment and floodplain soil in Reach D is not expected to result in adverse health effects for recreational users.

Lower Brier Creek

The Lower Brier Creek section of the stream runs on RDU property south of the main airport complex. After passing under I-40, this portion flows over Wake County property and past a small business park located off Aviation Parkway. Lower Brier Creek then empties into Lake Crabtree west of Aviation Parkway. This section of the stream flows primarily through an industrial area and is not readily accessible for recreational users. For this section of the stream, DPH assumed people might come in contact with the PCBs in the sediment and soil 26 days per year (see Appendix C for calculation of exposure factors).

PCBs were detected in all 6 sediment samples collected in Lower Brier Creek. Four of these detections exceeded the CREG (0.19 mg/kg). PCB detections in the sediment in Lower Brier Creek ranged from 0.134 mg/kg to 1.37 mg/kg. Estimated doses of PCBs from exposure to the sediment in this area, based on the maximum concentration of 1.37 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with these sediments for children or adults.

PCBs were detected in 23 of 24 floodplain soil samples collected in Lower Brier Creek, PCBs were detected in 23 samples. Nineteen of these detections exceeded the CREG (0.19 mg/kg).

PCB detections in the floodplain soil in Lower Brier Creek ranged from 0.0147 J mg/kg to 1.68 mg/kg. Estimated doses of PCBs from exposure to the soil in this area, based on the maximum concentration of 1.68 mg/kg, are below the health guideline value (0.00002 mg/kg/day MRL). In addition, an increased cancer risk is unlikely from contact with the floodplain soil in this area for children or adults.

To summarize, contact with the sediment and floodplain soil in Lower Brier Creek is not expected to result in adverse health effects for recreational users.

Health Effects of PCBs

PCBs are a group of synthetic chlorinated compounds. PCBs have no known smell or taste and can remain in the environment for long periods. Most of the research on health effects from PCB exposure has been done in animals. Some epidemiological studies have looked at human health effects from PCB exposure. In addition, most of the toxicity studies have been performed with unmodified Aroclor mixtures and not weathered mixtures that are typically found in the environment. Exposure to high levels of PCBs can cause skin conditions (i.e. acne and rashes) or liver damage (ATSDR 2005b). These levels are much greater than those found at the Ward Transformer site. Acne-like skin conditions have been seen in animals and humans. Additionally, in animal studies, PCB exposure has led to eye and skin damage, behavioral changes and liver damage. In epidemiological studies, children exposed to PCBs through their mothers, either before birth or via breast milk, had slightly lower birth weights, behavioral alterations, and immune system effects. The primary source of the PCBs in the mother's breast milk was thought to be the diet, particularly contaminated fish (ATSDR 2000b).

In addition to the non-cancer health effects described above, studies looking at occupational exposures have reported that workers exposed to high levels of PCBs have developed cancer of the liver and biliary tract (ATSDR 2006). Epidemiological studies have associated exposure to higher chlorinated congeners with an increased risk in non-Hodgkin's lymphoma (ATSDR 2011). Studies in rats have also reported liver tumors after exposure to different Aroclors (IRIS 1996). The U.S. Department of Health and Human Services National Toxicology Program has classified PCBs as "reasonably anticipated to be human carcinogens" (NTP 2014). EPA has classified PCBs as "probably carcinogenic to humans" and has calculated an oral slope factor of 2 per milligram per kilogram per day (IRIS 1996). The International Agency for Research on Cancer (IARC) has classified PCBs as carcinogenic to humans (IARC 2016).

Conclusions

After reviewing the environmental data, DPH concludes:

> **Conclusion 1: Children who come in contact with PCBs in Reach B stream sediment and floodplain soil during recreational activities might be at risk for harmful effects. Younger children (ages 1 to 2 years) are at the most risk.** Concentrations of PCBs are elevated in Reach B soil and sediment. Estimated doses from incidental ingestion of and direct skin contact with soil exceed ATSDR's health guidelines for young persons (ages 1-21 years) visiting or playing in the area. These doses approach levels associated with immune system effects in animal studies. This poses a health concern for children ages 1

to 2 years who are assumed to have more contact with soil during the same amount of time spent in the floodplain as older children and adults. A low increased risk of cancer has been calculated with adult and childhood exposures, but only following decades of exposure, which may not be occurring at this site.

Conclusion 2: People who come in contact with PCBs in Reach C, Reach D and Lower Brier Creek stream sediment and floodplain soil during recreational activities are not expected to be at risk for harmful effects. Available soil and sediment data have been evaluated using health-protective assumptions to consider exposures to recreational users of these areas through incidental ingestion of and direct skin contact with soil and sediment. The estimated doses of PCBs from sediment and soil for children and adults who play or wade in Reach C, Reach D, and Lower Brier Creek are not expected to cause adverse non-cancer health effects or result in an elevated cancer risk.

Recommendations

The DPH recommends the:

- local health department post advisory signs in the Reach B area where the stream may be accessed to reduce the possibility of exposure to PCBs.
- local health department take steps to inform and educate local residents and businesses of potential health risks from contamination downstream of the Ward Transformer site.
- people who spend time in Reach B thoroughly wash with soap and water hands, feet, and any skin or clothing that comes in contact with the sediment or soil.
- EPA focus initial clean-up efforts on the Reach B portion of the site in order to eliminate exposure and protect human health.
- EPA continue monitoring sediment and floodplain soil in the contaminated streams yearly throughout the clean-up process to ensure people are not exposed to harmful amounts of PCBs.
- Potentially Responsible Party (PRP) and/or EPA contractors use congener analysis instead of Aroclor analysis in future sampling in order to allow for a more accurate assessment of human health risk. If this level of analysis is not feasible, we recommend the PRP or EPA analyze at least 10% of samples are analyzed for congener analysis per EPA Region 4 guidance (EPA 2013).

Public Health Action Plan

The purpose of the Public Health Action Plan is to ensure that this health consultation provides a plan of action designed to mitigate or prevent harmful exposures.

Public Health Actions Completed

1. DPH and EPA staff held a public meeting on April 18, 2017 at Triangle Christian Center in Raleigh, NC to discuss the site, answer questions, and hear comments from the community.
2. DPH staff prepared a summary factsheet that is available on the Health Assessment, Consultation & Education (HACE) program's website[7].

Public Health Actions Planned

1. DPH will continue to work with the local health department to inform and educate the local community about potential health hazards from downstream contamination at the Ward Transformer site. This will include how to reduce exposures, developing and posting signs and distributing factsheets and other health education materials.
2. DPH will continue to monitor and assess the Ward Transformer NPL site and downstream areas while EPA and/or PRP contractors collect additional data throughout the clean-up process.

[7] http://epi.publichealth.nc.gov/oee/hace/by_site.html#W

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REPORT PREPARATION

The North Carolina Department of Health and Human Services prepared this health consultation for the Ward Transformer NPL site under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). We wrote it in accordance with the approved agency methods, policies, and procedures existing at the date of publication.

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Appendix A

Map of Ward Transformer Site

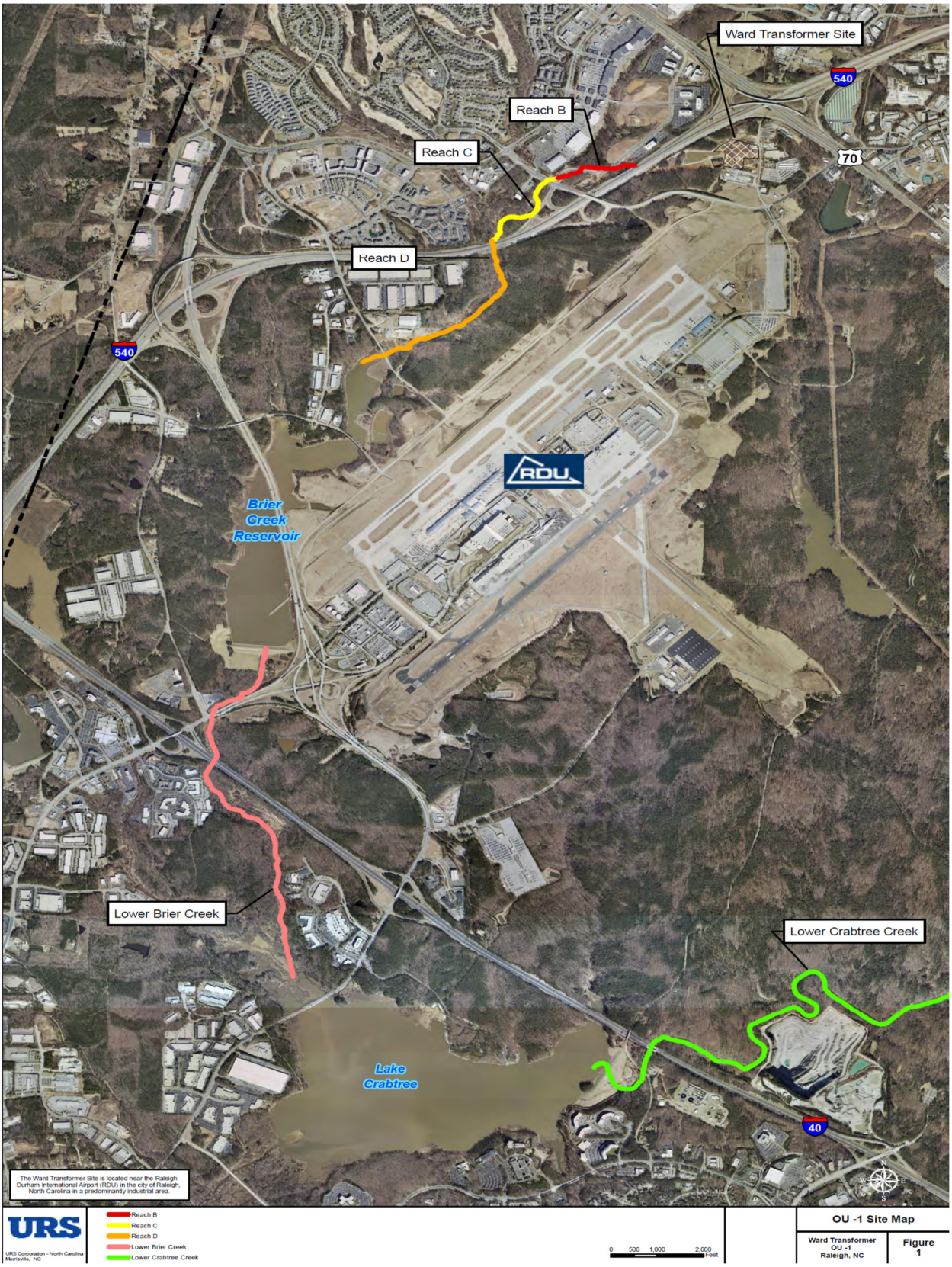

Figure 1. Map of the waters downstream from the former Ward Transformer facility (URS 2015a).

Appendix B

Tables

Table 1. Ward Transformer NPL site. Samples from ground surface to a depth of 6 inches collected between August and November 2014. Summary of sample total PCB concentrations[8] exceeding comparison values by stream section.

Reach B

Media	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV) (mg/kg)	Type of CV
Sediment	21	21	12	0.0214-7.54	0.19	CREG
Soil	22	20	18	0.0213-153	0.19	CREG

Reach C

Media	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV) (mg/kg)	Type of CV
Sediment	3	3	3	0.857-1.09	0.19	CREG
Soil	40	37	33	0.0407-2.04	0.19	CREG

Reach D

Media	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV) (mg/kg)	Type of CV
Sediment	22	22	10	0.0174J-6.41	0.19	CREG
Soil	30	26	22	0.015J-1.82	0.19	CREG

Lower Brier Creek

Media	Number of Samples	Number of Detections	No. of Detections Greater than CV	Range of Detections (mg/kg)	Comparison Values (CV) (mg/kg)	Type of CV
Sediment	6	6	4	0.134-1.37	0.19	CREG
Soil	24	23	19	0.0147J-1.68	0.19	CREG

Notes: CV = Comparison Value (ATSDR established screening value – August 2016)
CREG = Cancer Risk Evaluation Guide, ATSDR referenced value
mg/kg = milligrams contaminant per kilogram of soil
J = indicates estimated concentration

[8] Total PCBs were reported as the sum of the individual Aroclor concentrations (URS 2015b).

Table 2. Ward Transformer NPL site. Samples collected between August and November 2014. Non-cancer evaluation of combined incidental ingestion and dermal dose estimates for the maximum detected total PCB concentrations.

Reach B

Media	Calculated Maximum Ingestion Dose (mg/kg/day)	Calculated Maximum Dermal Dose (mg/kg/day)	Total Maximum Exposure Dose (mg/kg/day)	Health Guideline[9] / Type (non-cancer) (mg/kg/day)	Does total exposure dose exceed HG?
Sediment	4.7×10^{-6} (child)	8.3×10^{-7} (child)	5.5×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	3.4×10^{-7} (adult)	1.5×10^{-7} (adult)	4.8×10^{-7} (adult)		Adult NO
Soil[10]	1.9×10^{-4} (age 1-2)	1.7×10^{-5} (age 1-2)	2.1×10^{-4} (age 1-2)	2×10^{-5} ATSDR chronic oral MRL	Age 1-2 YES
	1.3×10^{-4} (age 2-6)	1.4×10^{-5} (age 2-6)	1.4×10^{-4} (age 2-6)		Age 2-6 YES
	6.8×10^{-5} (age 6-11)	1.2×10^{-5} (age 6-11)	8.0×10^{-5} (age 6-11)		Age 6-11 YES
	3.8×10^{-5} (age 11-16)	9.5×10^{-6} (age 11-16)	4.8×10^{-5} (age 11-16)		Age 11-16 YES
	3.0×10^{-5} (age 16-21)	2.9×10^{-6} (age 16-21)	3.3×10^{-5} (age 16-21)		Age 16-21 YES
	1.4×10^{-5} (age 21+)	3.0×10^{-6} (age 21+)	1.7×10^{-5} (age 21+)		Age 21+ NO

Reach C

Media	Calculated Maximum Ingestion Dose (mg/kg/day)	Calculated Maximum Dermal Dose (mg/kg/day)	Total Maximum Exposure Dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does total exposure dose exceed HG?
Sediment	1.4×10^{-6} (child)	2.4×10^{-7} (child)	1.6×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	9.7×10^{-8} (adult)	4.3×10^{-8} (adult)	1.4×10^{-7} (adult)		Adult NO
Soil	2.5×10^{-6} (child)	4.5×10^{-7} (child)	3.0×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	1.8×10^{-7} (adult)	8.1×10^{-8} (adult)	2.6×10^{-7} (adult)		Adult NO

[9] Health guideline (HG) for Aroclor 1254 was used because no health guidelines are currently available for total PCBs.
[10] Evaluation expanded for all age groups because the child dose for ages 1 to 2 years exceeded the health guideline.

Table 2 cont.

Reach D

Media	Calculated Maximum Ingestion Dose (mg/kg/day)	Calculated Maximum Dermal Dose (mg/kg/day)	Total Maximum Exposure Dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does total exposure dose exceed HG?
Sediment	4.0×10^{-6} (child)	7.1×10^{-7} (child)	4.7×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	2.9×10^{-7} (adult)	1.3×10^{-7} (adult)	4.1×10^{-7} (adult)		Adult NO
Soil	2.3×10^{-6} (child)	2.0×10^{-7} (child)	2.5×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	1.6×10^{-7} (adult)	3.6×10^{-8} (adult)	2.0×10^{-7} (adult)		Adult NO

Lower Brier Creek

Media	Calculated Maximum Ingestion Dose (mg/kg/day)	Calculated Maximum Dermal Dose (mg/kg/day)	Total Maximum Exposure Dose (mg/kg/day)	Health Guideline / Type (non-cancer) (mg/kg/day)	Does total exposure dose exceed HG?
Sediment	8.6×10^{-7} (child)	1.5×10^{-7} (child)	1.0×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	6.1×10^{-8} (adult)	2.7×10^{-8} (adult)	8.8×10^{-8} (adult)		Adult NO
Soil	2.1×10^{-6} (child)	1.9×10^{-7} (child)	2.3×10^{-6} (child)	2×10^{-5} ATSDR chronic oral MRL	Child NO
	1.5×10^{-7} (adult)	3.3×10^{-8} (adult)	1.8×10^{-7} (adult)		Adult NO

Notes: mg/kg/day = milligrams of contaminant per kilogram of body weight per day
ATSDR = Agency for Toxic Substances and Disease Registry
MRL = minimal risk level
HG = health guideline
Child dose listed is for children age 1-2 years

Table 3. Ward Transformer NPL site. Combined increased cancer risk estimates from incidental ingestion and dermal (skin) contact with soils and sediments collected between August and November 2014 based on maximum total PCB concentrations. Cancer risk calculated separately for children age 1 to 21 years and adults age 21 and older. Adult cancer risk calculated assuming a 33-year residency.

Reach B

Media	CSF $(mg/kg/day)^{-1}$	Maximum Concentration (mg/kg)	Estimated Increased Cancer Risk (cancer cases per number persons exposed)
Sediment	2	7.54	1 / million (child)
			<1 / million (adult)
Soil		153	4 / 100,000 (child)
			1 / 100,000 (adult)

Reach C

Media	CSF $(mg/kg/day)^{-1}$	Maximum Concentration (mg/kg)	Estimated Increased Cancer Risk (cancer cases per number persons exposed)
Sediment	2	1.09	<1 / million (child)
			<1 / million (adult)
Soil		2.04	<1 / million (child)
			<1 / million (adult)

Reach D

Media	CSF $(mg/kg/day)^{-1}$	Maximum Concentration (mg/kg)	Estimated Increased Cancer Risk (cancer cases per number persons exposed)
Sediment	2	6.41	<1 / million (child)
			<1 / million (adult)
Soil		1.82	<1 / million (child)
			<1 / million (adult)

Lower Brier Creek

Media	CSF $(mg/kg/day)^{-1}$	Maximum Concentration (mg/kg)	Estimated Increased Cancer Risk (cancer cases per number persons exposed)
Sediment	2	1.37	<1 / million (child)
			<1 / million (adult)
Soil		1.68	<1 / million (child)
			<1 / million (adult)

Notes: CSF = Cancer Slope Factor
mg/kg = milligrams contaminant per kilogram of soil
mg/kg/day = milligrams of contaminant per kilogram of body weight per day

Appendix C

Exposure Dose Equations and Cancer Evaluation

Exposure Dose Equations

The equations used to estimate exposure doses from exposure to sediment and floodplain soils contaminated with PCBs at the Ward Transformer NPL site are shown below. These equations can be found in the ATSDR Public Health Assessment Guidance Manual (ATSDR 2005a) or the EPA Risk Assessment Guidance for Superfund (EPA 2004). Population-specific exposure parameters (incidental ingestion rate and body weight) are consistent with ATSDR guidance (ATSDR 2014a, 2014b). Infants age 6 weeks to 1 year are not expected to be playing or wading in the stream area, therefore this assessment only evaluated exposure scenarios for people beginning at age 1 through adulthood.

Incidental ingestion of contaminants in soil and sediment

Exposure doses for ingestion of contaminants in soil and sediment are calculated using the maximum concentrations of contaminants in milligram per kilogram (mg/kg). The following equation is used to estimate the exposure doses resulting from ingestion of contaminated soil and sediment:

$$ED_s = \frac{C \times IR \times EF \times CF}{BW}$$

Where:

- ED_s = exposure dose soil and sediment (mg/kg/day)
- C = contaminant concentration (mg/kg)
- IR = intake rate of contaminated soil and sediment (mg/day)
- EF = exposure factor (unitless)
- CF = conversion factor (10^{-6} kg/mg)
- BW = body weight (kg)

The exposure factor is an expression of how often and how long a person might contact a substance in the environment. The exposure factor is calculated with the following general equation:

$$EF = \frac{F \times ED}{AT}$$

Where:

- F = frequency of exposure (days/year)
- ED = exposure duration (years) = 33-year residency (ATSDR 2014b)
- AT = averaging time (ED x 365 days/year)

The following derivation and value were used for the exposure factor for Reach B, Reach D, and Lower Brier Creek based on these sections flowing through industrial/commercial areas and it is not expected these areas would be frequented often by recreational users.

$$F = \frac{1\ day}{week} \times \frac{4.33\ weeks}{month} \times \frac{6\ months}{year} = \frac{25.98\ days}{year}$$

$$EF = \frac{\frac{25.98\ days}{year} \times 33\ \text{years}}{33\ years\ x\ \frac{365\ days}{year}} = 0.0711$$

The following derivation and value were used for the exposure factor for Reach C. This section flows through a residential area and recreational users might frequent this area more often than they would streams in industrial areas.

$$F = \frac{2\ days}{week} \text{ x } \frac{4.33\ weeks}{month} \text{ x } \frac{6\ months}{year} = \frac{51.96\ days}{year}$$

$$EF = \frac{\frac{51.96\ days}{year} \text{ x } 33 \text{ years}}{33\ years\ x\ \frac{365\ days}{year}} = 0.142$$

A 6-month timeframe was used for the annual dose, as it is not expected that persons would play or wade in the stream areas during the fall and winter months.

Note: For this assessment, the following values were used to estimate ingestion doses. Sediment ingestion rates are half the soil ingestion rates as the streams are not located near residences and sediment is not likely to be tracked into the home and become dust. In addition, soil ingestion rates are expected to be higher because soil is more accessible than sediment, which is submerged in the stream water.

Age Range	95th percentile soil ingestion rate (mg/day)	95th percentile sediment ingestion rate (mg/day)	Body Weight (kg)
1 to <2 years	200	100	11.4
2 to <6 years	200	100	17.4
6 to <11 years	200	100	31.8
11 to <16 years	200	100	56.8
16 to <21 years	200	100	71.6
21+ years	100	50	80.0

Notes: mg/day = milligrams of soil per day
kg = kilograms

Dermal (skin) contact with contaminants in soil and sediment

Exposure doses for dermal contact with contaminants in soil and sediment are calculated using the maximum concentrations of contaminants in milligram per kilogram (mg/kg). The following equation is used to estimate the exposure doses resulting from dermal contact with contaminated soil and sediment (EPA 2004):

$$DAD_s = \frac{C \text{ x } CF \text{ x } AF \text{ x } ABS_d \text{ x } EF \text{ x } SA}{BW}$$

Where:

DAD_s = dermal absorbed dose soil or sediment (mg/kg/day)
C = contaminant concentration (mg/kg)
CF = conversion factor (10^{-6} kg/mg)
AF = adherence factor of soil or sediment to skin (mg/cm^2/event)
ABS_d = dermal absorption factor (unitless)
EF = exposure factor (unitless)

SA = skin surface area (cm^2)
BW = body weight (kg)

The exposure factor is an expression of how often and how long a person might contact a substance in the environment. The same exposure factor equations and values were used for dermal contact as were used for ingestion (see above).

Note: For this assessment, the following values were used to estimate dermal absorbed doses:

Age Range (years)	Adherence factor (mg/cm^2/event)	Dermal Absorption factor	Skin surface area (cm^2)*	Body Weight (kg)
1 to <2	0.2	0.14	630	11.4
2 to <6	0.2	0.14	811	17.4
6 to <11	0.2	0.14	1240	31.8
11 to <16	0.2	0.14	1770	56.8
16 to <21	0.2	0.14	1950	71.6
21+	0.07	0.14	2275	80.0

Notes:
mg/cm^2/event = milligrams of PCB per square centimeter of skin per contact event with soil or sediment
cm^2 = square centimeter of skin available for contact with soil or sediment
kg = kilograms
*The skin surface area used is the sum of the surface area of the hands and feet as these would be expected to come in contact with soil and sediment

Cancer Health Effect Evaluation

Theoretical increased numbers of cancers are calculated for known or suspected cancer-causing contaminants using the estimated site-specific exposure dose and cancer slope factor (CSF) provided in ATSDR health guideline documents. DPH evaluates cancer health effects in terms of possible increased cancer risk over background levels. In North Carolina, approximately 30% of women and 50% of men (about 40% combined), will be diagnosed with cancer in their lifetime from a variety of causes. This is referred to as the "background cancer risk". The term "excess cancer risk" represents the risk on top of the background cancer risk. A "one-in-a-million" excess cancer risk (1/1,000,000 or 10^{-6} cancer risk) means that if 1 million people are exposed to the cancer-causing substance at a certain level every day of their lifetime (considered 78 years), then one cancer above the background number of cancers might develop in those 1 million people. In numerical terms, the background number of cancers expected in 1 million people over their life-time is 40% or 400,000. If they are all exposed to the cancer-causing substance daily throughout their life-time, then 400,001 people might get cancer, instead of the expected 400,000. The expression of the estimated cancer risk is not a prediction that cancer will occur, it represents the upper bound estimate of the probability of additional cancers, and merely suggests that there is a possibility. The actual risk might be much lower, or even no risk.

The estimated cancer risk calculation is:

Estimated Cancer Risk = Dose x CSF

Where:

Estimated cancer risk = Expression of the cancer risk (unitless)
Dose = Site-specific dose of carcinogen (mg/kg/day)
CSF = Cancer Slope Factor ($[mg/kg/day]^{-1}$), a measure of cancer potency

This calculation is based on the assumption that there is no safe level of exposure to a chemical that causes cancer. However, the calculated risk estimate is not exact and tends to overestimate the actual risk associated with exposures that may have occurred. This increased cancer risk estimate does not equal the increased number of cancer cases that will actually occur in the exposed population, but estimates an excess cancer risk expressed as the proportion of a population that might be affected by a carcinogen during a lifetime or other selected period of exposure.

For specific exposure situations DPH may use exposure periods of less than a lifetime to provide a more realistic estimation of the risks that are known or predicted to have occurred for a particular area. If information on the specifics of the exposure situations at a particular site is not known, then DPH will always use health protective values to estimate the maximum level of risk that we believe to be realistic. For the Ward Transformer NPL site, child cancer risk (age 1 to 21 years) and adult cancer risk (age 21 years and older) were evaluated separately as people are not expected to be recreating in the area from childhood through adulthood. For adults, a 33-year residency was used to calculate cancer risk based on ATSDR guidelines (ATSDR 2014b). Increased cancer risk was calculated separately for ingestion and dermal exposure and then added together to derive the combined increased cancer risk. The EPA Integrated Risk Information System (IRIS) recommends using the oral cancer slope factor (2 $[mg/kg/day]^{-1}$) for dermal exposures when an absorption factor is applied (IRS 1996). This cancer slope factor was used to calculate the combined increased cancer risk from incidental ingestion and dermal (skin) contact with PCBs at the Ward Transformer NPL site.